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Neighborhood Mobility and Unmet Physical Activity Need in Old Age: a Two-Year Follow-Up

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Running head: Mobility and unmet physical activity need

Abstract

Background: Many older people report willingness to increase outdoor physical activity (PA), but no opportunities for it, a situation termed as unmet PA need. We studied whether lower neighborhood mobility and PA precede the development of unmet PA need.

Methods: Community-dwelling 75-90-year-old people (n=700) were interviewed annually for two years. Unmet PA need, neighborhood mobility and PA were self-reported. Additionally, accelerometer-based step counts were assessed among a subgroup (n=156).

Results: Logistic regression analyses revealed that lower baseline neighborhood mobility (OR 3.02, 95% CI 1.86-4.90 vs. daily) and PA (OR 4.37, CI 2.62-7.29 vs. high) were associated with the development of unmet PA need over two years. Participants with higher step counts had lower risk for unmet PA need (OR 0.68, CI 0.54-0.87).

Conclusion: Maintaining higher PA levels and finding solutions for daily outdoor mobility especially for those with declines in health may protect from the development of unmet PA need.

Keywords: Aging, Outdoor mobility, Physical function

Many older people report that they would like to be more physically active but do not have an opportunity for that (Eronen et al., 2014; Rantakokko et al., 2010), which is a situation that is termed unmet physical activity need (Rantakokko et al., 2010). Those experiencing unmet PA need are motivated to increase PA, but may need support in PA participation, and thus, may form a fruitful target group for PA interventions (Rantakokko et al., 2010).

According to previous studies unmet PA need is more common among older people with musculoskeletal diseases and depressive symptoms (Rantakokko et al., 2010), and accumulation of risk factors including lower socioeconomic status, poorer health and mobility limitations increase the risk for the development of unmet PA need (Eronen, von Bonsdorff, Rantakokko, & Rantanen, 2012). An earlier study showed that older people experiencing unmet PA need are more likely to be physically inactive, but inactive older people do not always report unmet PA need (Eronen et al., 2012). Physical inactivity can be defined as not performing sufficient amount of PA i.e. not meeting the respective PA guidelines (Barnes et al., 2012). Unmet PA need describes the willingness and perceived opportunities for PA, not the actual amount of PA, and it is therefore conceptually different from physical inactivity. Furthermore, unmet PA need seems to be more common among those whose PA has recently reduced (Rantakokko et al., 2010). It has been suggested that unmet PA need is transient and older people adjust to lower levels of PA if opportunities for PA participation are not improved (Rantakokko et al., 2010). Many reasons may contribute to older people's perceived opportunities for PA participation including physical limitations, competing interests or difficulties accessing exercise facilities (Franco et al., 2015). The role of PA in the development of unmet PA need remains unclear and studies on whether lower levels of PA predict the development of unmet PA need over time are lacking.

The amount of PA tends to decrease with advancing age (DiPietro, 2001; Schrack et al., 2013). The most popular form of physical activity among older people is walking (Lim & Taylor, 2005). Walking is physical exercise but is also an essential part of transportation in terms that reaching public transportation or car often requires walking at least short distances (Rantanen, 2013). On days that older people stay inside or in the immediate vicinity of their homes, PA level remains low and it starts to increase as people move further away even if they use motorized transportation (Portegijs, Tsai, Rantanen, & Rantakokko, 2015). Previous findings show that going outdoors into the neighborhood at least once a week can help maintaining physical function among frail older people (Shimada et al., 2010), but going outdoors daily increases the probability of positive health outcomes even further (Jacobs et al., 2008).

We studied whether lower levels of self-reported PA, accelerometer-based step counts and lower frequency of neighborhood mobility were associated with the development of unmet PA need over a two-year follow-up period among community-dwelling older people. These assessment methods complemented each other and provided a more comprehensive picture of participants' PA level. Furthermore, we studied whether a recent reduction in PA and frequency of neighborhood mobility were associated with the development of unmet PA need.

Methods

The study is part of a larger two-year prospective cohort study of 75-90-year-old community-dwelling older adults conducted between years 2012-2014. Participants were recruited from a random sample (N=2550) drawn from the national population register based on age and place of residence. Of the initial sample, 848 were found eligible based on inclusion criteria (willingness to participate, living independently in the recruitment area, ability to communicate) (Rantanen et al., 2012). At baseline, participants were interviewed at their

homes. Of them, 816 of them participated in the one-year follow-up and 761 in the two-year follow-up conducted by phone (Rantakokko et al., 2016). In addition, a subgroup (n=174) wore accelerometers for 7 consecutive days at baseline. In the current analyses we included 700 people who did not have unmet PA need at baseline and who had data on unmet PA need at least on one of the follow-ups (accelerometer substudy n=156). The study has been approved by the Ethical Committee of the University of Jyväskylä. All participants were informed about the study and signed a written informed consent.

Unmet PA need

Unmet PA need was assessed at baseline, and one-year and two-year follow-ups with two questions: "Do you feel that you would have the opportunity to increase your level of outdoor PA if someone recommended you do so?" and "Would you like to increase your level of outdoor PA?". The response options were "yes" or "no". Participants, who reported that they wanted to increase their PA level, but perceived no opportunity to do so, at least at one of the follow-ups, were defined as those who developed unmet PA need (Rantakokko et al., 2010). Participants were then categorized into those who had developed unmet PA need over the follow-up and those who had not.

Self-reported PA level

Self-reported level of PA was assessed at baseline and the one-year follow-up with a modified version of a single-item scale (Grimby, 1986). The scale has been validated and found to correlate well with accelerometer-based measures of PA (Portegijs, Sipilä, Viljanen, Rantakokko, & Rantanen, 2017). The scale assesses the frequency and intensity of PA and has seven response options (mostly resting, mostly sitting, light PA, moderate PA about 3 h a week, moderate PA at least 4 h a week or heavier PA up to 4 h per week, engaging in active sports several times a week, participating in competitive sports). Reduction of PA level was assessed between baseline and the one-year follow-up. Those who reported less PA at one-

year follow-up than at baseline, were considered to have reduced their PA level (reduced PA level vs. no change or increased PA). For all other analyses PA was categorized into low activity (light PA at most), moderate activity (at most three hours per week of moderate activity) and high activity (at least four hours of moderate activity per week) (Portegijs et al., 2017).

Frequency of neighborhood mobility

Frequency of neighborhood mobility was assessed at baseline and during the follow-up with a question extracted from the University of Alabama at Birmingham Study of Aging Life-Space Assessment (LSA) questionnaire (Baker, Bodner, & Allman, 2003). Participants were asked to report how often they went out into their neighborhood (other than own yard or apartment building) during the past four weeks (daily, 4-6 times per week, 1-3 times per week and less than weekly). Reduction in the frequency of neighborhood mobility was assessed between baseline and the one-year follow-up. Participants, who reported less frequent neighborhood mobility at one-year follow-up than at baseline, were considered to have reduced neighborhood mobility (reduced vs. no change or increased). For all other analyses, response options were categorized into "3 times per week or less", "4-6 times per week" and "daily".

Accelerometer-based PA

At baseline, a subgroup of participants wore a tri-axial accelerometer (Hookie AM20 Activity Meter, Hookie Technologies Ltd, Espoo, Finland) on their right hip on their waking hours except when bathing or during other water-related activities for 7 consecutive days following the home interview. They were encouraged to maintain their normal daily routines during the measurement period. Participants were instructed to report their daily accelerometer wear time, including any potential breaks from wearing the accelerometer, into an activity diary (Rantanen et al., 2012).

From the accelerometer data, we used average daily step counts to describe participants' physical activity. We used defaults settings provided by the manufacturer for thresholds and formulas for calculating step counts. Average step counts were then calculated by dividing the total step counts by the number of valid days of measurement. A day was considered valid when at least 10 hours of wear time was reported. Participants who had at least four valid accelerometer days with no more than one day between consecutive valid days of measurement were included in the analyses (Tsai, L. T. et al., 2016).

Covariates

All covariates were assessed at baseline. Lower extremity performance was measured with the Short Physical Performance Battery (SPPB) (Guralnik et al., 1994) which includes tests of balance, walking speed and chair stands. The scale has a range from 0 to 12 with higher scores indicating better physical performance. Depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale (CES-D, range 0-60; higher scores indicate more depressive symptoms) (Radloff, 1977). Years of education was self-reported. Number of chronic diseases was self-reported and measured using a list of 22 common chronic diseases (Portegijs, Rantakokko, Mikkola, Viljanen, & Rantanen, 2014). Additional open-ended questions were included where participants could report any other physician diagnosed diseases.

Statistical methods

Participants' baseline characteristics were described using means with standard deviations or percentages. Medians with interquartile ranges were reported for average step counts among the subgroup who wore accelerometers. Group differences between those who developed unmet PA need over the follow-up and those who did not, were tested with Mann-Whitney U-test (continuous variables) and chi-square tests (categorical variables). Binary logistic regression analyses were performed to study the associations of baseline mobility and

PA variables with the development of unmet PA need over the two-year follow-up. In the analyses, participants with high PA level were set as the reference group. In addition, logistic regression analyses were performed to study whether reductions in self-reported PA and neighborhood mobility were associated with the development of unmet PA need at one- or two-year follow-up. In these analyses, participants who did not have reductions in their level of PA or neighborhood mobility formed the reference group. All models were adjusted first for age and sex, and then SPPB score, CES-D score, number of chronic diseases and years of education were added separately. Finally, a fully adjusted model was formed. In all models that included accelerometer data, accelerometer wear time was adjusted for. Models that included reduction of PA or frequency of neighborhood mobility were additionally adjusted for PA level or frequency of neighborhood mobility at baseline.

The data were analyzed using IBM SPSS Statistics 24 for Windows (IBM Corp, Armonk, NY, USA). The results were considered statistically significant when P-value was <0.050 or when 95% confidence intervals did not include 1.

Results

Baseline characteristics of the participants are presented in Table 1. Participants who developed unmet PA need over follow-up were older (p=0.002), more likely to be women (p=0.020) and had less years of education (p=0.007) when compared to participants without unmet PA need. Furthermore, they were physically less active (p<0.001) and had poorer lower extremity function (p<0.001), lower frequency of neighborhood mobility (p<0.001), more depressive symptoms (p<0.001), and more chronic diseases (p<0.001).

PA level, frequency of neighborhood mobility, step counts and the development of unmet PA need

Results of logistic regression analyses are presented in table 2. Participants with low baseline PA level had four-fold age- and sex-adjusted odds for developing unmet PA need

on the two-year follow-up period when compared to those who engaged in high levels of PA (OR 4.37, 95% CI 2.62-7.29). For participants who engaged in moderate PA at baseline, the age- and sex-adjusted odds for developing unmet PA need over two-year follow-up were nearly double compared to those with high PA levels (OR 1.89, 95% CI 1.10-3.23). After adjusting for other covariates, low PA level (OR 2.41, 95% CI 1.38-4.21), but not moderate (OR 1.62, 95% CI 0.93-2.82), remained statistically significantly associated with the development of unmet PA need (Table 2).

Participants, who went out into the neighborhood 3 times per week or less at baseline, had three-fold odds for the development of unmet PA need compared to those who went out daily, when adjusted for age and sex (OR 3.02, 95% CI 1.86-4.90). When adjusted further for other covariates, the association attenuated (OR 1.67, 95% CI 0.98-2.85). The age- and sex-adjusted odds were nearly double for those who went out into the neighborhood 4-6 times per week at baseline when compared to those who did so daily (OR 1.67, 95% CI 1.05-2.65). However, the association did not remain statistically significant when adjusting further for chronic diseases and depressive symptoms (Table 2).

Among the subgroup who wore accelerometers, participants who had higher average step counts at baseline had lower odds for the development of unmet PA need over the two-year follow-up period when adjusted for age, sex and average accelerometer wear time (OR 0.68, 95% CI 0.54-0.87 per 1000 step increase). The association remained statistically significant after adjusting further for SPPB score and CES-D score, chronic diseases and years of education (OR 0.74, 95% CI 0.58-0.95, Table 2).

Reductions in PA, neighborhood mobility and the development of unmet PA need

The odds for the development of unmet PA need were three-fold for those who had reduced PA compared to those with no change or an increase when adjusted for age, sex and baseline PA level (OR 3.10, 95% CI 1.79-5.34). The association remained statistically

significant after adjusting further for SPPB score, CES-D score, chronic diseases and years of education (OR 2.57, 95% CI 1.46-4.51, Table 2).

For participants who had reduced the frequency of going outdoors into the neighborhood, the odds for the development of unmet PA need were double when adjusted for age, sex and baseline frequency of neighborhood mobility and compared to those with no reduction (OR 2.06, 95% CI 1.31-3.24). The association did not markedly change after adding SPPB score, CES-D score, chronic diseases and years of education into the model (OR 1.95, 95% CI 1.21-3.15).

Discussion

Lower levels of PA, going out into the neighborhood less frequently and lower step count precede the development of unmet PA need. PA is considered a valued activity that can help older people to maintain their health and independence (Franco et al., 2015) as well as support satisfying basic psychological needs (Springer, Lamborn, & Pollard, 2013). The findings expand the current knowledge by providing a more comprehensive picture about the relationship between PA and unmet PA need among community-dwelling older people.

Inactivity is a known risk factor for health decline and thus, it is possible that declines in participants' health explain the observed associations. Although we adjusted the analyses for various health factors, we were only able to account for these at baseline and did not have the possibility to evaluate the severity of the diseases that participants reported. Engaging in PA (Paterson & Warburton, 2010) and daily outdoor mobility (Jacobs et al., 2008) reduce the risk for functional limitations in old age. Low levels of PA can accelerate functional decline and lead to mobility difficulties, a known risk factor for unmet PA need (Eronen et al., 2014). Depressive symptoms are also more likely to be reported by inactive older people (Lindwall, Rennemark, Halling, Berglund, & Hassman, 2007) and are known to coincide with unmet PA need (Rantakokko et al., 2010). Furthermore, older people who are physically less

active and go out less frequently may be unaware of opportunities for PA and thus, may be more likely to stay indoors as their health declines.

In line with earlier findings (Rantakokko et al., 2010), the present findings suggest that unmet PA need is more likely to develop for older adults with recently reduced PA level. This indicates that the will to be physically active remains despite decreased level of PA. Decreasing PA participation is often not a choice, but different barriers of PA, including poor health, mobility and environment-related barriers, may appear with advancing age and increase the risk for unmet PA need (Eronen et al., 2014). Furthermore, lower available energy and fatigability are associated with lower PA levels (Schrager, Schrack, Simonsick, & Ferrucci, 2014; Wanigatunga et al., 2018). Lack of energy may hinder older people's opportunities for PA participation, and for many activities the time getting ready and to reach the location may require more time and energy than they are willing to spare (Devereux-Fitzgerald, Powell, & French, 2018). As previously suggested, unmet PA need may be transient and experienced for some time after a reduction of PA (Rantakokko et al., 2010). If opportunities for PA participation are not improved, people may adapt to the situation and the will to be more physically active can be diminished, thus leaving PA levels permanently low. A recent study showed that adopting adaptive walking modifications while walking longer distances, such as using assistive device or stopping to rest, can help maintain outdoor mobility and prevent unmet PA need (Skantz et al., 2019). Encouraging the use of adaptive strategies to continue participation in outdoor PA could help alleviate unmet PA need.

Going outdoors is often a prerequisite for participation in physical activities and for many older people PA accumulates while attending to activities that require going outdoors, such as shopping and walking for exercise (Tsai, Li-Tang et al., 2016). We found that lower frequency of neighborhood mobility at baseline was associated with increased odds for the development of unmet PA over the follow-up period. This association was explained by

differences in health at baseline. Environmental barriers near the home entrance may hinder older people's opportunities to go outdoors especially among those with declined lower extremity function (Portegijs, Rantakokko, Viljanen, Rantanen, & Iwarsson, 2017). Reducing environmental barriers may help older people with declining physical function to maintain daily outdoor mobility and protect from the development of unmet PA need.

The strengths of the current study include a relatively large population-based sample of community-dwelling older adults and the longitudinal study setting that allowed for a study the development of unmet PA need over time. A further strength was the availability of both self-reported and accelerometer-based PA data. These assessment methods complemented each other and provided a more comprehensive picture of PA level in our study sample. Self-reported PA level captures intensity and frequency of PA, including household chores that may not typically be seen as PA. Frequency of going outdoors into the neighborhood reflects older people's PA, even though it is not perceived as PA per se. Accelerometers provide a more objective way of measuring PA and capture activities that people may have trouble recalling.

The study also has its limitations. First, reduction in self-reported PA and the incidence of unmet PA need was measured at the same time point for 25 participants, and reduction of neighborhood mobility and the incidence of unmet PA need for 29 participants. Although it is probable that the reductions in PA or neighborhood mobility happened prior the development of unmet PA need, we cannot rule out the possibility of this being the other way around. Second, although we adjusted the analyses for chronic diseases, lower extremity performance and depressive symptoms, we were only able to account for these at baseline. Thus, we cannot confirm whether changes in participants' health explain the observed associations. Third, as in many studies targeting the aging population, it is possible that the results are affected by selective mortality which causes changes to the aging cohorts (Zajacova

& Burgard, 2013). The drop-out rate by the second follow-up was 10%, and those with poorer health were more likely to have died or dropped out of the study.

Conclusions

The findings show that older people with relatively inactive lifestyle are at higher risk for developing unmet PA need over time. Thus, providing opportunities and supporting equal opportunities for PA participation is especially important for older people who are physically less active. Similarly, maintaining higher PA levels and finding solutions for maintaining daily outdoor mobility, especially for those with declines in health, may protect from the development of unmet PA need over time. Overall, older adults with unmet PA need form an important target group for PA interventions as they are already motivated to increase their level of PA but may need special support in PA participation. Given the many health benefits of PA, equal opportunities for PA participation should be secured for everyone, despite age and declines in health and function.

Acknowledgments

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Table 1. Baseline characteristics of the participants according to the development of unmet PA need over the follow-up

	Development of unmet PA need		
	Yes (n=139)	No (n=561)	P-value[a]
	% (f)	% (f)	
Women	69 (96)	58 (327)	**0.020**
PA level			**<0.001**
low	53 (74)	25 (139)	
moderate	28 (39)	32 (180)	
high	19 (26)	43 (242)	
Neighborhood mobility			**<0.001**
3 times or less	36 (50)	18 (98)	
4-6 times	34 (47)	31 (175)	
daily	30 (42)	51 (287)	
	Mean (SD)	Mean (SD)	P-value[b]
Age	81.27 (4.21)	80.04 (4.13)	**0.002**
Years of education	9.10 (4.43)	9.86 (4.18)	**0.007**
Number of chronic diseases	5.20 (2.46)	3.94 (2.26)	**<0.001**
SPPB score	8.60 (2.77)	10.20 (1.94)	**<0.001**
CES-D score	11.83 (7.57)	8.56 (6.14)	**<0.001**
	Development of unmet PA need among accelerometer subgroup		
	Yes (n=34)	No (n=122)	
	Median (IQR)	Median (IQR)	P-value[b]
Average daily step count	1125.50 (1760.55)	2737.07 (3096.05)	**<0.001**

[a]Chi-square test [b]Mann-Whitney U-test

SD=Standard Deviation, IQR=Interquartile Range, CES-D=Center for Epidemiologic Studies Depression Scale, SPPB=Short Physical Performance Battery

Table 2. The association of self-reported PA level, neighborhood mobility and average step counts with the development of unmet PA need over two years among those without unmet PA need at baseline

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)	Model 6 OR (95% CI)
Development of Unmet PA need (n=700)						
Physical activity level						
low vs. high	**4.37 (2.62-7.29)**	**2.81 (1.63-4.86)**	**3.93 (2.34-6.60)**	**3.61 (2.14-6.10)**	**4.27 (2.56-7.14)**	**2.41 (1.38-4.21)**
moderate vs. high	**1.89 (1.10-3.23)**	1.67 (0.97-2.89)	**1.77 (1.03-3.05)**	**1.83 (1.07-3.15)**	**1.89 (1.11-3.25)**	1.62 (0.93-2.82)
Neighborhood mobility						
3 times or less vs. daily	**3.02 (1.86-4.90)**	**1.98 (1.18-3.33)**	**2.68 (1.64-4.37)**	**2.48 (1.51-4.07)**	**2.94 (1.81-4.78)**	1.67 (0.98-2.85)
4-6 times vs. daily	**1.67 (1.05-2.65)**	**1.60 (1.00-2.58)**	1.55 (0.97-2.49)	1.51 (0.94-2.43)	**1.62 (1.02-2.59)**	1.42 (0.87-2.31)
Reduction in PA level vs. no change/increase[a]	**3.10 (1.79-5.34)**	**2.79 (1.60-4.88)**	**2.81 (1.62-4.86)**	**2.95 (1.70-5.11)**	**3.13 (1.81-5.40)**	**2.57 (1.46-4.51)**
Reduction in neighborhood mobility vs. no change/increase[b]	**2.06 (1.31-3.24)**	**1.98 (1.24-3.17)**	**2.02 (1.27-3.20)**	**1.97 (1.24-3.12)**	**2.09 (1.33-3.30)**	**1.95 (1.21-3.15)**
Development of Unmet PA need among subgroup (n= 152)*						
Average step count[c]	**0.68 (0.54-0.87)**	**0.73 (0.57-0.94)**	**0.69 (0.54-0.88)**	**0.69 (0.54-0.88)**	**0.69 (0.54-0.88)**	**0.74 (0.58-0.95)**

Note. Statistically significant values are bolded. Model 1 adjusted for age and sex, Model 2 adjusted for age, sex and SPPB score, Model 3 adjusted for age, sex and CES-D score, Model 4 adjusted for age, sex and number of chronic diseases, Model 5 adjusted for age, sex and years of education, Model 6 adjusted for age, sex, SPPB score and CES-D score, number of chronic diseases and years of education

* OR per 1000 step increase

[a] Adjusted for baseline PA level

[b] Adjusted for baseline frequency of neighborhood mobility

[c] Adjusted for accelerometer wear time