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- ACCEPTED FOR PUBLICATION –

Abstract

A growing body of work suggests that social and activity participation (SAP) may contribute to health and well-being. Studies examining the effects of these activities largely focused on healthy older adults and older adults with more resources, not on frail older adults. On the latter, there is a lack of information about which activities contribute most and whether their effects vary between men and women given the gender-differentiated social roles. To address these gaps we extracted longitudinal data from the D-SCOPE frailty program for 380 participants aged 60 years or older residing in Belgium. Structural equation models tested the relationships between six levels of SAP based on a taxonomy of social activities (Levasseur et al., 2010) – from level 1 (for oneself) to level 6 (for others) – on longitudinal changes in physical and mental deterioration, well-being, and gender differences within these relationships. Results first show that older adults at risk of frailty benefit longitudinally from participating in activities in terms of their physical deterioration and well-being. Second, socially oriented activities were significantly associated with lower levels of physical deterioration and higher levels of subjective well-being (SWB), and volunteering with higher levels of SWB. Heterogeneity of activities, regardless of level on the taxonomy of social activities, seems to benefit SWB and counteract physical deterioration. Third, gender differences were confirmed by two activities for women (alone, task-oriented) and three activities for men (alone, being with others, task-oriented e.g. associational membership). Results imply that the

activity itself may play a more important role than the nature of social involvement and social interaction in relation to health and well-being.

Keywords: social participation, activities, frailty, physical deterioration, mental deterioration, subjective well-being (SWB), gender, longitudinal data, structural equation modeling

Introduction

Studies focusing on social and activity participation (SAP) in later life and their relationship with health and well-being are prevalent in the current social sciences literature (Chen, et al., 2018; Johnson & Mutchler, 2014; Serrat et al., 2020). Participation, well-being, and healthy aging are also key topics within research and policy debates centering on health promotion (Beard et al., 2016). From a public health perspective, it is crucial to identify which type of SAP contributes to healthy aging and whether this differs among men and women. This investigation is important given the multiple benefits associated with SAP, such as greater well-being, an enhanced sense of purpose, and social integration (e.g. Bielak et al., 2012; Duppen et al., 2019a; Dury et al. 2019; Gonzales et al., 2015; Nimrod & Shrira, 2016). We therefore aim to understand how *differently* SAP relates to *longitudinal* changes in health and subjective well-being (SWB), and whether the effects of these activities vary for men and women given the gender-differentiated social roles.

Social and activity participation, health, and well-being

Several established bodies of literature have shed light on the various categories of individuals who engage in a wide range of SAP, considered as individual proximity to or involvement with others in society or the community, ranging from passive (solitary) to active (interaction) (Adams et al., 2011; Lennartsson & Silverstein, 2001; Levasseur et al., 2010), and excluding activities of daily living such as household chores. Theoretical and empirical studies focusing on productive aging, successful aging, activity theory, and healthy aging emphasize the importance of an engaged

lifestyle for older adults (e.g. Boudiny, 2013). The theory of productive aging (Bass & Caro, 2001) posits that SAP involves productive activities that are unpaid but socially valued in later life. By aging productively, older adults continue to contribute to their health, families, communities, and wider society (Butler & Gleason, 1985). SAP is also an important component of the MacArthur model of successful aging (Rowe & Kahn, 2015), in which older adults need to make ongoing efforts to sustain healthy mental and physical behaviors to age successfully. Accordingly, SAP – viewed as a collection of modifiable factors – contributes to reducing the risk of disease and disease-related disability. Life satisfaction (Neugarten, 1972) as well as SAP have been identified as key indicators of successful aging (Carr et al., 2018). Considered from an activity-focused theoretical perspective, SAP is associated with SWB, and specifically with life satisfaction (Havighurst, 1961; Lemon et al., 1972). Older adults who engage in a range of activities report higher levels of SWB, such as sustaining a sense of meaning, life satisfaction, and personal mastery (Lloyd & Auld, 2002; Wahrendorf & Siegrist, 2010). Healthy aging as final paradigm also stresses the importance of SAP in later life. In its public health framework of healthy aging, the WHO has emphasized the importance of considering approaches such as SAP that maximize individuals' functional abilities and contribute to reinforcing resilience and psychosocial growth (Beard et al., 2016).

Despite evidence of the positive effects of SAP on health and SWB, substantial questions remain about the impact of SAP among older adults (Bielak et al., 2012; Granbom et al., 2017; Matz-Costa et al., 2016; Serrat et al., 2020). First, scholars are currently seeking to elucidate whether and how participation in different types of activities may be associated with positive outcomes (e.g. health and wellbeing) in later life (e.g. Bielak et al., 2012; Carr et al., 2018; Ku et al., 2016; Morrow-Howell et al., 2014; Wang et al., 2002). While there is a growing body of

literature on the associations between different kinds of activities and health in later life, failure to examine such activities simultaneously constitutes a major research gap. This hinders understanding which range of activities relate more or less to health and well-being outcomes, and how (Matz-Costa et al., 2014; Morrow-Howell et al., 2014; Nimrod & Shrira, 2016; Serrat et al., 2020). Acquiring insights into a broad array of activities and their contribution to longitudinal evidence on healthy aging remains a priority (Morrow-Howell et al., 2014; Nimrod & Shrira, 2016).

Second, most studies have been cross-sectional, meaning that they could not establish a temporal association between SAP on the one hand and health (Kahana et al., 2013) and SWB on the other (Adams et al., 2011; Ku et al., 2016). To the best of our knowledge, to date no studies have explored the relationships between different types of SAP and longitudinal changes in health and SWB, or between interactive gender effects within these relationships.

Social and activity participation: need to focus on gender differences and on frail older adults

Studies have found that the salubrious effects of SAP on health among the older adult population may be moderated by several factors, such as older individuals' embodied cultural and socioeconomic characteristics (Petriwksyj et al., 2017). Less is known about the role of gender in the paths of SAP. According to Finkel and colleagues (2018), no existing theory specifically considers gender differences in SAP. Intuitively, gender differences in SAP may nonetheless be expected given the existence of gender-differentiated social roles. Interests and life experiences tend to differ along certain lines for men and women. Considered from a feminist gerontological perspective, life experiences are acknowledged to be structured by gender relations. It is widely accepted that gender (mostly) refers to a social construct based on a collective consensus on which

behaviors are defined as masculine and which as feminine (Calasanti, 2009, 2019). This social construct is also reflected in the gendered division of SAP (Nesteruk & Price, 2011), whereby older women tend to be more engaged in household activities and in helping others than older men, who appear to be more engaged outside the home, e.g. with sports, socially oriented activities (eating out), and civic activities (Li et al., 2011).

In studies of SAP in later life, apart from focusing on gender differences it is also important to include older adults who are confronted with frailty. Notwithstanding the advancing understanding of the benefits of SAP for older adults, most studies have focused on healthy and financially comfortable older adults (Matz-Costa et al., 2016). The reality is that within an aging society, more community-dwelling older adults are confronted with multidimensional frailty (Beard et al., 2016; Jacobs et al., 2016) and are more at risk of becoming frail due to, for example, a sedentary lifestyle (Hoogendijk et al., 2019). Studies on SAP should also include frail older adults (Johnson & Mutchler, 2014).

Conceptual framework

Building on the reviewed literature our aim was to investigate the effects of different types of SAP on longitudinal changes in health and SWB among community-dwelling older adults at risk of frailty, as well as the potential effect of gender on these associations (see Figure 1). One theoretical account for this association is the Levasseur taxonomy of social activities (Levasseur et al., 2010) which differentiates six distal to proximal levels of involvement with others in social activities and the goals of that activity. The six levels are a continuum and distinguish activities performed for oneself (levels 1 and 2), activities with others (levels 3 and 4), and activities for others (levels 5 and 6).

The first two levels are basic needs-oriented activities.

- Level 1: alone: doing an activity in preparation for connecting with others, solitary activities
- Level 2: being with others, activities for oneself but with people around

Social participation ranges from levels 3 to 6:

- Level 3: socially oriented activities
- Level 4: task-oriented activities

Lastly, social engagement activities include levels 5 and 6.

- Level 5: helping others
- Level 6: contributing to society

In our study, all six levels of SAP will be examined in relation to health and well-being, aiming to test three hypotheses (H). To maintain and measure a wide range of activities simultaneously, our levels 2 and 4 will contain two separate activities rather than one (see *Exogenous variables* below). Based on the theoretical framework, we aim to distinguish levels of social activity in terms of involvement and goals. Hence within this study and associated hypotheses we refer to a higher level of participation, taking into account the individual proximity of involvement with others and the associated objective of the activity. We use the Levasseur levels as different categories older adults can be active in.

Building on existing research that has examined the potential benefits of different SAP and has shown that activity engagement maintains or produces health for older adults (Morrow-Howell et al., 2014) and SWB (Matz-Costa et al., 2016), the first hypothesis is that older adults at risk of frailty, regardless of type of activity, benefit longitudinally from participating in SAP (H1).

Second, the six levels of SAP are found to predict outcomes in different ways (Andel et al., 2016; Hoogendijk et al., 2019; Morrow-Howell et al., 2014). Matz-Coast and colleagues (2016) discovered that to increase health and well-being in later life one must use one's body and mind, interact socially, and benefit others. We hypothesize that the higher the level of participation/social interaction on the Levasseur taxonomy, the better the health and SWB of older adults will be (H2).

Given the existing gender differentiation of SAP (Burr et al., 2018; Yang & Pang, 2016), we hypothesized that the relationship between SAP and health and SWB (Nimrod & Shrira, 2016) might differ between men and women (H3).

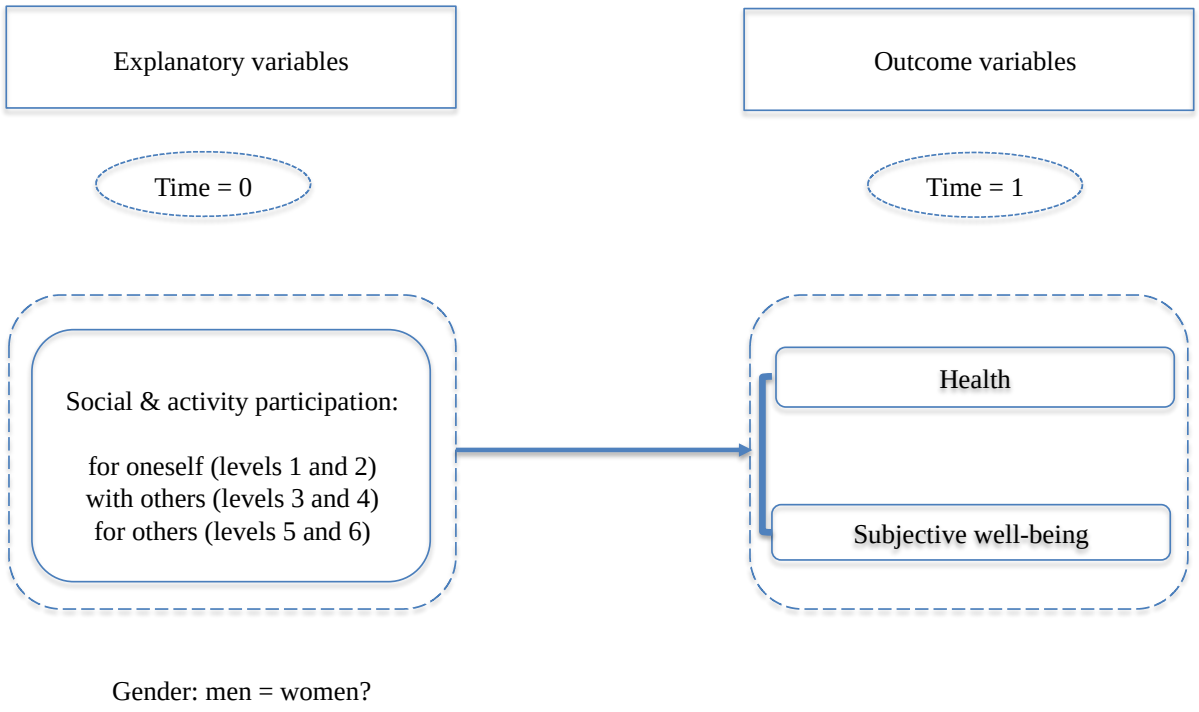

Figure 1. Conceptual framework depicting the effects of social and activity participation on health and well-being, and the relation with gender

Methods

Data and Sample

Data were derived from the longitudinal D-SCOPE frailty study conducted in three municipalities of Flanders, Belgium: Knokke-Heist, Ghent, and Tienen (see Lambotte et al., 2018 for a full description). A two-wave interview-based survey was administered in 2017 and 2018 among participants selected randomly from census records within each municipality (300 addresses and replacement addresses). Inclusion criteria were designed to target frail, older, self-reliant individuals aged 60+, living at home, assessed through risk profiles, and with at least one risk factor for frailty: age, gender, marital status, moved in the past 10 years, and migration background

(Dury et al., 2017). At baseline, 869 people with risk profiles indicating frailty responded. A follow-up survey was conducted six months later in 2018, with 568 respondents agreeing to participate. When reducing the sample size at follow-up from 568 to 383 respondents we excluded those individuals who were part of the experimental group (N=185) (they received a visit from a social worker who started an intervention for their needs, competences, and strengths, such as home care or participation in associational activities). We employed Little's missing completely at random (MCAR) test, which failed to reject the hypothesis that all of the missing values were MCAR, x^2=737.501, df=683, p=.073 (Schafer & Graham, 2002).

The D-SCOPE protocol was reviewed and approved by the medical ethics committee of Vrije Universiteit Brussel in Brussels, Belgium (reference number: B.U.N. 143, 201, 630, 458). Prior to conducting the baseline assessment, the researchers obtained written consent from all participants.

Measures

For all hypothesis, three measures are used as outcomes: physical deterioration, mental deterioration, and SWB. For physical deterioration we used the physical subscale of the Comprehensive Frailty Assessment Plus Instrument (De Roeck et al., 2018), which evaluates general physical health with four items. Participants were asked to indicate whether their health status had hampered them in performing the following activities: walking up a hill or stairs, bending or lifting, less demanding activities, and going for a walk. All answers are given on Likert scales: 0 (disagree), 1 (≤3 months), and 2 (>3 months). Scores for physical deterioration were scored by totaling item responses, recalculated and ranged from 0 to 100, with higher scores

indicating higher physical deterioration (De Roeck et al., 2018). The scale showed acceptable reliability (Peterson, 1994) with Cronbach's alpha 0.825.

Mental deterioration defined as general mood or affect (including feelings of depression, anxiety, emotional loneliness, health, and psychological well-being) was measured with the mental health subscale of the Comprehensive Frailty Assessment Plus Instrument (De Roeck et al., 2018). Respondents were asked to indicate in what way they agreed with eight statements: (1) I feel unhappy or depressed, (2) I feel like I'm losing my self-confidence, (3) I feel like I cannot cope with problems, (4) I feel under constant pressure, (5) I feel like I'm not worth anything anymore, (6) I miss having people around me, (7) I experience a general sense of emptiness, and (8) I often feel rejected. A 4-point Likert scale was used for each response: 0 (disagree) to maximum 4 (agree). Scores for mental deterioration were scored by totaling item responses, recalculated and ranged from 0 to 100, with higher scores indicating higher mental deterioration.

To measure SWB we used the validated Short Well-being Instrument for Older Adults (SWIO), specifically developed to measure the SWB of a population of frail community-dwelling individuals. This scale has three subdimensions: sense of mastery (three items, e.g. "having little control over the things that happen"), meaning of life (three items, e.g. "I understand my life's meaning"), and life satisfaction (three items, e.g. "I am satisfied with my life") (Duppen et al., 2019b). Responses were given on a Likert scale ranging from 0 (disagree) to 4 (agree). SWB was scored by totaling item responses, recalculated and ranged from 0 to 100, with higher scores indicating greater levels of SWB.

Exogeneous Variables

For SAP, we applied the classification system of Levasseur et al. (2010), differentiating the six distal to proximal levels of involvement with others in social activities as outlined in the Background section. Level 1: reading, gardening; Level 2: cultural events (concerts, movies), solo sports (walking, biking); Level 3: eating out, outings; Level 4: adult education, associational membership; Level 5: helping friends and family, childcare; Level 6: formal volunteering. Baseline SAP was measured by frequency of participation using a 4-point scale (1=never, 2=seldom, 3=monthly, 4=weekly), with higher scores denoting higher frequency of participation.

Other demographic variables were assessed too: age (mean=74.61, range=60-93, SD=7.89), gender (0=male, 1=female), highest educational level (five categories: no degree, primary education, middle secondary, higher secondary, higher education). Marital status was measured by four dummy variables: widowed, divorced, single, and cohabiting, with married respondents as reference category and monthly household income (five categories: <€1000, €1000–€1499, €1500–€1999, €2000-€2499, >€2500).

Data Analysis

We conducted the data analysis using R (R Core Team, 2019), testing assumptions of normality, independence, multicollinearity, and homoscedasticity in relation to SAP. We conducted descriptive analyses to determine the characteristics of the study sample, including calculations of frequencies and proportions of categorical variables (gender, marital status, household income), and means and standard deviations for continuous variables (age, physical and mental deterioration, SWB, SAP) and for the overall sample as well as for gender-stratified subsamples.

Next, we conducted bivariate tests to assess differences between men and women in relation to sociodemographic characteristics (age, marital status, household income), physical and mental deterioration, subjective well-being, and SAP.

The hypotheses are addressed using various structural equation modeling (SEM) techniques with the R package lavaan (Rosseel, 2012). Model fits are investigated using a combination of fit indices for all models. First, a non-significant p-value of the chi-square suggests that the proposed model fits the data well, as the observed covariance matrix is considered similar to the model-implied covariance matrix. The comparative fit index (CFI) is suitable for small ($n<100$) sample sizes (Bentler, 1995). Values should exceed .90 or ideally .95 (Kenny, 2014). The Tucker-Lewis Index (TLI), >0.90 and >0.95, indicates acceptable and excellent fit with the data, respectively (Kenny, 2014). For the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR), a value <0.04 indicates a good fit and <0.08 a moderate fit (Kline, 2010; Marsh et al., 2010).

Hypothesis 1

The first hypothesis studies whether older adults at risk of frailty benefit longitudinally from SAP, regardless of type of activity. This hypothesis is addressed by creating an overall activity participation measure. We opted not to average the activity participation variables, as this assigns equal weights to all measures and information might get lost. Rather, a two-step approach is adopted. First, a confirmatory factor analysis (CFA) is used in which all activity variables load on one latent variable, with factor loadings of same-level activities constrained to the same value. If

this one-factor model indeed fits the data adequately, factor scores are calculated (i.e. for each individual the estimated value for the latent variable is calculated) to obtain an overall measure of "activity participation". Note that in this CFA model, the observed activity variables are ordinal endogenous variables consisting of four categories. Hence the mean and variance corrected weighted least squares (WLSMV) estimator was selected – it was chosen over the mean-adjusted least squares (WLSM), as it is generally favored by computer simulation studies (Finney & DiStefano, 2013). With this WLSMV estimator, lavaan will use diagonally weighted least squares (DWLS) to estimate the model parameters, but it will use the full-weight matrix to compute robust standard errors, and a mean- and variance-adjusted test statistic. The WLSMV estimator in lavaan can only be used with complete data, resulting in a data frame of 372 observations.

In a second step, a path model is fitted in which SWB and physical and mental health (the exogenous variables) are all predicted by this overall activity participation variable, the baseline variables of SWB, physical and mental health (the endogenous variables), and the sociodemographic measures (age, education, marital status, income). For this second model, full information maximum likelihood (FIML) is used (Arbuckle, 1996) – a case-wise maximum likelihood estimation procedure that includes all available data from that case (i.e. in the lavaan package, the argument missing="fiml.x" is specified). An unrestricted (h1) model is automatically estimated, so that all common fit indices are available.

Hypothesis 2

As the first hypothesis sheds light on the question of whether older adults at risk of frailty generally benefit longitudinally from doing activities, the second hypothesis studies which of the activities are important. Concretely, a path model is constructed where the same variables are entered as in

step 2 of the first hypothesis, only the overall activity participation variable is replaced by the eight separate SAP variables. Path coefficients of same-level activities are constrained to the same value, as it is theoretically assumed that they yield identical effects on SWB and physical and mental deterioration. Estimated path coefficients are directly compared using Wald tests, with the standard error of the difference between two estimates calculated following the delta method. Note that the SAP variables are exogenous in this analysis. The lavaan manual states that exogenous ordinal variables should have a coding scheme reflecting the order and can be treated as a numeric covariate (Rosseel, 2020). Simulation studies reveal that for ordinal variables with four categories, robust ML is an acceptable choice when the structural parameters are of interest (Rhemtulla, Brosseau-Liard, & Savalei, 2012). Especially when the underlying distribution is nonnormal, as with these activity variables, the robust ML is preferred over the robust categorical least squares methodology (Rhemtulla et al., 2012). In line with these findings, FIML estimation with robust (Huber-White) standard errors and a scaled test statistic that is (asymptotically) equal to the Yuan-Bentler test statistic is applied for this second hypothesis (the MLR estimator in lavaan).

Hypothesis 3

Lastly, the third hypothesis studies potential gender differences in the previous model. The path model from the second hypothesis is transformed into a multiple-group model, grouping on gender. Equality constraints are imposed on same-level activities for each gender separately. As in hypothesis 2, lavaan's MLR estimator is used. This hypothesis is first answered in general terms using a model comparison with the scaled chi-square difference test and the Satorra Bentler method (2001). Here the freely estimated two-group model (with differing estimates for men and

women) is compared with a two-group model in which the path coefficients of the SAP variables are constrained to the same value for men and women. In essence, the first model allows the estimates for men and women to differ, whereas the second model assumes the path coefficients of the SAP variables to be identical for men and women. When this test yields a significant result, the estimates per group (men and women) are inspected. We formally tested which of these path coefficients differ between men and women by subtracting their corresponding estimates and testing whether this new parameter differs significantly from zero. Wald tests with the standard error of the difference calculated following the delta method were used here.

Results

The sample comprised 372 community-dwelling older adults at risk of frailty. Of the participants, aged 60-93 (mean=74.61, SD=7.89), more than half were men (52.2%), 59.1% had no partner, and 42% had a monthly household income below €1,500.

Table 1 shows the results obtained for the means, standard deviation, and relative percentages for each study variable at baseline. Compared with the men in the sample, the women were older, had lower household incomes, were more frequently widowed, demonstrated higher levels of physical deterioration and well-being, and engaged less frequently in sports and associational memberships. See Table 1 for an overview of the significant differences found between men and women.

<Insert Table 1 around here>

Hypothesis 1

Step1: Confirmatory Factor Analysis.

First, a confirmatory factor analysis supports the theoretical assumption that the factor loadings of same-level activities are identical (difference factor loadings level 2 = -.260, p=.113; difference factor loadings level 2 = -.266, p=.148). Accordingly, equality constraints were imposed in a one-factor CFA to force the factor loadings of same-level activities to be identical. Results are shown in Table 2. This model has a good model fit (x^2_{22}=25.076, p=.293; CFI=.994, TLI=.992, RMSEA=.019, and SRMR=.06) and all factor loadings are significant (all p <.001). The results indicate that this one-factor model is suitable to explain the data. Factor scores were created. This new variable is labelled "activity participation" and can be used in the subsequent analysis.

Step 2: Path model with factor scores.

We found a good model fit (x^2_{22}=3.264, p=.196; CFI=.999, TLI=.973, RMSEA=.041, SRMR=.005). All factor loadings were significant (all p <.001). Activity participation has a significant association with the follow-up measures of physical deterioration (*B*=-12.081, SE=3.939, p=.002) and well-being (*B*=.053, SE=2.079, p=.980), but not with mental deterioration (*B*=5.812, SE=1.954, p=.003), indicating that the more participants were active, the lower their physical deterioration and the greater their well-being at follow-up. For physical deterioration we found a significant association (*B*=.618, SE=.042, p<.001) with physical deterioration at baseline. Hence the higher the physical deterioration at baseline, the higher the score for physical deterioration at follow-up. A significant association between physical deterioration and activity participation (*B*=-12.081, SE=3.939, p=.002) was found. Age is a significant predictor of physical deterioration at follow-up. Older participants tend to experience more physical deterioration than their younger peers (*B*=0.477, SE=0.188, p=.011). Divorced older adults tend to experience higher physical deterioration than their married counterparts (*B*=8.612, SE=4.003, p=.031).

For mental deterioration we found a significant association with mental deterioration at baseline (*B*=0.442, SE=0.045, p<.001), so the higher the mental deterioration at baseline, the higher the mental deterioration at follow-up. For physical deterioration at follow-up we found a significant association for mental deterioration and for SWB at baseline. Age is also a significant predictor of mental deterioration at follow-up. Older participants tend to experience more mental deterioration than younger participants (*B*=0.271, SE=0.099, p=.006). Divorced older adults tend to experience more mental deterioration than their married counterparts (*B*=4.439, SE=2.110, p=.035).

For SWB at follow-up, significant effects of SWB (*B*=0.568, SE=0.048, p<.001) and of mental deterioration (*B*=-0.106, SE=0.042, p=.011) were found at baseline.

<Insert Table 2 around here>

Hypothesis 2

For the second hypothesis (Table 3) there is a good model fit: x^2_6=6.291, p =.908 (Yuan-Bentler correction factor); Robust CFI=1, Robust TLI=0.997, Robust RMSEA=.011 (90% CI: 0–0.066), SRMR=.004). Physical deterioration at follow-up was significantly predicted by level-2 activities (being with others) (*B*=-2.707, SE=0.871, p=.002). There was also a marginal significant effect of level-3 activities (socially oriented activities; *B*=-2.491, SE=1.343, p=.064). Older adults who performed these activities demonstrated lower physical deterioration. Moreover, results for physical deterioration at follow-up reveal a significant association with physical deterioration at baseline (*B*=0.596, SE=0.046, p<.001), so the higher the physical deterioration at baseline, the higher the physical deterioration at follow-up. Age is a significant predictor of physical deterioration at follow-up (*B*=0.521, SE=0.192, p=.011), meaning that older participants tend to

experience more physical deterioration than younger participants. Being divorced is also significant (*B*=9.979, SE=4.326, p=.021), demonstrating that divorced older adults tend to experience more physical deterioration than their married counterparts.

For mental deterioration, in line with the results of the previous hypothesis, none of the activities significantly predict mental deterioration at follow-up (all p>.10). We found significant effects of mental deterioration at baseline (*B*=.442, SE=.070, p<.001), SWB at baseline (*B*=-.270, SE=.065, p<.001), age (*B*=.289, SE=0.111, p=.009), and being divorced (*B*=4.792, SE=2.146, p=.026).

For SWB at follow-up, there was a positive significant effect for level-2 activities (being with others) (*B*=.781, SE=0.396, p=.048), for level-3 activities (socially oriented activities; *B*=1.281, SE=.648, p=.048), and for level-6 activities, (contributing to society/volunteering) (*B*=1.402, SE=.615, p=.023). Performing these activities demonstrated a positive effect for SWB. There was also a significant association with SWB at baseline (*B*=.565, SE=.054, p<.001), so the higher the SWB at baseline, the higher the SWB at follow-up. A significant association was found with physical deterioration at baseline (*B* =-.028, SE=.025, p=.029).

<Insert Table 3 around here>

Hypothesis 3

The model comparison between a model that forces the path coefficients of the activity variables of men and women to be equal and a model that allows these estimates to differ is found to be significant (χ^2_{27}=512.657, p=.002), indicating that there are indeed gender-based differences in the effects of the activity variables. Next, a multiple-group model is fitted, which yielded a good model fit (χ^2_{11}=20.087, p=1.055; Robust CFI=0.990, Robust TLI=0.893, Robust RMSEA=0.067 (90%

CI: 0–0.103) & SRMR=0.006). Results are shown in Table 4. First, for men only level 6 (contributing to society/volunteering) has a marginally significant association with physical deterioration (*B*=3.215, SE=1.673, p=.055). Specifically, the more men volunteer, the higher their physical deterioration at follow-up. For mental deterioration a significant association with level 1 (alone) was observed, implying that the more actively men perform at home, the more mental deterioration they tend to experience at follow-up (*B*=2.498, SE=1.041, p=.016). For SWB, the output shows that men who did more level-2 and level-3 activities tended to experience greater SWB at follow-up (*B*=1.725, SE=0.545, p=0.002 and *B*=1.689, SE, 0.859, p=0.049, respectively), whereas participating in level-1 or level-4 activities were associated with lower levels of SWB at follow-up (*B*=-2.479, SE=1.061, p=0.020 and *B*=-0.855, SE=0.498, p=0.086, respectively).

By contrast, for women only we see that those participating more in level-1 and level-2 activities tend to experience less physical deterioration at follow-up (*B*=-5.313, SE=2.748, p=0.053 and *B*=-4.046, SE=1.260, p=0.001), whereas women who participate more in level-4 activities experience more physical deterioration at follow-up (*B*=1.987, SE=1.192, p=0.095). Note that the latter effect is only marginally significant.

When formally testing for gender differences, for physical deterioration a marginally significant trend is found between men and women for level-1 activities (diff =6.848, p=.065) and level-4 activities (task-oriented activities) (diff =-3.025, p=.038). Women who participated more in level-4 activities experienced more physical deterioration (*B*=1.987, SE=1.192, p=0.095), whereas no significant association was found between this activity and physical deterioration for men (*B*=-1.038, SE=.842, p=218). For mental deterioration, a gender difference was found only for level-1 activities (diff=3.691, p=0.030). For SWB, statistical differences between the genders

were found for level-1 (diff=-5.972, p=0.004) and level-2 activities (diff=2.023, p=0.009), and a marginally significant difference for task-oriented activities (level 4; diff=-1.338, p=0.064).

<Insert Table 4 around here>

Discussion

Gaining insight into which SAP can function as a preventive action is of vital importance (Hoogendijk et al., 2019). We have aimed to advance knowledge on the association between SAP and health and well-being in later life by simultaneously investigating different activity levels in a less healthy (at risk of frailty) or frail population. Longitudinal analyses have been performed to understand whether and which SAP promotes health and well-being. We projected gaining insight into the role of gender in the association between different activities and health and well-being. To achieve a better understanding of these relationships, we constructed three hypotheses.

The first hypothesis indicates that older adults at risk of frailty benefit longitudinally from participating in activities in terms of physical deterioration and well-being. For mental deterioration no significant effect of participating in activities was found. Our first hypothesis generally supported the fundamental premise that engagement in activities, regardless of activity type, contributes to reduce physical deterioration and produces SWB among older adults, their frailty notwithstanding. Our results support a core premise of productive aging theory (Bass & Caro, 2001) and activity theory (Havighurst, 1961; Lemon et al., 1972), namely the claim that the initiation and maintenance of a diverse range of SAP benefits older individuals' health and SWB. In other words, remaining engaged to continue with SAP, even in the face of increasing frailty, supports successful aging (Rowe & Kahn, 2015) or healthy aging (WHO, 2015).

The second hypothesis posited that the association between SAP and health and well-being depends on the SAP level in the taxonomy of Levasseur and colleagues (2010): we expected that

the higher the interaction and goal of the participation level, the better health and well-being. This hypothesis was not supported. However, our results show that the associations are complex, as suggested by the different longitudinal findings for the three outcome measures. More specifically, for physical deterioration performing activities for oneself such as attending cultural events and engaging in solo sports (level 2), as well as socially oriented activities (level 3), appear to have a positive effect longitudinally. These findings are consistent with results of other studies, such as those of Matz-Costa et al. (2016) and Hoogendijk et al. (2019), which found that physical activities like walking and biking reduce sedentary life and contribute to lower risks for physical frailty. Still, activities with higher levels of social interaction and engagement do not contribute to physical deterioration (rejecting hypothesis 2).

A different picture emerged for mental deterioration. All activities, despite the positive effects found in other studies – ranging from activities alone (levels 1 & 2) to activities with others (levels 3 & 4), and for others (levels 5 & 6) – do not appear to play a role in maintaining or improving mental deterioration longitudinally.

For SWB, activities for oneself but with people around (level 2), socially oriented activities like eating out (level 3), and contributing to society/formal volunteering (level 6) had a positive effect. The results demonstrate that a higher level of participation on the taxonomy of social activities does not improve SWB. Doing activities for oneself, with others and for others all appear to be associated with positive outcomes for SWB. This also suggests that heterogeneity of activities, regardless of level on the taxonomy, produces health and SWB in later life.

The third hypothesis, theorizing that the association between SAP and good health and SWB differs by gender, was confirmed. For women, performing activities alone (level 1) related with less physical deterioration, whereas greater physical deterioration related to performing task-

oriented activities (level 4). Greater well-being was reflected in performing activities alone at home (level 1). A plausible explanation for the finding on such activities is that they may be perceived from a gendered division that is imbued with societal perceptions and expectations that they should be performed by women (Calasanti, 2009, 2019; Nesteruk & Price, 2011). Societies are organized on the basis of gender and reflect gender identities that arise in social interaction and may disadvantage women, which may also be related to women's inability or unwillingness to participate in associational or organizational activities (Calasanti, 2009; Martinson & Minkler, 2006, p. 322). However, the greater the physical deterioration when performing task-oriented activities, such as associational membership (level 4), may be linked to the role overload theory (Davis, 1996).

For men, doing activities alone at home (level 1) results in more mental deterioration and performing activities with others (level 2) results in higher levels of SWB. Our results corroborate previous studies stating that men are active more often in activities outside the home, such as solo sports and cultural events (level 2), which may contribute to higher levels of SWB (Ang, 2018; Hoogendijk et al., 2019).

This study is not without limitations and results should be interpreted with caution. First, although we considered a wide range of SAP, this range could have been extended even further by including religious activities, for example (Putnam et al., 2014), or hosting events at home as a task-oriented activity at level 4, since both activities involve collaboration with others (Everard et al., 2000). Second, we did not consider the contexts of the activities, such as extent of others' involvement or subjective aspects. The levels of discretionary involvement, enjoyment, stress, and other relevant factors remain unspecified, notwithstanding evidence that involvement in an activity is not adequate in and of itself for understanding its outcomes (Matz-Costa et al., 2014). As noted

by Adams et al. (2011), the classification of activities according to two or more dimensions such as social/active and social/passive offers a promising avenue for further research. Third, the time frame of our study was short (six months), so our ability to understand the associations of activities with health and SWB outcomes over time was constrained. In future studies, a qualitative research design would provide added value to gain insight into levels of discretionary involvement and the role of gender. In addition, the effect of the various combinations of activities on health and well-being could be assessed, given that several studies have shown that well-being outcomes vary as a result of the combination of activities (Morrow-Howell et al., 2014; Vozikaki et al., 2017). Lastly, recent literature has analyzed in-depth the effects of using factor scores as a predictor or outcome in subsequent analysis. Even though estimates are indeed biased when factor scores are used as outcome variables, they showed the unbiasedness of the estimated coefficients when the factor score is used as predictor analytically and in simulation studies in both simple and complex settings (Devlieger et al., 2016; Loncke, 2018). Moreover, the SAP variables are measured on a 4-point scale and are exogeneous variables in this analysis. The lavaan manual states that for exogeneous ordinal variables, a coding scheme reflecting the order should be used and can be treated in the model as any other numeric covariate. However, one should be aware that a different interpretation is mandatory for such ordinal variables: the coefficients should be interpreted as moving from one level (e.g. the value 1 on the scale) to the next (e.g. the value 2 on the scale). Simulation studies reveal that for ordinal variables with four categories, robust ML is an acceptable choice when structural parameters are of interest (Rhemtulla, Brosseau-Liard, & Savalei, 2012) – especially when the underlying distribution is nonnormal, as with these activity variables.

In sum, the main contribution of this study is the finding that heterogeneity of activities, regardless of its level on the taxonomy, produces health and SWB in later life. It also demonstrates

that by studying a wide range of activities simultaneously among individuals at risk of frailty a broader picture of their health and well-being can be obtained (Johnson & Mutchler, 2014). The findings themselves support that the engagement of older (frail) adults in diverse levels of SAP contributes to their health and well-being, regardless of level of social interaction. Activities for oneself, like attending cultural events and solo sports; activities with others, such as eating out; or activities for society, such as volunteer work all benefit one's health and well-being. Our study expands on the current literature and taxonomy of Levasseur by providing evidence that regardless of level of participation on the taxonomy of social activities, engaging in activities for oneself, with others or for others all have a positive effect on health and well-being in later life. Our research also clarifies that some of the activities can be beneficial to varying degrees based on the health outcomes of interest, and demonstrated that SAP is gender-differentiated. Considered from a healthy aging perspective (WHO, 2015), this study offers a new perspective for examining how specific activities are associated with healthy aging in frail, older adults, and presents a more realistic portrayal of the kinds of activities they engage in (Morrow-Howell et al., 2014). Hence it is important to emphasize heterogeneity of activity in later life. Programs and interventions should alternate between activities for oneself, with others and for others, given that the activity itself may play a more important role than the nature of social involvement and social interaction in relation to health and well-being (Duppen et al. 2019a).

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Table 1 Characteristics of the study sample and baseline health, well-being, social and activity participation, and gender differences

		Overall *N*=372 (100%)	Men *N*=194 (52.2%)	Women *N*=178 (47.8%)	**p*-value
Age in years M (SD)		74.61 (7.89)	73.86 (7.55)	75.41 (8.12)	0.165
Household income (euros) N (%)	0–999	16 (4.8%)	7 (4.0%)	9 (5.7%)	<0.001
	1001–1499	125 (37.2%)	47 (26.6%)	78 (49.1%)	
	1500–1999	80 (23.8%)	49 (27.7%)	31 (19.5%)	
	2000–2499	53 (15.8%)	31 (17.5%)	22 (13.8%)	
	2500+	62 (18.5%)	43 (24.3%)	19 (11.9%)	
Marital status N (%)	Married	128 (34.4%)	84 (43.3%)	44 (24.7%)	<0.001
	Cohabiting	24 (6.5%)	16 (8.2%)	8 (4.5%)	
	Single	26 (7.0%)	18 (9.3%)	8 (4.5%)	
	Divorced	73 (19.6%)	34 (17.5%)	39 (21.9%)	
	Widowed	121 (32.5%)	42 (21.6%)	79 (44.4%)	
Educational level N (%)	No degree	6 (1.6)	3 (1.6)	3 (1.7)	<0.001
	Primary education	22 (6.0%)	12 (6.3%)	10 (5.6%)	
	Middle secondary	95 (25.8%)	33 (17.3%)	62 (35.0%)	
	Higher secondary	139 (37.8%)	75 (39.3%)	64 (36.2%)	
	Higher education	28.55 (34.87)	21.50 (31.21)	36.23 (37.05)	<0.001
Physical deterioration M (SD)		17.22 (20.58)	14.60 (20.26)	20.04 (20.59)	0.531
Mental deterioration M (SD)		78.10 (18.30)	79.22 (18.70)	76.83 (17.81)	0.716
Subjective well-being M (SD)					
Social and activity participation M (SD)					
Level 1	Activities in preparation for connecting with others (1-4)	3.69 (0.811)	3.69 (0.839)	3.71 (0.782)	0.875
Level 2	Activities with others around: cultural events (1-4)	1.80 (0.947)	1.79 (0.967)	1.80 (0.929)	0.762
Level 2	Activities with others around: solo sports (1-4)	2.75 (1.402)	2.92 (1.371)	2.57 (1.418)	0.012
Level 3	Socially oriented activities (1-4)	3.02 (1.076)	3.05 (1.107)	2.98 (1.044)	0.426
Level 4	Task-oriented activities: adult education (1-4)	1.409 (0.937)	1.361 (0.872)	1.461 (1.003)	0.328
Level 4	Task-oriented activities: associational membership (1-4)	1.86 (1.202)	1.97 (1.261)	1.74 (1.125)	0.046
Level 5	Helping others (1-4)	2.15 (1.305)	2.15 (1.317)	2.16 (1.296)	0.987
Level 6	Contributing to society: formal volunteering (1-4)	1.38 (0.936)	1.41 (0.963)	1.34 (0.909)	0.262

Notes: Frequencies with percentages (%) as well as means (M) and standard deviations (SD) are displayed in the table. Differences between men and women, reflected in the proportions of categorical variables, were *tested using Chi-square tests, T-tests and Mann-Whitney U-tests, and were performed to compare the mean values of health and well-being with social and activity participation.

Table 2 Path model addressing hypothesis 1. The association between the general activity participation measure and physical and mental deterioration and subjective well-being at follow-up, while controlling for different variables.

	Exogenous variables		
	Physical deterioration B (SE)	**Mental deterioration B (SE)**	**Subjective well-being B (SE)**
Endogenous variables			
Activity participation	-12.081 (3.939)**	0.053 (2.079)	5.812 (1.954)**
Physical deterioration at baseline	0.618 (0.042)***	0.012 (0.022)	-0.037 (0.021)
Mental deterioration at baseline	-0.074 (0.086)	0.442 (0.045)***	-0.106 (0.042)**
Subjective well-being at baseline	-0.146 (0.100)	-0.262 (0.053)***	0.568 (0.048)***
Control variables			
Age	0.477 (0.188)*	0.271 (0.099)**	-0.084 (0.093)
Educational level	-0.857 (1.463)	-0.592 (0.779)	-0.730 (0.733)
Marital status			
Widowed	2.512 (3.653)	2.425 (1.950)	-0.249 (1.843)
Divorced	8.612 (4.003)*	4.439 (2.110)*	0.004 (1.987)
Single	4.546 (5.384)	0.260 (2.853)	1.247 (2.607)
Cohabiting	-2.601 (5.464)	0.023 (2.908)	-1.844 (2.688)
Income	1.221 (1.363)	-0.995 (0.744)	1.064 (0.671)
Covariances			
Physical deterioration			
Mental deterioration	65.586 (16.062)***		
Subjective well-being	-38.335 (15.140)**		
Mental deterioration			
Subjective well-being	-58.323 (8.559)***		

*p<.05, **p<.01, ***p<.001, $^{+}$p< .10.

Table 3 Path model addressing hypothesis 2. The association between the different activity participation levels of Levasseur and physical and mental deterioration and subjective well-being at follow-up, while controlling for different variables.

		Exogenous variables		
		Physical deterioration B (SE)	**Mental deterioration B (SE)**	**Subjective well-being B (SE)**
Path coefficients				
Endogenous variables				
Activities for oneself				
Level 1: Activities in preparation for connecting with others		-1.259 (2.051)	0.870 (0.939)	-0.155 (1.005)
Level 2: Activities with others: cultural events		-2.707 (0.871)**	-0.425 (0.424)	0.781 (0.396)*
Level 2: Activities with others: solo sports		-2.707 (0.871)**	-0.425 (0.424)	0.781 (0.396)*
Activities with others				
Level 3: Socially oriented activities		-2.491 (1.343)$^{+}$	-0.150 (0.722)	1.281 (0.648)*
Level 4: Task-oriented activities: adult education		0.353 (0.748)	0.106 (0.442)	-0.259 (0.381)
Level 4: Task-oriented activities: associational membership		0.353 (0.748)	0.106 (0.442)	-0.259 (0.381)
Activities for others				
Level 5: Helping others		0.874 (1.046)	0.862 (0.548)	-0.126 (0.475)
Level 6: Contributing to society: formal volunteering		1.279 (1.240)	-0.098 (0.692)	1.402 (0.615)*
Physical deterioration at baseline		0.596 (0.046)***	0.007 (0.026)	-0.028 (0.025)
Mental deterioration at baseline		-0.063 (0.100)	0.442 (0.070)***	-0.112 (0.051)*
Subjective well-being at baseline		-0.129 (0.107)	-0.270 (0.065)***	0.565 (0.054)***
Control variables				
Age		0.521 (0.192)**	0.289 (0.111)**	-0.101 (0.110)
Educational level		-0.919 (1.410)	-0.693 (0.867)	-0.536 (0.694)
Marital status				
Widowed		3.819 (3.340)	2.559 (2.000)	0.000 (2.066)
Divorced		9.979 (4.326)*	4.792 (2.146)*	-0.237 (2.160)
Single		4.823 (5.169)	0.340 (2.467)	1.322 (2.363)
Cohabiting		-2.550 (4.385)	0.305 (3.254)	-2.032 (2.300)
Income		1.324 (1.241)	-1.146 (0.784)	1.233 (0.743)
Covariances				
Physical deterioration & Mental deterioration	62.646 (19.662)**			
Physical deterioration & Subjective well-being	-36.117 (16.193)*			
Mental deterioration & Subjective well-being	-57.312 (12.164)***			

*p<.05, **p<.01, ***p<.001, $^{+}$p<.10.

Table 4 Path model addressing hypothesis 3. The association between social and activity participation and health and subjective well-being on might differ between men and women

	Exogenous variables								
	Physical deterioration			Mental deterioration			Subjective well-being		
	Men	Women	Difference	Men	Women	Difference	Men	Women	Difference
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Endogenous variables									
Activities for oneself									
Level 1: Activities in preparation for connecting with others	1.535 (2.503)	-5.312 (2.748)$^{+}$	6.848 (3.717)$^{+}$	2.498 (1.041)*	-1.044 (1.338)	3.691 (1.702)*	-2.479 (1.061)*	3.500 (1.801)$^{+}$	-5.972 (2.090)†
Level 2: Activities with others: social events	-1.433 (1.083)	-4.046 (1.260)†	2.614 (1.662)	-0.330 (0.558)	-0.692 (0.657)	-0.082 (1.021)	1.725 (0.545)†	-0.300 (0.549)	2.023 (0.773)†
Level 2: Activities with others: solo sports	-1.433 (1.083)	-4.046 (1.260)†	2.614 (1.662)	-0.330 (0.558)	-0.692 (0.657)	-0.082 (1.021)	1.725 (0.545)†	-0.300 (0.549)	2.023 (0.773)†
Activities with others									
Level 3: Socially oriented activities	-1.416 (1.449)	-3.016 (2.462)	1.601 (2.857)	-0.516 (0.919)	1.480 (1.139)	-1.972 (1.465)	1.689 (0.859)*	-0.088 (1.046)	1.780 (1.354)
Level 4: Task-oriented activities: adult education	-1.038 (0.842)	1.987 (1.192)$^{+}$	-3.025 (1.459)*	-0.417 (0.543)	0.972 (0.739)	-1.491 (0.908)	-0.855 (0.498)$^{+}$	0.485 (0.525)	-1.338 (0.723)$^{+}$
Level 4: Task-oriented activities: associational membership	-1.038 (0.842)	1.987 (1.192)$^{+}$	-3.025 (1.459)*	-0.417 (0.543)	0.972 (0.739)	-1.491 (0.908)	-0.855 (0.498)$^{+}$	0.485 (0.525)	-1.338 (0.723)$^{+}$
Activities for others									
Level 5: Helping others	-0.463 (1.303)	1.457 (1.645)	-1.920 (2.098)	0.861 (0.784)	1.105 (0.745)	-0.251 (1.082)	-0.075 (0.668)	-0.098 (0.611)	0.024 (0.905)
Level 6: Contributing to society: formal volunteering	3.215 (1.673)$^{+}$	-0.478 (1.776)	3.691 (2.440)	0.660 (0.974)	-1.272 (1.024)	1.790 (1.419)	0.655 (0.803)	2.680 (0.948)†	-2.025 (1.242)
Physical deterioration at baseline	0.548 (0.066)‡	0.595 (0.066)‡	-0.048(0.093)	-0.023 (0.041)	0.044 (0.031)	-0.068 (0.051)	-0.035 (0.035)	-0.025 (0.031)	-0.010 (0.047)
Mental deterioration at baseline	-0.062 (0.133)	-0.091 (0.138)	0.028 (0.192)	0.416 (0.105)‡	0.462 (0.075)‡	-0.051 (0.128)	-0.026 (0.069)	-0.218 (0.057)‡	0.192 (0.089)*
Subjective well-being at baseline	-0.219 (0.139)	-0.070 (0.156)	-0.150 (0.210)	-0.244 (0.084)†	-0.329 (0.096) †	0.078 (0.127)	0.604 (0.065)‡	0.467 (0.074)‡	0.137 (0.099)
Age	0.464 (0.263)$^{+}$	0.612 (0.306)*		0.194 (0.155)	0.335 (0.152)*		-0.045 (0.147)	-0.060 (0.149)	
Educational level	-1.547 (1.813)	-0.385 (2.300)		-2.100 (0.979)*	0.597 (1.355)		-0.315 (0.927)	-0.317 (1.028)	
Marital status									
Widowed	2.204 (4.701)	1.665 (5.010)		3.613 (2.644)	2.070 (3.017)		-2.752 (2.557)	2.065 (3.259)	
Divorced	10.689 (6.043)$^{+}$	8.398 (6.309)		6.666 (2.973)*	3.374 (3.271)		-1.856 (3.102)	0.879 (3.425)	
Single	-2.058 (3.975)	18.205 (11.987)		0.838 (3.488)	0.781 (3.529)		-0.097 (3.007)	3.474 (3.383)	
Cohabiting	3.776 (5.660)	-13.381 (8.777)		1.190 (4.328)	0.558 (3.471)		-3.752 (3.296)	2.322 (2.968)	
Income	0.831 (1.482)	1.592 (2.408)		-0.345 (0.971)	-2.730 (1.259)*		0.962 (0.824)	1.715 (1.371)	
Covariances									
Physical deterioration & mental deterioration	62.582 (23.858)†	49.500 (25.229)*							
Physical deterioration & subjective well-being	-46.521 (20.988)*	-20.694 (18.777)							
Mental deterioration & subjective well-being	-60.121 (12.924)‡	-43.784 (16.620)†							

*p<.05, †p< .01, ‡p<.001, $^{+}$p<.10.