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Do mobility, cognitive functioning, and depressive symptoms mediate the association between social activity and mortality risk among older men and women?

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Abstract

Background: Social activity and health correlate in old age, but less is known about what explains this association. The aim of this study was to investigate whether mobility, cognitive functioning, and depressive symptoms mediate the association between social activity and mortality risk, or whether they alternatively should be considered as prerequisites for social activity in older Finnish men and women.

Methods: In 1988, 406 men and 775 women aged 65-84-years took part in face-to-face interviews about their health, socioeconomic status, and social activities. Confirmatory factor analyses were used to form latent variables describing collective and productive social activity. Latent variable models were used to investigate the possible pathways between social activity, mobility, cognitive functioning, depressive symptoms, and mortality risk.

Results: In the 21-year follow-up, 89% of men and 81% of women had died. Collective and productive social activity correlated with a lower risk for mortality among men and women. Part of the association between social activity and mortality was mediated by mobility. Cognitive functioning and depressive symptoms were not mediators in the association. Instead, good cognitive functioning and having less depressive symptoms were prerequisites for participating in collective social activity among men and women. Among men, good cognitive functioning, and among women, good cognitive functioning and having less depressive symptoms were prerequisites for productive social activity.

Conclusion: The health-enhancing influences of social activity may be partly explained by better mobility among persons who are socially active. Moreover, social activity may maintain mobility and thus decrease mortality risk, as many social activities also include physical activity. Better cognitive functioning and having less depressive symptoms should be considered as prerequisites for participating in social activities.

Keywords: Interpersonal relations, mortality, mobility limitation, cognition, ageing

INTRODUCTION

Social connections and interaction are important parts of everyday life of older people as they may generate well-being (Chappell and Badger 1989) and enable receiving and giving social support even after the health begins to decline (Penninx et al 1999). The social aspect is included in various leisure activities (hobbies), because they provide opportunities to form social connections and meet friends and acquaintances. Social activity has often been investigated as a combined measure including activities such as attending cultural and sporting events, religious services, organizational activities, going on trips, participation in social groups, visiting relatives and friends, doing voluntary work, and helping other people (e.g. (Krueger et al., 2009). Social activity has also been investigated as an interaction occurring in informal (such as telephone contact and getting together with family members, relatives, friends, and neighbours) and formal (e.g. meeting attendance, religious participation, volunteer work) contexts (Utz, Carr, Nesse, & Wortman, 2002). While the area of research on social activity and its influence on health have received considerable attention, there is still little consensus on the relevant constructs (Mendes de Leon, 2005). Distinctions between relevant constructs involve content, context, and consequences for the individual.

Based on the content and context of the activity, prerequisites required for participation, and consequences for the society, social activity has been conceptually divided into collective, productive, and political social participation (Bukov, Maas, & Lampert, 2002). In this paper our focus is only on the collective and productive aspects of the conceptual model. When participating in collective social activity, a person gives his/her time and acts together with other people. This kind of activity can also be seen as personal involvement in the community, in which the individual is more concerned with his or her own development and well-being (Broese van Groenou & Deeg, 2010). Productive social activity occurs when a person gives his/her time and is doing something for the well-being of another person or for common good. Doing volunteer work and helping others are examples of productive social activity (Bukov et al., 2002).

Also consequences for the person him/herself may vary depending on the type of the activity. Collective social activity includes leisure activities which are usually carried out in a context offering opportunities for socializing, interaction, and sharing experiences (Mannell & Kleiber, 1997), and function as a source of emotional support. Thus, collective social activity may enable interaction which provides a feeling of being liked, trusted and accepted, understood, provide the experience that others like to be either emotionally or physically close to him/her, and thus satisfy the social need of affection (Steverink & Lindenberg, 2006). As a consequence, a person may also undergo experiences of mattering (Taylor & Turner, 2001) and a sense of belonging to a group with whom one shares common interests and social activities (Mancini & Blieszner, 1992). Productive social activity may give feelings of doing good things, doing things well, being a good person, being useful, contributing to a common goal, and being part of a functional group, and thus satisfy the need of behavioural confirmation (Steverink & Lindenberg, 2006). Productive activity may also generate reassurance of worth, i.e. a sense of competence and esteem, and give an opportunity for nurturance which refers to being responsible for care of others (Weiss, 1973). Studies on distinct consequences of collective and productive social activities on cognitive functioning and mobility are rare, but it is conceivable that each type of activity includes both cognitive and physical stimulation and thus enhances cognitive functioning and mobility of older people.

Fulfilment of the above mentioned psychosocial or social needs may maintain and improve health of older people. The study by Penninx and colleagues (1997) showed that those who received emotional support and were not feeling lonely had reduced mortality risk. Mattering to others may decrease depressive symptoms (Taylor & Turner, 2001) which have been found to be associated with mortality in old age (Almeida, Alfonso, Hankey, & Flicker, 2010; Sun, Schooling, Chan, Ho, & Lam, 2010). Greater feelings of usefulness and mastery are associated with lower mortality risk in older adults (Gruenewald, Karlamangla, Greendale, Singer, & Seeman, 2007; Gruenewald, Karlamangla, Greendale, Singer, & Seeman, 2009; Penninx et al., 1997). Self-efficacy may prevent worsening of functional ability (Mendes de Leon, Seeman, Baker, Richardson, & Tinetti, 1996) which in turn is a risk factor for mortality (Miller & Weissert, 2000).

In all, we expected that collective and productive social activities represent different dimensions of social activity, because the resources people give when participating in these activities, their orientation towards them, and the needs met by participation in them differ. We expected that activities such as visiting cultural activities, acting in organizations, dancing, and travelling are usually carried out in a context offering opportunities for socializing, interaction, and sharing experiences. Thus, these activities may be included into collective social activity. We expected that when people help others they give their time, use their capabilities, do good things, and may feel useful and needed. Thus helping others can be included into productive social activity. Furthermore, we expected that collective and productive social activities are associated with mortality risk, but that they may influence health through different pathways.

Many studies among older people have shown that social activity correlates with health outcomes such as survival (e.g. (Brown, Nesse, Vinokur, & Smith, 2003; Sabin, 1993; Seeman, 2000; Walter-Ginzburg, Blumstein, Chetrit, & Modan, 2002). However, less is known about the factors which underlie the association between social activity and mortality risk. Results of earlier discussed psychosocial factors give some clues, but how about important health-related factors? Based on previous results, we included three mediator candidates of health status in our models: mobility, cognitive functioning, and depressive symptoms. Each factor is tied to everyday life practices, and decline in them threatens independence and presents challenges to the health care system. A mediation model may be used to better understand the association between social activity and mortality.

Results from longitudinal studies show that more frequent participation in social activities decreases the risk for developing mobility disability (Avlund, Vass, & Hendriksen, 2003; Avlund, Lund, Holstein, & Due, 2004; James, Boyle, Buchman, & Bennett, 2011). Mendes de Leon and colleagues (Mendes de Leon, Glass, & Berkman, 2003) found that there was a strong cross-sectional association between social activity and better mobility and that the longitudinal protective effect of social activity diminished slowly over time. Mobility impairments, in turn, predict mortality risk (Guralnik & Ferrucci, 2003; Hirvensalo, Rantanen, & Heikkinen, 2000). Higher levels of social activity also predict better cognitive functioning

(e.g. (Barnes, Mendes de Leon, Wilson, Bienias, & Evans, 2004; Bassuk, Glass, & Berkman, 1999; Beland, Zunzunegui, Alvarado, Otero, & Del Ser, 2005; Krueger et al., 2009; Zunzunegui, Alvarado, Del Ser, & Otero, 2003), although the results have not been consistent across studies (Aartsen, Smits, van Tilburg, Knipscheer, & Deeg, 2002). Social or productive participation may also delay arising depressive symptoms among those not depressed at baseline (Glass, Mendes de Leon, Bassuk, & Berkman, 2006; Wahrendorf, Ribet, Zins, & Siegrist, 2008). Cognitive impairment (Lavery, Dodge, Snitz, & Ganguli, 2009; Sampson, Bulpitt, & Fletcher, 2009; Wilson et al., 2009) and depression (Almeida et al., 2010; Almeida et al., 2010; Sun et al., 2010), in turn, have been found to predict mortality risk in old age. Consequently, it is possible that participation in social activities maintains better mobility and cognitive functions, and prevents increase in depressive symptoms of the participants.

On the other hand, it is possible that better mobility and cognitive functioning and having less depressive symptoms are prerequisites for participating in social activities. In general, the onset of health problems was a major reason for reduction in social participation in old age (Bukov et al., 2002). There is some evidence that cognitive decline may affect the social network. Aartsen and colleagues ((Aartsen, van Tilburg, Smits, & Knipscheer, 2004) found that cognitive decline was associated with loss of relationships, most likely friends and neighbours. Although previous participation in leisure activities predicts late-life participation patterns as people age, impaired mobility and cognition may lead to giving up those activities (Agahi, Ahacic, & Parker, 2006). Resulting from scarcity of the studies concerning different health factors as prerequisites for social activity it is important also to focus on the question whether mobility, cognitive functioning, and depressive symptoms are prerequisites for social activity. This may add the understanding of the factors which need to be taken into account when planning actions to support vulnerable aged people to participate in activities outside home.

The purpose of the present study was to investigate whether mobility, cognitive functioning, and depressive symptoms operate as mediators in the association between social activity and mortality risk, or whether they alternatively should be considered as prerequisites for social activity in 65- to 84-year-old Finnish men and women.

METHODS

Study population and data collection

The data were gathered as part of the Evergreen project, a multidisciplinary, longitudinal research program (Heikkinen, 1998). The study population consisted of people born between 1904 and 1923 who were resident in the city of Jyväskylä, Finland in 1988. Of this group 1 600 persons were randomly sampled for recruitment into the study, with oversampling of those aged 75 years or older at baseline. Of these people, 36 persons had died between the sampling and beginning of the baseline study, 33 had been placed in a nursing home or hospital before the interview and 5 had moved. Of the remaining individuals, 1 224 took part in the baseline interview in 1988. Reasons for non-participation (n=302) included unwillingness to participate in the study (n=158), health problems (n=57), and other reasons (n=60), or the person was not reached (n=27). We excluded from the analyses 21 persons who died during 1988, less than one year from baseline, because closeness of death may have influenced measurements. We also excluded 22 persons who had a large amount of missing data in their baseline questionnaire. Thus our analyses were based on 1 181 individuals, comprising 406 men and 775 women.

Measures

Dates of death obtained from the population register included all the deaths that occurred between January 1988 and December 2009. *Survival time* was calculated as the number of days from January 1st 1988 to either the date of death or the end of the follow-up period (December 14th 2009).

Collective social activity: Participants were asked about their involvement in different kinds of hobbies such as cultural activities (visiting the theatre, going to concerts or movies, etc.), artistic hobbies (playing a musical instrument, singing in a choir, etc.), acting in organizations, congregational activities (activities organized by the church), and studying. The response options were regularly, occasionally, or not at all. For dancing, frequency of participation was categorised as at least once a month, less frequently than once a month, or not at all. For

physical activity pursued in groups, frequency of participation was categorised as at least once a week, less frequently than once or twice a month, or not at all. For domestic and foreign travel, the response options were a few times a year, once a year or less frequently, or not at all. In each variable the most frequent participation was scored 2, the second most frequent participation 1, and the least frequent participation 0.

Productive social activity: The participants were asked about giving help to relatives, friends, or neighbours in cooking, shopping, child caring, cleaning, going for a walk, washing clothes, going to the bank or post office, or in some other way. Frequency of helping in the above-mentioned activities was categorised as “at least once a month”, which scored 2, “less frequently than once a month”, which scored 1, or “not at all”, which scored 0.

Mobility: Participants were asked about ability to walk indoors, outdoors, and climb stairs. The response options were categorized as “yes, without difficulties”, which scored 0, and “has difficulties/not able/needs somebody to help”, which scored 1. A composite score (range 0–3) was calculated for the three mobility dimensions.

Cognitive functioning: To measure cognitive functioning, the Mini-D test was used (Erkinjuntti, Laaksonen, Sulkava, Syrjalainen, & Palo, 1986). The test is based on the theory of Luria, and was originally developed in order to screen for dementia, but it has been used also to assess general cognitive functions in orientation, learning and memory, visualization, reasoning, and problem-solving (Takkinen & Ruoppila, 2001). The test measures orientation in time and place, short and long-term memory, understanding of metaphorical expressions, writing skills, perceiving a figure, and arithmetic skills. The Mini-D test correlates strongly with other cognitive measures such as Digit Span, Digit Symbol, and Word Fluency in aged persons (Ruoppila & Suutama, 1997). We used a summary score of the 35 items of the Mini-D test. A larger score indicates better cognitive functioning, and the scale maximum is 43.

Depressive symptoms: Depressive symptoms were assessed using the Revised Beck’s Depression Inquiry (RBDI) (Raitasalo, 1995) which is a modified version of Beck’s Depression Scale (Beck, Rial, & Rickels, 1974). The RBDI correlates strongly with original

Beck's Depression Scale, both measuring perceived depressive symptoms (Raitasalo, 1995). In the RBDI, higher scores indicate greater severity of symptoms, and the maximum score is 39.

Covariates included age, full-time education (in years), and morbidity. Morbidity was assessed according to self-reported physician-diagnosed chronic diseases lasting more than 3 months. Diseases were subsequently classified by a physician according to the ICD-9. We included in the analyses serious diseases (ischemic heart disease, cardiac insufficiency, heart infarction, cerebral infarction, and chronic obstructive pulmonary disease) and other less serious diseases which are, however, likely to restrict social participation (e.g. diabetes, other cardiovascular diseases, epilepsy, Parkinson's disease, paralysis, muscular skeletal diseases, and mental disorders). The number of all chronic diseases was used in the analyses.

Statistical analysis

Analyses were conducted in four steps. First, we validated the two-factor structure of the social activity data by using exploratory factor analysis. Second, we used the confirmatory factor analysis to assess the paired associations of the social activity factors (latent variables) on mobility, cognitive functioning, and depressive symptoms. Third, we then tested the effects of mobility, cognitive functioning, depressive symptoms, and social activity on mortality risk using proportional hazards models adapted for factor variables. Fourth, the proportional hazards models were extended to mediator models to investigate pathways between the (collective and productive) social activity factors and mortality risk with mobility, cognitive functioning, and depressive symptoms as possible mediators in our main hypothesized model, and in competing models, including one with mobility, cognitive functioning, and depressive symptoms as prerequisites for the social activity dimensions. Since the models were non-nested, we compared them using three standard information criteria: Akaike information criterion (AIC), Bayesian information criterion (BIC), and sample-size adjusted BIC (aBIC). We also used the AIC-based evidence ratio (Burnham & Anderson, 2004) to assess the probability of information loss related to using a less well fitting model on data. In the latent variable models mortality risk was adjusted for age, education, and chronic diseases. The likelihood ratio test in two-group analyses for men and women showed that both the factor

structure ($p < 0.001$) and the mediating effects ($p < 0.001$) differed between the sexes. Thus, we constructed completely separate models for men and women. The analyses were performed with MPLUS version 5.21 (Muthén & Muthén, 1998-2009). The Multiple Imputation (MI) procedure of SAS for Windows, version 9.1, was used to impute missing values using the available information from the model variables and also additional variables on various background characteristics, physical activity, functional ability, perceived memory, and mental alertness.

RESULTS

The percentages of participation in social activities and the factor loadings and coefficients of determination for collective and productive social activity are shown in Table 1 for men and women separately. Overall, 80 per cent of men and 76 per cent of women had at least one regular social activity, and 26 per cent of men and 27 per cent of women helped others in one or more tasks at least once a month. Among both men and women, cultural activities, artistic hobbies, organizational participation, studying, travelling, dancing, and physical activity pursued in groups formed a latent variable describing collective social activity. Helping others in cooking, shopping, child care, cleaning, going for a walk, washing clothes, going to the bank or post office, and helping in some other way formed a latent variable describing productive social activity. The bivariate correlation between the social activity factors was moderate. In further latent variable models, we specified the same measurement model for the two factors. We do not report the factor structure and significance of factor loadings of further models, as they remained similar in these analyses.

[Table 1]

No mobility problems were reported by 69 per cent of men and 56 per cent of women, while difficulties in two or three mobility dimensions were reported by 17 per cent of men and 24 per cent of women. The mean (standard deviation) in the Mini-D test was 36.4 (5.4) for men and 36.2 (5.3) for women. The mean in the Revised Beck's Depression Inquiry was 2.7 (3.02)

for men and 3.6 (3.4) for women. On average men had 1.06 (0.98) chronic diseases and women 1.16 (1.05).

Among men, 89 per cent had died during 21-year follow-up, yielding a mortality rate of 7.9 deaths per 100 person-years. Collective social activity correlated with mortality and with mobility, cognitive functioning, and depressive symptoms all of which, in turn, also correlated with mortality (Table 2). Productive social activity also correlated with mortality, mobility, and cognitive functioning, but not with depressive symptoms. In the full path model, controlled for age, education, and number of chronic diseases, mobility and cognitive functioning mediated the effect of collective and productive social activity on mortality risk (Figure 1). There was also a statistically significant direct effect of collective social activity on mortality risk. No mediating effect was observed for depressive symptoms.

[Table 2]
[Figure 1]

Among women, 81 per cent had died during the follow-up, yielding a mortality rate of 6.4 deaths per 100 person-years. The results of the preliminary analyses for women were comparable to the results obtained for men except that productive social activity was also correlated with depressive symptoms, but not with cognitive functioning (Table 2). The results of the full pathway model for women were comparable to the results for men except that no mediating effect was observed for cognitive functioning (Figure 2).

[Figure 2]

Comparing the information criteria showed that the competing models fitted better to the data than the mediating model (Model 1) (Table 3). The likelihood that any one of the models other than model 8 would minimize information loss more efficiently was less than 0.001, indicating that model 8 was clearly the best fitting model to the data. This was case in both men and women.

[Table 3]

In the competing model among men, results showed that good cognitive functioning was a prerequisite for collective and productive social activities (Figure 3). Having less depressive symptoms was a prerequisite for participating in collective social activities. Mobility functioned as a mediator between social activity factors and mortality risk. Among women, the results were comparable to those obtained for men except that having less depressive symptoms was a prerequisite also for productive social activity (Figure 4). Among both sexes, there remained an independent effect of collective social activity on mortality risk.

[Figure 3]
[Figure 4]

DISCUSSION

The aim of this study was to investigate whether mobility, cognitive functioning, and depressive symptoms mediate the association between social activity and mortality risk, or whether they alternatively should be considered as prerequisites for social activity in older Finnish men and women. Results showed that, among both men and women, mobility mediated part of the association between collective social activity and mortality risk. Instead, good cognitive functioning and having less depressive symptoms can be better seen as prerequisites for participating in collective social activity among older men and women. Among men, good cognitive functioning, and among women, good cognitive functioning and having less depressive symptoms were prerequisites for productive social activity.

One of our main findings was that mobility mediated part of the association between social activity and mortality. Mobility is a good health indicator because decline in mobility captures the overall impact of chronic conditions (Guralnik et al., 1993), the effect of physiological changes (Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1995; Rantanen et al., 2001), and lifestyle activities (Avlund et al., 2003; Fujita, Fujiwara, Chaves, Motohashi, & Shinkai, 2006). Earlier, Buchman and colleagues (Buchman et al., 2009) found that decrease in social activity

was associated with a more rapid rate of decline in motor function, which in turn was associated with increased mortality risk. First of all, most of the activities studied here also include physical activity, which has potential for maintaining mobility. Second, social interaction may encourage a more active lifestyle, thereby helping to maintain better mobility. Our data, as well as earlier theoretical background (Agahi et al., 2006), showed that mobility can also be seen as a prerequisite for participating in various out-of-home activities. However, a model showing that mobility mediated part of the association between social activity and mortality risk was clearly the best fitting model to the data.

Another main finding was that better cognitive functioning was a prerequisite enabling older persons to participate more actively in social activities (see Aartsen et al. 2002, (Agahi et al., 2006). It is possible that withdrawing from participation in social activities outside the home may be among the first signs of worsening cognitive functioning. Another potential explanation has to do with the role of cognitive functioning for transportation to social activities. In Finland people aged 70 years need to have a doctor's assessment of their competency to drive a car. If cognitive functioning has worsened and a serious memory disorder is apparent, the driving license may be revoked. However, according to the "use it or lose it" hypothesis of cognitive aging, social activity offers protective benefits from age-related cognitive decline (Bielak, 2010). Thus, it may also be possible that participation in various hobbies may include cognitive stimulation and help to maintain better health, although our data did not support this perspective.

Based on the earlier literature we hypothesized that social participation may prevent increasing depressive symptoms which in turn may be associated with decreased mortality risk. Although a representative, random sample was drawn, it is probable that those with depressive symptoms did not participate in the study, thus reducing the observed variance in the Revised Beck's Depression Inquiry. Another reason why depressive symptoms were not associated with mortality risk in the final model may be that depressive symptoms have shared underlying causes (shared variance, see e.g. Shapiro et al. 1999) with mobility and cognitive functioning among men, and with mobility among women. Mobility and cognitive functioning were stronger risk factors for mortality than depressive symptoms in both sexes, which

reduced the coefficient for depressive symptoms. It is also possible that residual correlation from important omitted effects influenced the estimates of the predictor-mediator-outcome pathway, although we were unable to specify or adjust for effects of this kind. Instead, the results showed that depressive symptoms were a prerequisite for more active participation in collective social activities. Among women, having less depressive symptoms was a prerequisite also for productive social activity. It is conceivable that those having a lot of depressive symptoms are not inclined to participate in various social activities outside home, and they may need extra support to find activities they like, to motivate them and provide them with a company for participating.

The direct effect of collective social activity on mortality risk observed even after adding mobility, cognitive functioning, and depressive symptoms into the models suggests that other mechanisms not studied here may explain the association. Social participation may be associated with better quality of life, happiness, and experiencing life as worth living (Golden, Conroy, & Lawlor, 2009). Feelings of purpose in life have been found to be related to decreased mortality risk in older people (Boyle, Barnes, Buchman, & Bennett, 2009). Older people, whose subjective wellbeing is good, may have also better coping strategies (Segerstrom, Taylor, Kemeny, & Fahey, 1998). Receiving social support from social relationships may help to buffer stress in times of crisis (Uchino, 2004). Multiple social roles or giving social support to other people are also associated with feelings of personal control and sense of self-efficacy (Adelmann, 1994; Krause, Herzog, & Baker, 1992). Self-efficacy has been found to be related to better self-rated health (Parkatti, Deeg, Bosscher, & Launer, 1998), which in turn is associated with decreased mortality risk (Ford, Spallek, & Dobson, 2008; Idler & Benyamini, 1997; Lyyra, Leskinen, Jylha, & Heikkinen, 2009).

The strengths of this study were a representative population-based sample of older people living in the community, data collection through face-to-face interviews, a high response rate (80 %), and a long follow-up time for mortality. Furthermore, in Finland, register-based data on mortality is reliable and coverage is complete. A potential limitation of this study was that other meaningful social activities may exist that were not captured in our interview, such as informal social gatherings and volunteering. Another potential limitation is that some of the

study items collected in the 1980s at the baseline of the study may not be consistent with present-day knowledge of the topic. We were not always able to know whether some activities categorized as collective were not in fact done alone. However, we are fairly sure that activities such as singing, painting, or studying are carried out in a social context in our data. Community music and art classes are highly developed in the area of residence of our sample, and for example the University of the Third Age has been an important venue for education older people. Not including these activities would have led to underestimation of participation in collective social activities. One limitation is the cross-sectional study frame for the explanatory variables. However, we have studied both mediation and competing models, and determined the best fitting model to the data.

Conclusion: Social activity decreases mortality risk among older men and women. The association may partly be explained by better mobility. Good cognitive functioning and having less depressive symptoms may be prerequisites for participating in social activities. However, more research on the direction of the association between cognitive functioning, depressive symptoms, and social activity is needed in order to achieve a deeper understanding of this association.

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Author contributions

K. Pynnönen: Conception and design, drafting the manuscript, acquiring the funding for conducting the research. T. Törmäkangas: Contribution to the design of the study, data analysis, critical revision for important intellectual content. T. Rantanen: Critical revision for important intellectual content. T-M. Lyyra: Contribution to the design of the study, critical revision for important intellectual content.

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Table 1. Proportion of participation in social activities, standardized factor loadings for confirmatory factor analysis, 95 % confidence intervals and coefficient of determination (R^2) for social activity factors, and factor correlations among men (n=406) and women (n=775).

	Men					**Women**				
	Participation,%		Factor			Participation, %		Factor		
Collective social activity	Reg.[1]	Occas.[2]	loadings	95% CI	R^2	Reg.[1]	Occas.[2]	loadings	95% CI	R^2
Receptive cultural activities	9	46	0.759	0.66, 0.86	0.58	11	49	0.697	0.62, 0.77	0.49
Studying	7	3	0.669	0.51, 0.83	0.45	4	3	0.526	0.38, 0.67	0.28
Travelling in home country	70	18	0.665	0.54, 0.79	0.44	64	21	0.683	0.60, 0.77	0.47
Travelling abroad	14	39	0.537	0.41, 0.66	0.29	12	36	0.654	0.58, 0.73	0.43
Organizational participation	27	15	0.535	0.41, 0.66	0.29	24	10	0.596	0.51, 0.68	0.36
Dancing	8	16	0.553	0.43, 0.68	0.31	4	7	0.690	0.58, 0.80	0.48
Artistic hobbies	13	9	0.440	0.27, 0.61	0.19	10	6	0.459	0.35, 0.57	0.21
Physical activity pursued in groups	7	3	0.281	0.08, 0.48	0.08	10	2	0.420	0.28, 0.56	0.18
Congregational activities	7	9	0.137	-0.03, 0.31	0.02	20	13	0.061	-0.03, 0.15	0.00
Productive social activity										
Helping in shopping	13	7	0.906	0.84, 0.97	0.82	9	7	0.825	0.71, 0.94	0.68
Helping in washing clothes	3	3	0.885	0.80, 0.97	0.78	5	3	0.880	0.77, 1.00	0.77
Helping in going to the bank or post office	8	7	0.852	0.78, 0.93	0.73	4	5	0.763	0.64, 0.89	0.58
Helping in cleaning	11	6	0.848	0.76, 0.93	0.72	6	2	0.907	0.80, 1.02	0.82
Helping in cooking	7	4	0.821	0.72, 0.92	0.67	9	5	0.745	0.63, 0.86	0.55
Helping in going for a walk	2	2	0.556	0.32, 0.79	0.31	6	4	0.570	0.44, 0.70	0.33
Helping in child caring	7	7	0.394	0.23, 0.56	0.16	8	9	0.308	0.18, 0.44	0.10
Helping in some other way	3	11	0.352	0.20, 0.51	0.12	3	8	0.251	0.11, 0.40	0.06
Correlation between factors			0.345	0.20, 0.49				0.270	0.15, 0.40	

[1]: Regularly in receptive cultural activities, studying, organizational participation, artistic hobbies, and congregational activities; at least few times a year in travelling in home country and abroad; at least once a month in dancing; at least once a week in physical activities pursued in groups; and at least once a month in helping tasks.

[2]: Occasionally in receptive cultural activities, studying, organizational participation, artistic hobbies, and congregational activities; once a year or less frequently in travelling in home country and abroad; less frequently than once a month in dancing; less frequently that once or twice a week in physical activities pursued in groups; and less frequently than once a month in helping tasks.

Table 2. Unstandardized bivariate path coefficients (Est.) and 95 % confidence intervals (CI) between social activity factors, mortality, mobility, cognitive functioning and depressive symptoms among men (n=406) and women (n=775).

	Mortality		Mobility		Cognitive functioning		Depressive symptoms		Collective social activity		Productive social activity	
Men	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI
CSA	**-0.49**	-0.78, -0.21	**-0.79**	-1.32, -0.26	**2.46**	0.97, 3.95	**-1.67**	-2.67, -0.66	-	-	-	-
PSA	**-0.06**	-0.13, -0.00	**-0.27**	-0.45, -0.09	**0.46**	0.09, 0.83	-0.00	-0.20, 0.19	-	-	-	-
Mobility	**0.43**	0.32, 0.53	-	-	-	-	-	-	**-0.38**	-0.59, -0.17	**-1.12**	-1.68, -0.55
Cognit func	**-0.07**	-0.09, -0.04	-	-	-	-	-	-	**0.08**	0.04, 0.12	**0.16**	0.08, 0.25
Depr sympt	**0.08**	0.05, 0.11	-	-	-	-	-	-	**-0.11**	-0.18, -0.05	**-0.12**	-0.23, -0.01
Women												
CSA	**-0.38**	-0.57, -0.20	**-1.03**	-1.49, -0.56	**2.80**	1.90, 3.70	**-1.17**	-1.71, -0.63	-	-	-	-
PSA	**-0.10**	-0.17, -0.02	**-0.37**	-0.58, -0.16	0.16	-0.11, 0.43	**-0.35**	-0.58, -0.11	-	-	-	-
Mobility	**0.40**	0.31, 0.48	-	-	-	-	-	-	**-0.41**	-0.55, -0.27	**-0.72**	-1.00, -0.44
Cognit func	**-0.06**	-0.08, -0.04	-	-	-	-	-	-	**0.10**	0.07, 0.14	**0.08**	0.11, 0.58
Depr sympt	**0.05**	0.02, 0.07	-	-	-	-	-	-	**-0.09**	-0.13, -0.05	**-0.15**	-0.23, -0.08

Note: CSA = collective social activity, PSA = productive social activity.

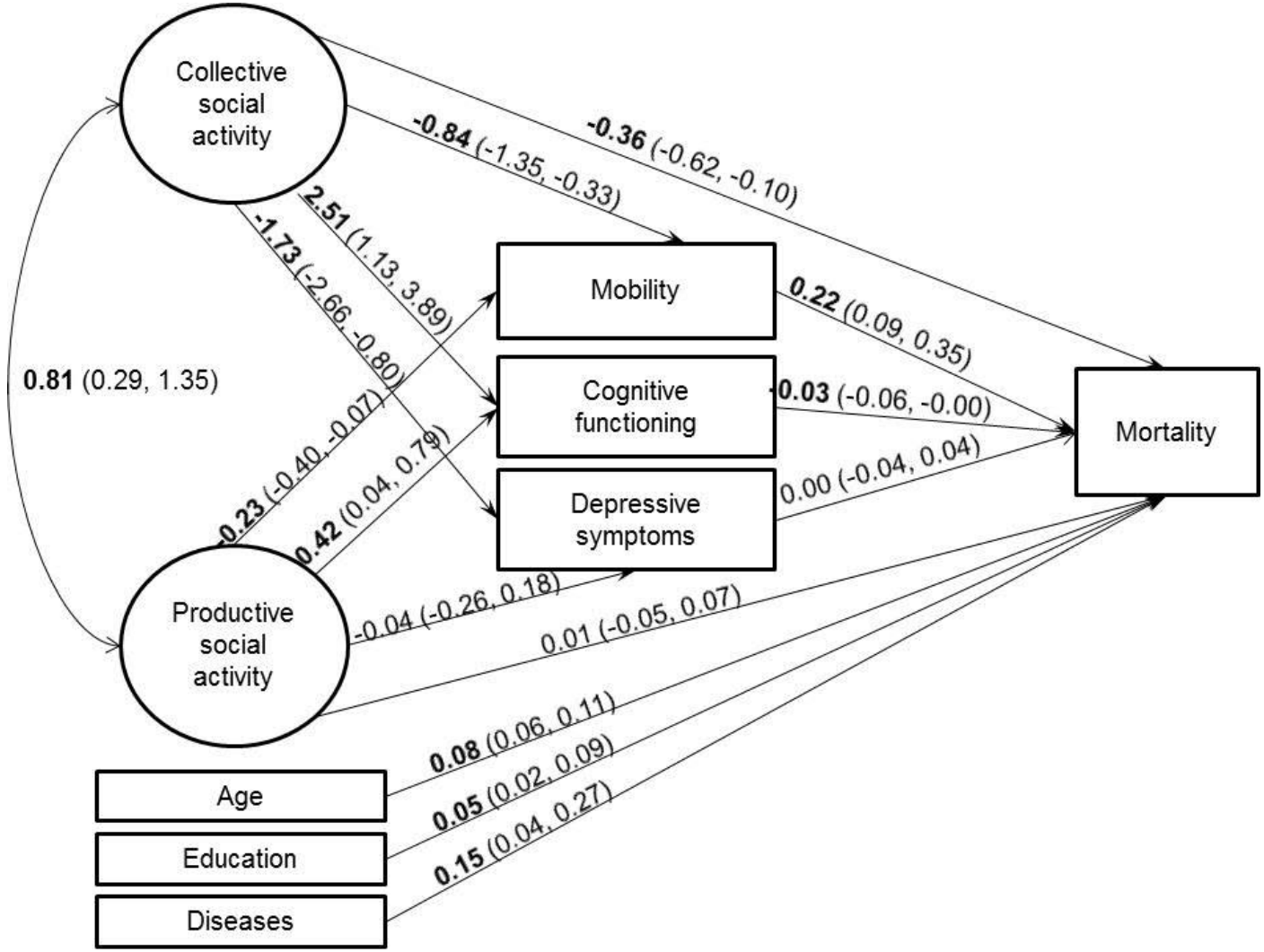

Figure 1. Unstandardized path coefficients (95 % confidence intervals) of latent factor mediator model for social activity factors, mobility, cognitive functioning, depressive symptoms, and mortality risk among men (n=406).

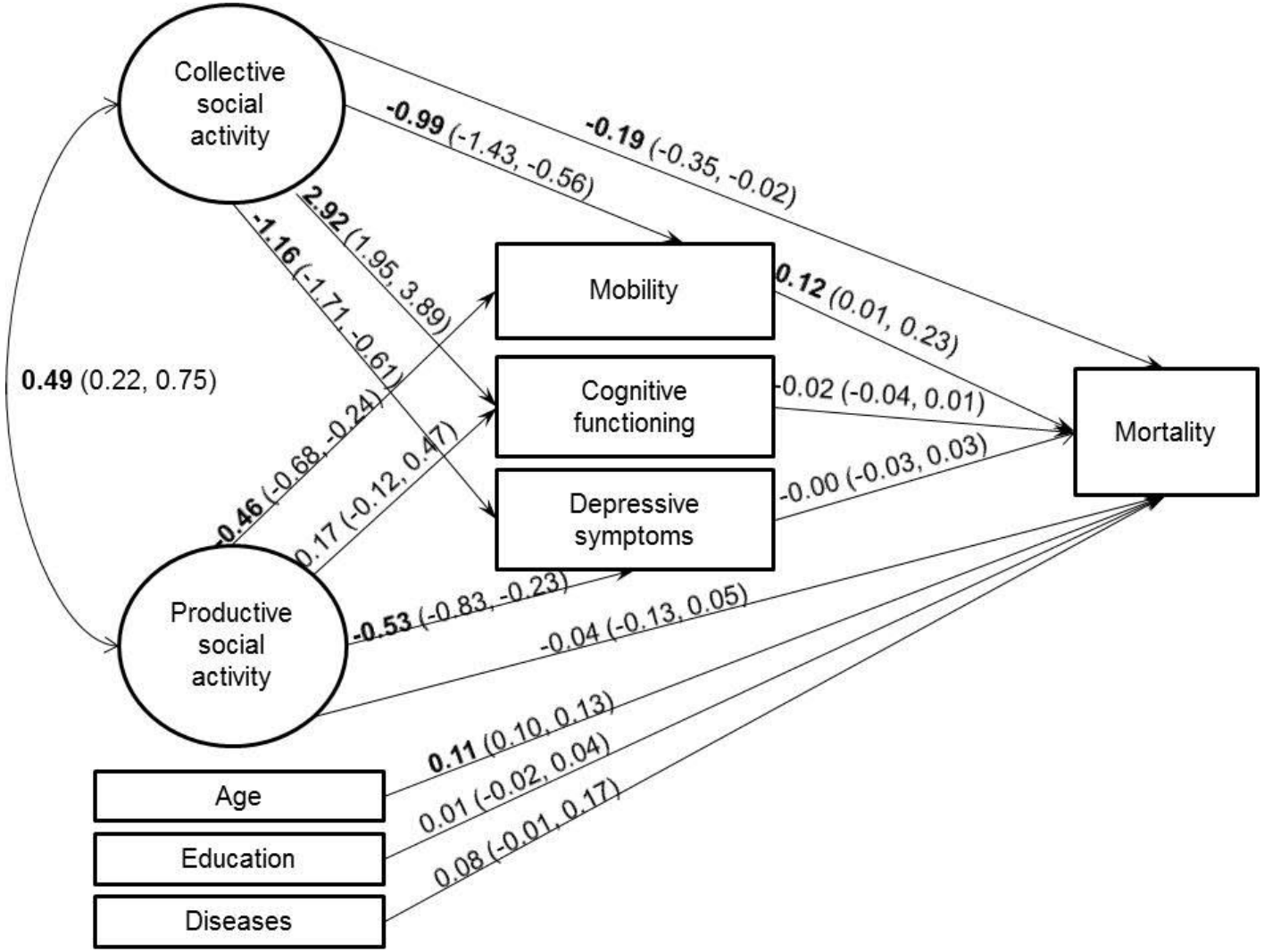

Figure 2. Unstandardized path coefficients (95 % confidence intervals) of latent factor mediator model for social activity factors, mobility, cognitive functioning, depressive symptoms, and mortality risk among women (n=775).

Table 3. Number of free parameters (*df*), scaling parameters of the robust maximum likelihood estimation method, information criteria (Akaike information criterion, AIC, Bayesian information criterion, BIC, and sample-size adjusted BIC, aBIC) of non-nested mediator models among men (n=406) and women (n=775).

	Model	Direction of causation			df	AIC	BIC	aBIC
Men	1	(C,P) → Mob	(C,P) → DepS	(C,P) → Cog	73	18872	19165	18933
	2	Mob → (C,P)	(C,P) → DepS	(C,P) → Cog	73	18867	19159	18928
	3	Mob → (C,P)	DepS → (C,P)	(C,P) → Cog	71	16834	17118	16893
	4	(C,P) → Mob	(C,P) → DepS	Cog → (C,P)	71	16834	17118	16892
	5	(C,P) → Mob	DepS → (C,P)	(C,P) → Cog	71	16815	17100	16874
	6	Mob → (C,P)	(C,P) → DepS	Cog → (C,P)	71	16351	16636	16411
	7	Mob → (C,P)	DepS → (C,P)	Cog → (C,P)	69	14337	14613	14394
	8	(C,P) → Mob	DepS → (C,P)	Cog → (C,P)	69	14313	14590	14371
Women	1	(C,P) →Mob	(C,P) → DepS	(C,P) → Cog	73	35262	35602	35370
	2	Mob → (C,P)	(C,P) → DepS	(C,P) → Cog	73	35245	35585	35353
	3	Mob → (C,P)	DepS → (C,P)	(C,P) → Cog	71	31232	31563	31337
	4	(C,P) → Mob	(C,P) → DepS	Cog → (C,P)	71	31232	31563	31337
	5	(C,P) → Mob	DepS → (C,P)	(C,P) → Cog	71	31164	31494	31269
	6	Mob → (C,P)	(C,P) → DepS	Cog → (C,P)	71	30530	30860	30635
	7	Mob → (C,P)	DepS → (C,P)	Cog → (C,P)	69	26521	26842	26623
	8	(C,P) → Mob	DepS → (C,P)	Cog → (C,P)	69	26404	26726	26506

Note. Mortality was the dependent variable in the models. Mortality risk was adjusted for age, education, and number of chronic diseases.
Note. Arrows point the direction between variables in the path models.
Note. (C,P) = Separate collective and productive social factors, Mob = mobility, DepS = Revised Beck's Depression Inquiry score, Cog = MiniD-test score.
Note. AIC: Akaike information criterion, BIC: Bayesian information criterion; aBIC: sample-size adjusted BIC, where $n^* = (n + 2) / 24$, *df*: number of free parameters in the model.
Note. In all models the probability that the worse fitting models minimize information loss was less than 0.001.

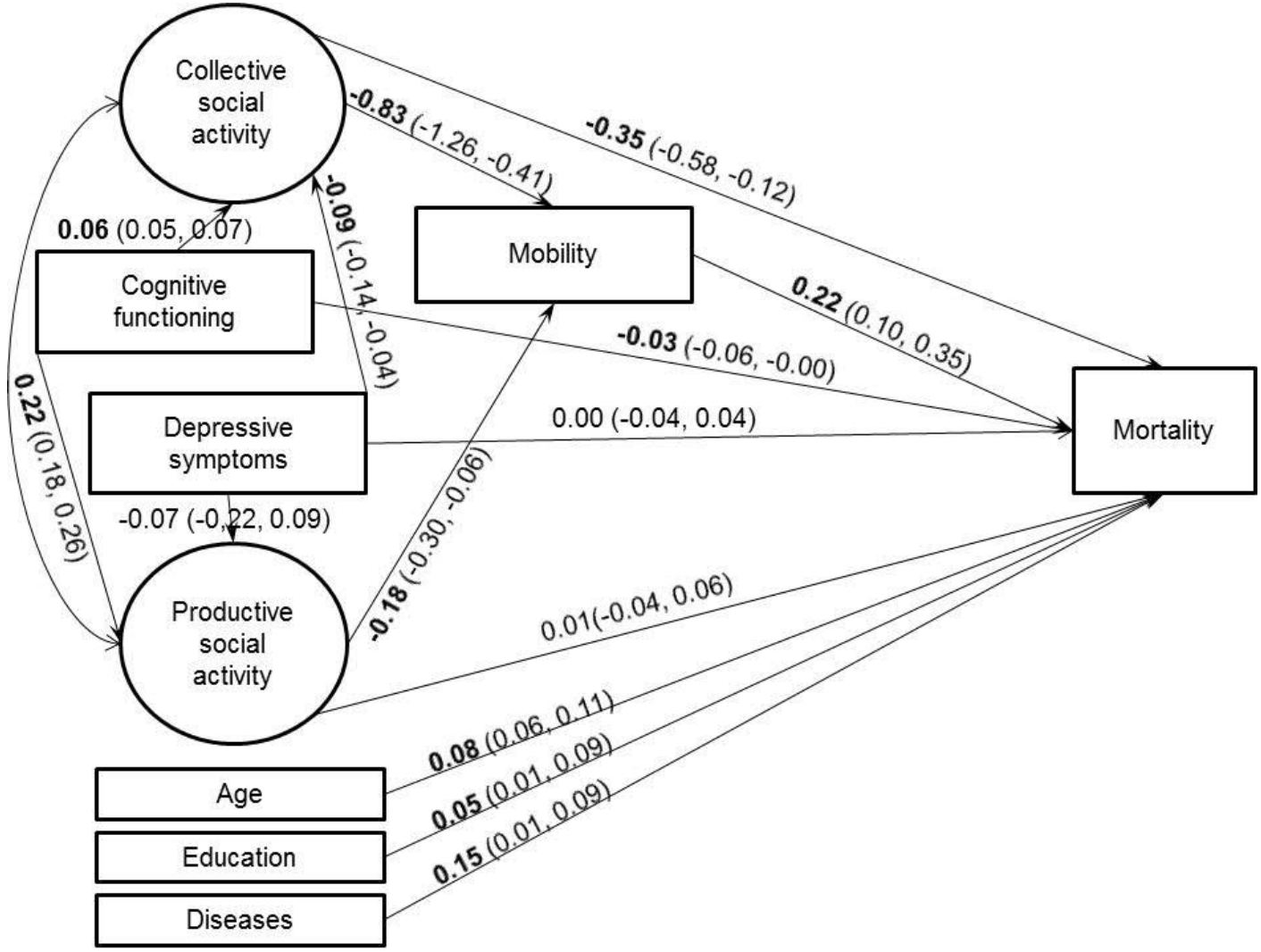

Figure 3. Unstandardized path coefficients (95 % confidence intervals) of latent factor resource model for cognitive functioning, depressive symptoms, social activity factors, mobility, and mortality risk among men (n=406).

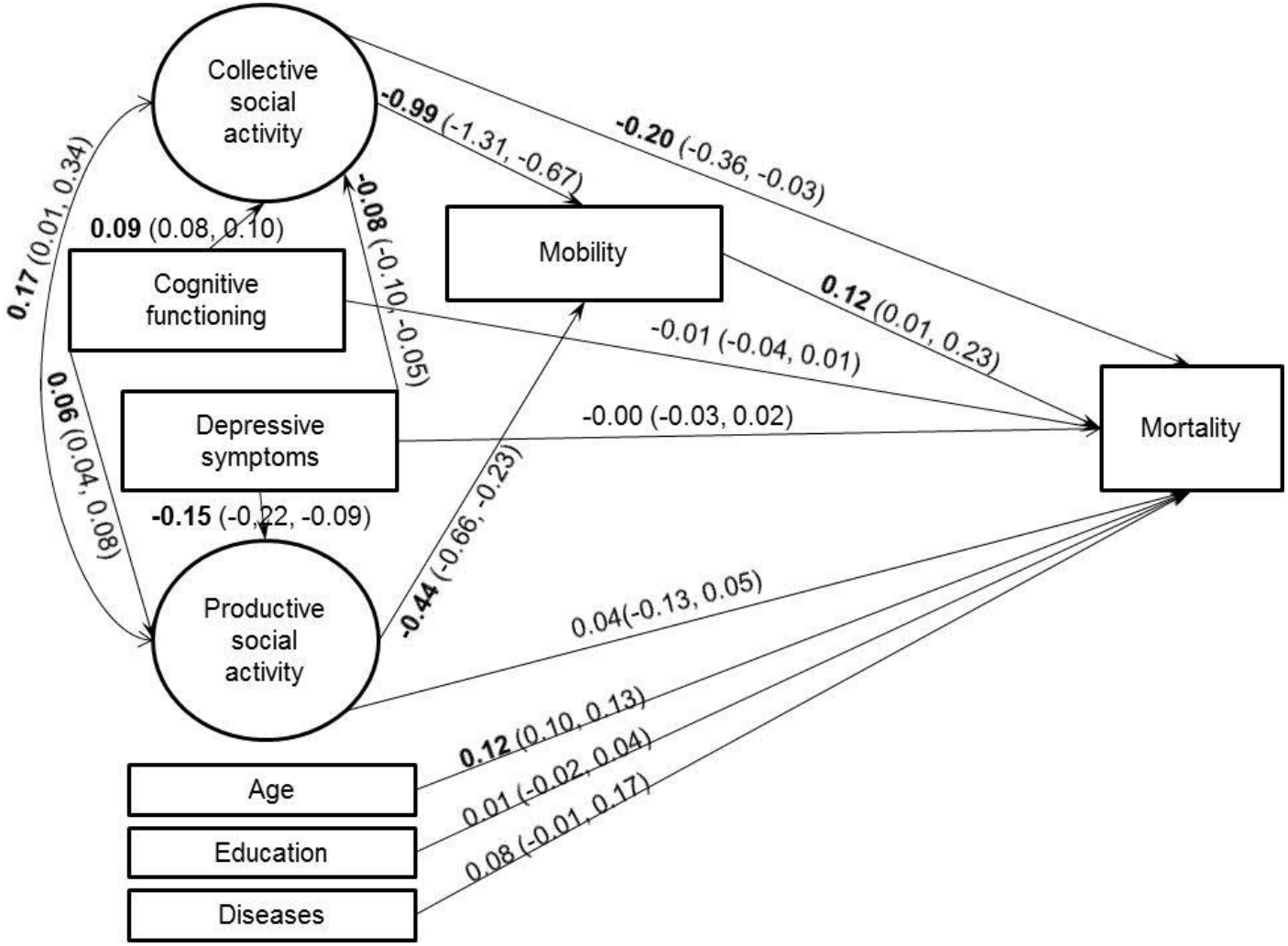

Figure 4. Unstandardized path coefficients (95 % confidence intervals) of latent factor resource model for cognitive functioning, depressive symptoms, social activity factors, mobility, and mortality risk among women (n=775).