

Profiles of Physical Function, Physical Activity, and Sedentary Behavior and their Associations with Mental Health in Residents of Assisted Living Facilities

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1 Profiles of Physical Function, Physical Activity, and Sedentary Behavior and their
2 Associations with Mental Health in Residents of Assisted Living Facilities.

3
4 **Abstract**

5 **Background.** The current study used latent profile analyses to identify classes of older
6 participants based on physical health, physical function, light physical activity, moderate-to-
7 vigorous physical activity, and sedentary behavior, and then examined differences in mental
8 health between these classes.

9 **Methods.** 85 residents ($M = 77.5$ years old, $SD = 8.2$) from assisted living facilities
10 participated. Light physical activity, moderate-to-vigorous physical activity, and sedentary
11 behavior were assessed by accelerometers, physical function was measured using different
12 tasks (mobility, grip strength, and spirometry), and body mass index was calculated. Mental
13 and physical health (i.e., anxiety, depression, fatigue, vitality, and subjective mental and
14 physical health) were assessed by questionnaires.

15 **Results.** Latent profile analyses revealed three classes: ‘Class 1: Low physical function and
16 physical activity with a highly sedentary lifestyle’ (27.1%), ‘Class 2: Moderate physical
17 function and physical activity with a moderate sedentary lifestyle’ (41.2%), ‘Class 3: High
18 physical function and physical activity with an active lifestyle’ (31.8%). The results revealed
19 that the latter class reported better mental health than the other two classes.

20 **Conclusions.** This study suggests that health promotion for older adults might benefit from
21 identifying profiles of movement-related behaviors when examining the links between
22 physical activity and mental health. Future study should test the intervention potential of this
23 profiling approach.

24 *Keywords:* Latent profile analysis, active lifestyle, accelerometer, older adults
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Introduction

With an increasingly aging population, it is important to explore factors related to maintaining good physical and mental health in older age. Recent evidence indicates that approximately 15% of older people (≥ 60 years) across the world are diagnosed with a mental health disorder (WHO, 2016). This study examined mental health and some of its movement-related correlates in residents in assisted living facilities. Assisted living facilities offer assistance with daily living activities, but the residents are largely independent (Carder, 2002). Poor mental health is prevalent in older adults residing in these settings and related to transfers to nursing homes (Aud & Rantz, 2005; Watson, Garrett, Sloane, Gruber-Baldini, & Zimmerman, 2003) such transfers have individual and societal costs (Hawes, Rose, & Phillips, 1999).

A physically active lifestyle is central to maintaining mental health in older adults. For example, engagement in objectively-assessed daily moderate-to-vigorous physical activity is related to lower prevalence of depressive symptoms (Vallance et al., 2011). Light physical activity, the most common intensity of physical activity for older adults, can also be important for reaping mental health benefits (Buman et al., 2010; Song, Lee, Baek, & Miller, 2011). Recent evidence also indicates that sedentary behavior is negatively associated with psychological health in adults independently of physical activity. For example, higher levels of sedentary behavior were related to depression or depressive symptoms (Hamer et al 2014, Kang et al 2013, Lucas et al 2011), however this has not been found in other studies (Rosenberg et al 2016).

Older adults living in assisted living facilities are at greater risk of experiencing compromised psychological health (Watson et al., 2003), and have lower levels of light physical activity compared to those living independently (Moran et al., 2015). Given the important roles of physical activity and sedentary behavior in mental health in community

51 dwelling older adults, gaining more knowledge about these associations in people living in
52 assisted living facilities might be informative to improve mental health in this particular
53 population of older adults.

54 Physical function is another factor related to physical and mental health in older
55 adults. For example, better physical function has been related to less time spent sedentary
56 (Lee et al., 2015) and a smaller risk for re-hospitalization (Soley-Bori et al., 2015). However,
57 the reported associations between physical function and mental health in people living in
58 assisted living facilities are inconsistent. For example, a pilot study of assisted living facility
59 residents revealed no associations between the use of a walking aid and depressive symptoms
60 (Wyrick, Parker, Grabowski, Feuling, & Ng, 2008), but grip strength and repeated chair rise
61 were related to depression in another study (Giuliani et al., 2008). Such inconsistent findings
62 might suggest that when exploring the associations between functional ability and mental
63 health, it is important to incorporate a range of measures of physical function. Given that
64 some of the measures have been reported to be influenced by physical activity, levels of
65 physical activity should also be taken into consideration. Unfortunately, studies that reported
66 on associations between physical function and mental health in residents of assisted living
67 facilities did not report physical activity.

68 Latent profile analysis was used to identify such profiles. With this method,
69 individuals are classified into distinct classes on the basis of their homogeneity of scores for
70 different behaviors (i.e., light physical activity, moderate-to-vigorous physical activity,
71 physical function, and sedentary behavior; Soley-Bori et al., 2015). Subsequently, differences
72 between the classes of people on dependent variables of interest can be explored. This
73 person-centered model can be distinguished from a variable-centered model (e.g., regressions,
74 ANOVAs) in which the aim is to explore relations between variables, ignoring how these
75 variables are combined within people. A person-centered model is more appropriate when

76 individuals in a sample have heterogeneous characteristics (Muthen & Muthen, 2000). As
77 such, this model is more suitable for use when considering the variable health status of
78 residents in assisted living facilities. Previous studies adopting latent profile analysis revealed
79 that different profiles reflecting mental health and health-related variables were related to
80 self-reported physical activity in middle aged adults (Gerber & Jonsdottir, 2014). To date,
81 latent profile analysis has not been used to explore the associations between physical function,
82 light physical activity, moderate-to-vigorous physical activity, sedentary behavior, and
83 mental health in older adults. The primary aim of this study was, therefore, to examine such
84 associations using latent profile analysis. We hypothesized that a number of distinguishable
85 profiles would be identified based on individuals' physical function, physical health, light
86 physical activity, moderate-to-vigorous physical activity, and sedentary behavior proportions.
87 Further, we expected the individuals in profiles with better physical function, more light
88 physical activity, more moderate-to-vigorous physical activity, and less sedentary behavior
89 would report better mental health than those individuals in profiles with worse physical
90 function and less movement.

91 **Methods**

92 **Participants**

93 Participants were recruited from 13 assisted living facilities across England. Assisted
94 living facilities were identified through either online searches or via websites
95 (www.housingcare.org). Following approval from managers of interested facilities, residents
96 were informed of the study through their assisted living facilities newsletter or well-being
97 staff, as well as during coffee morning or monthly meetings. A total of 85 residents (female=
98 68.2%, male= 31.8%, $M_{\text{age}}= 77.46$, $SD= 8.17$, age range= 65-99 years) took part in the study
99 (see Table 1). Demographic information and disease prevalence are reported in Table 1.
100 Residents who needed a wheelchair or scooter for their daily activities were excluded from

101 the study. The majority of the participants did not use an assistive device for walking (80%);
102 only 9 participants (10.6%) used a stick and 8 participants (9.4%) used a walking frame. The
103 study was approved by the Ethical Review Committee of a UK university. All participants
104 provided informed consent before participating.

105 **Procedures**

106 All assessments were carried out in a dedicated space in the participants' assisted
107 living facilities. All participants completed two testing sessions, which were scheduled one
108 week apart. At the beginning of the first session, research staff explained all procedures to the
109 participants. After this, body composition, spirometry, grip strength, and timed up and go
110 assessments were conducted. These measurements took approximately 40 minutes and were
111 carried out between 9 am and 4 pm. Following these measurements, a questionnaire pack was
112 given to participants, who were asked to complete it during the next week. In addition,
113 participants were given an accelerometer to wear during that week, and were asked to keep an
114 activity diary to record the wear time of the accelerometers.

115 **Measures**

116 *Body composition:* A portable body composition monitor (TANITA BC-545N) was
117 used to measure weight (kg). Height (m^2) was measured using a stadiometer (Seca Leicester
118 Height Measure). Body mass index (BMI) was calculated using the formula: weight [kg] /
119 height [m^2].

120 *Lung function:* Spirometry was conducted to measure lung function using a hand-held
121 spirometer (Micro Medical Micro Ms03 spirometer). Participants were seated for at least 5
122 minutes before the assessment was taken, and remained seated throughout. First, a clip was
123 placed on the nose of the participants to prevent exhaling or inhaling through the nose. All
124 participants conducted this assessment twice with a short break in between the assessments.
125 Forced expiratory volume in 1 second was provided and reported on the screen of the monitor.

126 Forced expiratory volume in 1 second was recorded as the highest volume of exhaling
127 (American Thoracic Society, 1987). The mean of two forced expiratory volume in 1 second
128 results was taken and was standardised by height² (forced expiratory volume in 1 second/ht²)
129 (Miller, Pedersen, & Dirksen, 2007).

130 *Grip strength test:* Grip strength was measured using a digital dynamometer (TAKEI
131 T.K.K. 5401 Grip-D, Japan). Participants were asked to stand up and grip the dynamometer
132 as tight as possible with their dominant hand (Shinkai et al., 2003). The test was conducted
133 twice, with the second test done approximately 10 seconds after the first assessment. The
134 average of the two measurements of grip strength was calculated and expressed in kg.

135 *Mobility test:* The Timed Up and Go test was conducted to measure mobility,
136 including the use of assistive device, and balance (Podsiadlo & Richardson, 1991).
137 Participants were asked to get up from their chair, walk 3 meters and return to the chair.-A
138 researcher demonstrated the procedure and participants were given the opportunity to practice.
139 Mobility was measured as the number of seconds taken to complete the task.

140 *Subjective physical and mental health:* The SF-12 was used to measure physical
141 health and mental health of the participants (Ware, Kosinski, & Keller, 1996). In this 12-item
142 questionnaire (6 items for each sub scale) participants were asked to respond to statements
143 which asked about their general physical and mental health over the last 4 weeks (e.g.,
144 “During the past 4 weeks, how much did pain interfere with your normal activities?”;
145 “During the past 4 weeks, did you have a lot of energy?”). Items were weighted and summed
146 according to existing guidelines (Ware, Kosinski, & Keller, 1998). A higher score of
147 subjective physical health and mental health indicates better physical and mental health
148 respectively.

149 *Subjective vitality:* The 5-item subjective vitality scale was selected (Ryan &
150 Frederick, 1997). Items (e.g., “I felt alive and full of vitality”) were rated on a 7-point scale

151 ranging from 1 (*not at all true*) to 7 (*very true*). Participants' responses across the 5 items
152 were averaged to provide an overall score for subjective vitality.

153 *Anxiety and depression:* The Hospital Anxiety and Depression Scale (HADS) was
154 used to measure anxiety and depressive symptoms (Zigmond & Snaith, 1983). This
155 questionnaire comprises 7 items to measure anxiety (e.g., "I can sit at ease and feel relaxed")
156 and 7 items for depression (e.g., "I still enjoy the things I used to enjoy"). The items were
157 summed for analysis.

158 *Fatigue:* Feelings of "general fatigue", "physical fatigue", "reduced activity", "mental
159 fatigue", "reduced motivation" were assessed using the Multiple Fatigue Index (MFI-20;
160 Smets, Garssen, Bonke, De, & Haes, 1995). A five-point scale was used ranging from (1) *yes,*
161 *that is true* to (5) *no, that is not true* to answer questions (e.g., "I feel fit"). For the purpose of
162 latent profile analysis, individual subscales were calculated and all subscales were summed to
163 represent the overall degree of fatigue experienced.

164 *Quality of life:* Quality of life was measured using the Dartmouth CO-OP Chart
165 (Jenkinson, Mayou, Day, Garratt, & Juszczak, 2002). The scale identifies 9 domains relevant
166 to quality of life (i.e., physical fitness, feelings, daily activities, social activities, pain, change
167 in health, overall health, social support, and quality of life), and a reference is made to the
168 past 4 weeks (e.g., for emotional problems: "During the past 4 weeks, how much have you
169 been bothered by emotional problems such as feeling anxious, depressed, irritable or
170 downhearted and sad?"). A total score was used for the purposes of latent profile analysis.

171 *Physical activity and sedentary behavior:* Activity monitors (models: GT3X+,
172 WGT3X-BT; ActiGraph, Pensacola, FL, USA) were used to assess sedentary behavior, light
173 physical activity, and moderate-to-vigorous physical activity. These two accelerometer
174 models have demonstrated high intra-monitor reliability and have been validated with
175 acceptable criteria (Miller, 2015). The monitors were set to collect counts at 60s epochs. An

176 algorithm was adopted to classify non-wear time (consecutive zeros: 90 minutes, tolerance
177 allowance: 2 minutes between 0 and <100 counts; Choi, Ward, Schnelle, & Buchowski,
178 2012). Participants were instructed to wear their monitor on their right hip and to remove it
179 during sleep and water-based activities (e.g., showering, swimming). Based on the daily start
180 and stop times of wearing accelerometers recorded in a time log by participants, we set a time
181 frame to represent waking hours (7 am – 10:30 pm). Data recorded during this time frame
182 were extracted to determine minutes per day spent sedentary and in different intensities of
183 physical activity. Inclusion criteria for valid accelerometer data were 10 hours of wear time
184 per day, on a minimum of 3 days, including a weekend day. Data from participants meeting
185 these criteria were retained for use in subsequent analyses ($N = 101$, accelerometer protocol
186 compliance = 89, no questionnaire responses = 4). The final sample, therefore, included $N =$
187 85 participants. Classification of the accelerometer data was conducted using criteria by
188 Matthews et al. (2008) for sedentary behavior, and Troiano et al. (2008) for light physical
189 activity and moderate-to-vigorous physical activity: sedentary = 0 to 99 counts per minute
190 (cpm), light physical activity = 100-2019 cpm, moderate physical activity = 2020-5998 cpm,
191 vigorous physical activity = ≥ 5999 cpm. The sum of moderate physical activity and vigorous
192 physical activity represented moderate-to-vigorous physical activity.

193 Minutes spent sedentary, in light physical activity, and in moderate-to-vigorous
194 physical activity recorded across all valid days were summed and divided by the number of
195 valid days to determine minutes/day spent in each activity. For the purpose of latent profile
196 analysis, activities were expressed as a percentage of wear time (calculated as minutes spent
197 in each activities (min/day) / average wear-times (min/day) x 100), in order to adjust for
198 inter-participant variability in accelerometer wear time (Booth et al., 2014).

199 **Statistical analysis**

200 IBM SPSS version 22.0 was used to calculate descriptive statistics and estimate
201 bivariate correlations. Missing data (26 items from different questionnaires were missing)
202 were imputed using the expectation maximization (EM) algorithm (Enders, 2001). We ran
203 LPA in Mplus version 7.4 (Muthén & Muthén, 2015) using the robust maximum likelihood
204 (MLR) estimator. All physical function variables (continuous) were standardized into z -
205 scores. The BCH method (Asparouhov & Muthén, 2014) was employed for class
206 comparisons using the mental health variables as (continuous) as auxiliary distal outcomes. A
207 nested model comparison approach was used, comparing more complex models (k -class
208 model) with simpler models ($k-1$ class model) to determine the number of classes to retain in
209 the final model. We estimated models with one to four latent classes. When deciding on the
210 final latent class solution, we used a number of statistical criteria, such as the Akaike
211 information criterion (AIC), Bayesian information criterion (BIC), the sample-size adjusted
212 BIC (SSA-BIC), Lo-Mendell-Rubin adjusted LRT test (adjusted LMR), bootstrapped
213 likelihood ratio test (BLRT), entropy, and proportion of participants in each class. Lower AIC,
214 BIC, and SSA-BIC values indicate better model fit. Statistically, significant adjusted LMR
215 and BLRT values indicate that the k -class model provides a better fit to the data compared to
216 the $k-1$ class model. In addition, higher entropy and the proportion of participants in each
217 class were also considered when comparing the nested models. We took the class size into
218 account because very small class sizes may result in imprecision and low power (Berlin,
219 Williams, & Parra, 2014). These statistical criteria, in combination with substantive meaning,
220 guided the choice of the final model (Marsh, Lüdtke, Trautwein, & Morin, 2009). Finally, we
221 conducted chi-square difference tests using the BCH method to examine differences amongst
222 the classes regarding mental health. Initially, 100 starting values were used with the 20 best
223 retained for the final solution. The final model was also replicated using 500 random start
224 values.

Results

Table 2 displays the descriptive statistics and bivariate correlations between the study variables. The participants spent on average 201.13 min/day (SD= 71.96) in light physical activity, 9.74 min/day (SD= 9.62) in moderate-to-vigorous physical activity, and 511.93 min/day (SD= 105.72) in sedentary behavior. As can be seen from Table 2, light physical activity, moderate-to-vigorous physical activity, subjective physical health, forced expiratory volume in 1 second, and mobility were positively correlated with mental health, whereas sedentary behavior was negatively correlated with mental health. No statistically significant correlations were found between grip strength, BMI, and mental health.

The statistical criteria indicated that the three-class model had a better model fit compared to the two-class model (except for the lower entropy value; Table 3). Some model fit indices indicated a slightly better model fit for a four class model compared to the three-class model. Adding a fourth class, however, did not provide a better understanding of the data and one of the classes in the four-class solution was very small ($n \approx 11$). In line with recommendations by Marsh et al. (2009), we considered the theoretical and substantive meaning of each class and concluded that adding a fourth class did not contribute to a better understanding of the data in the current study. The three latent classes are graphically depicted in Figure 1. The first class (class 1) was labeled ‘low physical function and physical activity (including light physical activity and moderate-to-vigorous physical activity) with a highly sedentary lifestyle’ and contained 27.1% of the sample. Class 1 was characterized by people who were not very physically active, perceived their physical health as poor, and showed poor physical functioning. The second class (class 2) was referred to as ‘moderate physical function and physical activity with a moderate sedentary lifestyle’ and consisted of 41.2% of the sample. Class 2 was characterized by moderately active people who reported moderate levels of physical health and showed moderate physical functioning. The third class

250 (class 3) was labeled ‘high physical function and physical activity with an active lifestyle’
251 and included 31.8%. Class 3 was characterized by physically active people that reported that
252 their physical health was good and showed a high level of physical functioning. The largest
253 mean differences across all profile indicators were found between class 1 (low physical
254 function and physical activity with a highly sedentary lifestyle) and class 3 (high physical
255 function and physical activity with an active lifestyle).

256 Table 4 shows the latent profile characteristics of the three-class model. Large effect
257 sizes (Cohen's $d \geq 0.8$; Cohen, 1988) were observed across all profile indicators between
258 class 1 and class 3. In contrast, the effect sizes of the differences between class 2 and class 1
259 ranged from medium to large, and those between class 3 and class 2 ranged from small to
260 large (small = 0.2, medium = 0.5; Cohen, 1988).

261 The mental health scores of the three classes are presented in Table 5. The means of
262 subjective mental health and vitality (higher values indicate better mental health) increased
263 from class 1 to class 2 to class 3. The means of quality of life, anxiety, depression, and
264 fatigue (higher values indicate worse mental health) showed an opposite pattern and
265 decreased from class 1 to class 2 to class 3 (Table 5). The overall tests for the class
266 comparisons were statistically significant for all mental health variables, except subjective
267 mental health, indicating an overall difference amongst the three classes. The specific class
268 comparisons showed that people in class 1 reported lower quality of life, less vitality, and
269 higher levels of depression and fatigue, compared to individuals in classes 2 and 3. People in
270 class 1 also reported lower levels of subjective mental health and higher levels of anxiety
271 compared to individuals in class 3. In class 2 people also reported lower quality of life, less
272 vitality, and higher levels of anxiety, depression, and fatigue compared to individuals in class
273 3. Large effect sizes were found between class 1 and class 3 for vitality ($d = 1.24$), fatigue (d
274 $= -1.89$), depression ($d = -1.67$), anxiety ($d = -1.02$), and quality of life ($d = -1.43$).

275 Given the high correlation between sedentary behavior and light physical activity, an
276 additional latent profile analysis was conducted without light physical activity as one of the
277 factors. These analyses revealed that taking out light physical activity did not significantly
278 influence the number of participants in each class (class 1: 28.2%, class 2: 42.4%, class 3:
279 29.4%). Importantly, the reported differences between the classes with regard to the mental
280 health outcomes remained similar to the ones presented above.

281 Discussion

282 The present study used latent profile analysis to classify individuals, based on their
283 physical health, physical function, physical activity, and sedentary behavior proportions, in
284 one of three distinct classes. All class indicators were standardized and the classes were
285 compared against each other on the basis of whether their mean score on each class indicator
286 was around the mean ($z = 0$) of the whole sample, above the mean (positive z scores) or
287 below (negative z scores) the mean. The first class (27.1% of the sample) included
288 individuals who, compared to the other two classes, had much lower levels of physical
289 activity, higher levels of sedentary behavior, were more overweight, and had poorer
290 functional health. The second class was the largest class (41.2%) and included individuals
291 who had average scores, compared to the other two classes, on all class indicators. The third
292 class (31.8%) included individuals who were substantially more active and less sedentary
293 than the rest of the sample, were somewhat leaner, and had somewhat better physical health
294 and functioning.

295 The most notable differences between classes 1 and 3 were found in sedentary
296 behavior, light physical activity, moderate-to-vigorous physical activity, mobility, and
297 perceived physical health. The results showed a large effect size (Cohen's $d \geq 0.8$; Cohen,
298 1988) in mobility between classes 1 and 3 and 1 and 2. Given that older adults spend a great
299 amount of time engaging in light physical activity (e.g., walking; Ainsworth et al., 2000;

300 Westerterp, 2008), this suggests that walking might be particularly important in terms of
301 supporting the mental health of older adults in assisted living facilities. It is also worth noting
302 that sedentary behavior and light physical activity were highly correlated, and that the
303 associations between sedentary behavior and light physical activity with mental health and
304 functional measures were the reverse of each other. This suggests that the message for
305 residents of assisted living facilities would be to spend less time in sedentary behavior and
306 more time in light physical activity. Indeed, the importance of replacing sedentary behavior
307 with this ‘nonexercise’ activity (light physical activity) has recently been reported to have a
308 significant effect on mortality risk (Matthews et al., 2015).

309 However, the classes not only differentiate between health behaviors, there are also
310 notable differences in physical function, with lung function, grip strength, and mobility being
311 substantially poorer in class 1 compared to class 3. From a clinical perspective, this suggests
312 that those with poorer physical function could also be at higher risk to suffer from poorer
313 mental health. Of particular interest is perceived physical health, given that poorer perceived
314 physical health is a strong predictor of all-cause mortality (Phillips, Der, & Carroll, 2010).

315 The results of the present study also indicated differences between class 1 and class 3
316 in several mental health indicators. These results are in line with previous studies showing
317 that lower anxiety and depression symptoms (Azevedo Da Silva et al., 2012; Song et al.,
318 2011), lower fatigue (Vallance, Boyle, Courneya, & Lynch, 2014), and higher walking speed
319 (Ní Mhaoláin et al., 2012) were related to higher levels of physical activity.

320 These results further show that those with greater physical function and a more active
321 and less sedentary lifestyle had better mental health compared to those with poorer functional
322 ability and low PA and highly sedentary lifestyle. This finding emphasises that interventions
323 aimed at improving physical function and encouraging an active lifestyle are likely to have an
324 important impact on mental health. Despite the effect sizes being somewhat smaller, it is also

325 worth noting the differences in mental health between class 1 and class 2. This shows that
326 even those with moderate physical function and physical activity with a moderately sedentary
327 lifestyle have better mental health compared to those with low physical function and physical
328 activity and a highly sedentary lifestyle. This implies that a small change in lifestyle and
329 physical function could lead to improvements in mental health. This is in line with physical
330 activity guidelines which state that even if older adults cannot achieve the recommended
331 level of physical activity, some physical activity engagement is better than no physical
332 activity engagement (Warburton & Bredin, 2016).

333 The present study incorporated a range of profiles based on movement-related
334 behaviors and functional abilities and examined differences amongst these profiles in mental
335 health outcomes. Importantly, our findings extend previous findings by taking a person-
336 centered approach and examining how physical activity, sedentary behavior, physical
337 function, and health combine into distinct profiles, instead of examining them as independent
338 predictors of mental health. For example, inspecting the effect sizes of the differences
339 between all three classes (Table 4), shows consistently high effect sizes in terms of levels of
340 physical activity, sedentary behavior, and physical health. Differences in functional ability
341 and BMI are also important but smaller in size, depending on which classes are compared.
342 Identifying classes of individuals is important for reaching better conclusions. For example,
343 comparing individuals on the basis of their physical functioning scores, without taking into
344 consideration how active these individuals are, is likely to give a false indication of how their
345 functional ability relates to their mental health.

346 This study is not without limitations. The cross-sectional study design does not allow
347 for the assessment of temporal patterns or causal relations between the variables in the
348 profiles and the mental health variables. Further, the stability of the class membership over
349 time could not be tested. No information was available regarding the medication taken by the

350 participants, therefore future studies could explore the impact of medication on the outcome
351 measures and class profiles. Another limitation is the small sample size. In the current study
352 we used many and high quality indicators (e.g., objectively-assessed physical activity,
353 sedentary behavior and physical function), two factors that can compensate for small sample
354 sizes, for example, by decreasing mean class proportion bias (Wurpts & Geiser, 2014). Small
355 sample sizes in latent profile analysis with a moderate numbers of classes can explain more
356 variance compared to many classes derived from large sample sizes (Marsh et al., 2009).
357 However, future research with large sample sizes should further examine the profiles and the
358 associations found in the present study. Participants were recruited from different assisted
359 living facilities. As the number of participants from each assisted living facility ranged from
360 1 to 33 residents, it is not possible to conduct any meaningful comparisons between the
361 residents from the different assisted living facilities. Similarly, the majority of the participants
362 did not use a walking aid, therefore, it was not possible to explore the influence of the use of
363 walking aids on our results. In addition, no data were collected considering the person-
364 centered care activities in each assisted living facility, which could have an impact of some of
365 the outcome measures. Therefore, future research is warranted to explore the impact of these
366 kind of activities on the associations reported in the current study. Notwithstanding these
367 limitations, the study makes several unique contributions to the literature. Strengths of this
368 study include objective assessments of physical function, physical activity, and sedentary
369 behavior in assisted living facility residents. This is particularly relevant given the known
370 underestimation of sedentary behavior and over estimation of physical activity when using
371 self-reported measures (Tudor-Locke & Myers, 2001). Another strength is the inclusion of
372 multiple mental health indices, both negative (e.g., depression) and positive (e.g., vitality).
373 The majority of the studies which assessed the associations between physical activity,
374 sedentary behavior, and functional ability have limited their assessment to only a few

375 measures of mental health (Biswas et al., 2015; Chodzko-Zajko et al., 2009; Turvey, Schultz,
376 Beglinger, & Klein, 2009). The person-focused approach we used provides an alternative
377 view to the traditional variable-centered approach utilized in the literature that examines
378 activity-related correlates of mental health in older adults. Lastly, our research investigates
379 older adults in assisted living facilities, an under-researched group of older adults.

380 Findings from our study could be utilized to help these individuals remain mobile and
381 mentally healthy, and avoid or prolong move to full care facilities. Our findings can be useful
382 for health promotion research and practice in terms of developing more targeted/profile-based
383 interventions that take into account variations in scores across a range of movement and
384 functional abilities. Further research should develop targeted interventions (focusing on
385 improving physical functioning or levels of physical activity or both) based on individuals'
386 profiles to examine changes in means and proportions of each class, and whether such
387 changes predict changes in mental health outcomes.

388 **Conflict of Interest**

389 There are no conflicts of interest.

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References

- Ainsworth, B., Haskell, W., Whitt, M., Irwin, M., Swartz, A., Strath, S., ... Leon, A. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise*, 32(9), S498-504.
- Asparouhov, T., & Muthén, B. (2014). *Muthén, B. . Auxiliary variables in mixture modeling: Using the BCH method in Mplus to estimate a distal outcome model and an arbitrary second model. Paper can be downloaded from here Mplus Web Notes No 21* (Vol. Mplus Web).
- Aud, M., & Rantz, M. (2005). Admissions to skilled nursing facilities from assisted living facilities. *Journal of Nursing Care Quality*, 20(1), 16–25.
- Berlin, K. S., Williams, N. A., & Parra, G. R. (2014). An introduction to latent variable mixture modeling (part 1): overview and cross-sectional latent class and latent profile analyses. *Journal of Pediatric Psychology*, 39(2), 174–87.
<http://doi.org/10.1093/jpepsy/jst084>
- Biswas, A., Oh, P. I., Faulkner, G. E., Bajaj, R. R., Silver, M. A., Mitchell, M. S., & Alter, D. A. (2015). Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults a systematic review and meta-analysis. *Annals of Internal Medicine*. American College of Physicians.
- Booth, J. N., Leary, S. D., Joinson, C., Ness, A. R., Tomporowski, P. D., Boyle, J. M., & Reilly, J. J. (2014). Associations between objectively measured physical activity and academic attainment in adolescents from a UK cohort. *British Journal of Sports Medicine*, 48(3), 265–70. <http://doi.org/10.1136/bjsports-2013-092334>
- Buman, M. P., Hekler, E. B., Haskell, W. L., Pruitt, L., Conway, T. L., Cain, K. L., ... King, A. C. (2010). Objective light-intensity physical activity associations with rated health in

- older adults. *American Journal of Epidemiology*, 172(10), 1155–65.
<http://doi.org/10.1093/aje/kwq249>
- Carder, P. C. (2002). The social world of assisted living. *Journal of Aging Studies*, 16(1), 1–18. [http://doi.org/10.1016/S0890-4065\(01\)00031-7](http://doi.org/10.1016/S0890-4065(01)00031-7)
- Chodzko-Zajko, W., Proctor, D., Singh, M., Minson, C., Nigg, C., Salem, G., & Skinner, J. (2009). Exercise and physical activity for older adults. *Medicine And Science In Sports And Exercise*, 41(7), 1501–1530. <http://doi.org/10.1249/MSS.0b013e3181a0c95c>
- Choi, L., Ward, S. C., Schnelle, J. F., & Buchowski, M. S. (2012). Assessment of wear/nonwear time classification algorithms for triaxial accelerometer. *Medicine and Science in Sports and Exercise*, 44(10), 2009–2016.
<http://doi.org/http://dx.doi.org/10.1249/mss.0b013e318258cb36>
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ: Erlbaum.
- Enders, C. (2001). A primer on maximum likelihood algorithms available for use with missing data. *Structural Equation Modeling*, 8(1), 128–141.
http://doi.org/http://dx.doi.org/10.1207/s15328007sem0801_7
- Gerber, M., & Jonsdottir, I. (2014). Physical activity in employees with differing occupational stress and mental health profiles: A latent profile analysis. *Psychology of Sport and Exercise*, 15(6), 649–658. <http://doi.org/10.1016/j.psychsport.2014.07.012>
- Giuliani, C. A., Gruber-Baldini, A. L., Park, N. S., Schrodt, L. A., Rokoske, F., Sloane, P. D., & Zimmerman, S. (2008). Physical performance characteristics of assisted living residents and risk for adverse health outcomes. *Gerontologist*, 48(2), 203–212.
- Hawes, C., Rose, M., & Phillips, C. (1999). *A national study of assisted living for the frail elderly: Results of a national survey of facilities*. US Department of Health and Human

Services. Retrieved from <http://aspe.hhs.gov/basic-report/national-study-assisted-living-frail-elderly-results-national-survey-facilities>

Jenkinson, C., Mayou, R., Day, A., Garratt, A., & Juszczak, E. (2002). Evaluation of the Dartmouth COOP charts in a large-scale community survey in the United Kingdom. *Journal of Public Health Medicine, 24*(2), 106–111.
<http://doi.org/http://dx.doi.org/10.1093/pubmed/24.2.106>

Lee, J., Chang, R. W., Ehrlich-Jones, L., Kwok, C. K., Nevitt, M., Semanik, P. A., ... Dunlop, D. D. (2015). Sedentary behavior and physical function: objective evidence from the Osteoarthritis Initiative. *Arthritis Care & Research, 67*(3), 366–73.
<http://doi.org/10.1002/acr.22432>

Marsh, H., Lüdtke, O., Trautwein, U., & Morin, A. J. (2009). Classical Latent Profile Analysis of Academic Self-Concept Dimensions: Synergy of Person- and Variable-Centered Approaches to Theoretical Models of Self-Concept. *Structural Equation Modeling, 16*(2), 191–225. <http://doi.org/10.1080/10705510902751010>

Matthews, C. E., Chen, K. Y., Freedson, P. S., Buchowski, M. S., Beech, B. M., Pate, R. R., & Troiano, R. P. (2008). Amount of time spent in sedentary behaviors in the United States, 2003-2004. *American Journal of Epidemiology, 167*(7), 875–881.
<http://doi.org/http://dx.doi.org/10.1093/aje/kwm390>

Matthews, C. E., Moore, S. C., Sampson, J., Blair, A., Xiao, Q., Keadle, S. K., ... Park, Y. (2015). Mortality Benefits for Replacing Sitting Time with Different Physical Activities. *Medicine and Science in Sports and Exercise, 47*(9), 1833–1840.
<http://doi.org/10.1249/MSS.0000000000000621>

Miller, J. (2015). Cross-Generation Accuracy. Retrieved from <http://actigraphcorp.com/wp-content/uploads/2015/04/cross-generation-accuracy.pdf>

- Miller, M., Pedersen, O., & Dirksen, A. (2007). A new staging strategy for chronic obstructive pulmonary disease. *International Journal of Chronic Obstructive Pulmonary Disease*, 2(4), 657.
- Moran, F., MacMillan, F., Smith-Merry, J., Kilbreath, S., & Merom, D. (2015). Perceived Barriers, Facilitators and Patterns of Physical Activity of Older-old Adults Living in Assisted Retirement Accommodation: a qualitative and quantitative pilot research. *J Gerontol Geriatr ...*, 4(6). <http://doi.org/10.4172/2167-7182.1000255>
- Muthen, B., & Muthen, L. K. (2000). Integrating Person-Centered and Variable-Centered Analyses: Growth Mixture Modeling With Latent Trajectory Classes. *Alcoholism: Clinical and Experimental Research*, 24(6), 882–891. <http://doi.org/10.1111/j.1530-0277.2000.tb02070.x>
- Muthén, L., & Muthén, B. (2015). *Mplus User's Guide*. (Muthén & Muthén, Eds.) (Seventh Ed). Los Angeles, CA.
- Ní Mhaoláin, A. M., Fan, C. W., Romero-Ortuno, R., Cogan, L., Cunningham, C., Kenny, R.-A., & Lawlor, B. (2012). Frailty, depression, and anxiety in later life. *International Psychogeriatrics*, 24(8), 1265–74. <http://doi.org/10.1017/S1041610211002110>
- Phillips, A. C., Der, G., & Carroll, D. (2010). Self-reported health, self-reported fitness, and all-cause mortality: prospective cohort study. *British Journal of Health Psychology*, 15(Pt 2), 337–46. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/19619405>
- Podsiadlo, D., & Richardson, S. (1991). The timed “Up & Go”: a test of basic functional mobility for frail elderly persons. *Journal of the American Geriatrics Society*, 39(2), 142–148. <http://doi.org/http://dx.doi.org/10.1111/j.1532-5415.1991.tb01616.x>
- Rosenberg, D. E., Bellettiere, J., Gardiner, P. A., Villarreal, V. N., Crist, K., & Kerr, J. (2016). Independent Associations Between Sedentary Behaviors and Mental, Cognitive,

- Physical, and Functional Health Among Older Adults in Retirement Communities. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, 71(1), 78–83. <http://doi.org/10.1093/gerona/glv103>
- Ryan, R. M., & Frederick, C. (1997). On energy, personality, and health: subjective vitality as a dynamic reflection of well-being. *Journal of Personality*, 65(3), 529–565. <http://doi.org/http://dx.doi.org/10.1111/j.1467-6494.1997.tb00326.x>
- Shinkai, S., Kumagai, S., Fujiwara, Y., Amano, H., Yoshida, Y., Watanabe, S., ... Shibata, H. (2003). Predictors for the onset of functional decline among initially non-disabled older people living in a community during a 6-year follow-up. *Geriatrics and Gerontology International*, (3), S31–S39. <http://doi.org/http://dx.doi.org/10.1111/j.1444-0594.2003.00094.x>
- Smets, E. M. A., Garssen, B., Bonke, B., De, M., & Haes, J. C. J. (1995). The multidimensional Fatigue Inventory (MFI) psychometric qualities of an instrument to assess fatigue. *Journal of Psychosomatic Research*, 39(3 SRC), 315–325. [http://doi.org/http://dx.doi.org/10.1016/0022-3999\(94\)00125-o](http://doi.org/http://dx.doi.org/10.1016/0022-3999(94)00125-o)
- Soley-Bori, M., Soria-Saucedo, R., Ryan, C. M., Schneider, J. C., Haynes, A. B., Gerrard, P., ... Kazis, L. E. (2015). Functional Status and Hospital Readmissions Using the Medical Expenditure Panel Survey. *Journal of General Internal Medicine*, 30(7), 965–72. <http://doi.org/10.1007/s11606-014-3170-9>
- Song, M. R., Lee, Y.-S., Baek, J.-D., & Miller, M. (2011). Physical activity status in adults with depression in the National Health and Nutrition Examination Survey, 2005–2006. *Public Health Nursing*, 29(3), 208–17. <http://doi.org/10.1111/j.1525-1446.2011.00986.x>
- Troiano, R. P., Berrigan, D., Dodd, K. W., Mâsse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine and Science*

in Sports and Exercise, 40(1), 181–8. <http://doi.org/10.1249/mss.0b013e31815a51b3>

Tudor-Locke, C., & Myers, A. (2001). Challenges and opportunities for measuring physical activity in sedentary adults. *Sports Medicine*, 31(2), 91–100.

<http://doi.org/10.2165/00007256-200131020-00002>

Turvey, C. L., Schultz, S. K., Beglinger, L., & Klein, D. M. (2009). A longitudinal community-based study of chronic illness, cognitive and physical function, and depression. *The American Journal of Geriatric Psychiatry : Official Journal of the American Association for Geriatric Psychiatry*, 17(8), 632–41.

<http://doi.org/10.1097/JGP.0b013e31819c498c>

Vallance, J. K., Boyle, T., Courneya, K. S., & Lynch, B. M. (2014). Associations of objectively assessed physical activity and sedentary time with health-related quality of life among colon cancer patients. Vallance, J. K., Boyle, T., Courneya, K. S., & Lynch, B. M. (2014). Associations of objectively assessed physical activity and. *Cancer*, 120(18), 2919–2926. <http://doi.org/10.1002/cncr.28779>

Vallance, J. K., Winkler, E. A. H., Gardiner, P. A., Healy, G. N., Lynch, B. M., & Owen, N. (2011). Associations of objectively-assessed physical activity and sedentary time with depression: NHANES (2005-2006). *Preventive Medicine*, 53(4–5), 284–8.

<http://doi.org/10.1016/j.ypmed.2011.07.013>

Warburton, D. E. R., & Bredin, S. S. D. (2016). Reflections on Physical Activity and Health: What Should We Recommend? *Canadian Journal of Cardiology*. Pulsus Group Inc.

Ware, J., Kosinski, M., & Keller, S. (1996). A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Medical Care*, 34(3), 220–233. <http://doi.org/10.1097/00005650-199603000-00003>

Ware, J., Kosinski, M., & Keller, S. (1998). How to Score the SF-12 Physical and Mental

Health Summary Scale (Second Edition).

Watson, L., Garrett, J., Sloane, P., Gruber-Baldini, A., & Zimmerman, S. (2003). *Depression in assisted living: Results from a four-state study. American Journal of Geriatric Psychiatry.*

Westerterp, K. R. (2008). Physical activity as determinant of daily energy expenditure. *Physiology & Behavior, 93*(4–5), 1039–43.

<http://doi.org/10.1016/j.physbeh.2008.01.021>

World Health Organization. (2016). WHO | Mental health and older adults. Retrieved June 16, 2016, from <http://www.who.int/mediacentre/factsheets/fs381/en/>

Wurpts, I. C., & Geiser, C. (2014). Is adding more indicators to a latent class analysis beneficial or detrimental? Results of a Monte-Carlo study. *Frontiers in Psychology, 5*(AUG). <http://doi.org/10.3389/fpsyg.2014.00920>

Wyrick, S., Parker, D., Grabowski, D., Feuling, H. M., & Ng, A. V. (2008). Relationships Among Walking Aids, Physical Activity, Depression, Fatigue, and Perceived Health in Assisted-Living Residents: A Pilot Study. *Journal of Applied Gerontology, 27*(4), 511–522. <http://doi.org/10.1177/0733464808315288>

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica, 67*(6), 361–370.

<http://doi.org/http://dx.doi.org/10.1111/j.1600-0447.1983.tb09716.x>

Table 1.

Demographics and Characteristics of Participants

Variable	
Age, <i>M (SD)</i>	77.46 (\pm 8.17)
Sex, <i>n (%)</i>	85
Male	27 (31.8 %)
Female	58 (68.2 %)
Education	
Secondary, <i>n (%)</i>	26 (30.6 %)
Higher, <i>n (%)</i>	8 (9.4 %)
Post graduate, <i>n (%)</i>	1 (1.2 %)
Other, <i>n (%)</i>	8 (9.4 %)
None of above, <i>n (%)</i>	32 (37.6 %)
Missing	10 (11.8 %)
Age left school, <i>M (SD)</i>	15.29 (<i>SD</i> 1.13)
Missing, <i>n (%)</i>	3 (3.5 %)
Marital status	
Married/co-habitated, <i>n (%)</i>	35 (41.2 %)
Widowed, <i>n (%)</i>	39 (45.9 %)
Single (never married), <i>n (%)</i>	2 (2.4 %)
Separate, <i>n (%)</i>	9 (10.6 %)
No. of children, <i>M (SD)</i>	2.4 (<i>SD</i> 1.29)
Missing, <i>n (%)</i>	2 (2.4 %)
Alcohol consumption	
Current, <i>n (%)</i>	51 (60.0 %)
Previous, <i>n (%)</i>	17 (20.0 %)
Never, <i>n (%)</i>	15 (17.6 %)
Missing, <i>n (%)</i>	2 (2.4 %)
Smoking	
Currently, <i>n (%)</i>	4 (4.7 %)
Previously, <i>n (%)</i>	43 (50.6 %)
Never, <i>n (%)</i>	37 (43.5 %)
Missing, <i>n (%)</i>	1 (1.2 %)
Ethnicity	
White British, <i>n (%)</i>	81 (95.3 %)
Irish, <i>n (%)</i>	2 (2.4 %)
Other white, <i>n (%)</i>	1 (1.2 %)
Asian, <i>n (%)</i>	1 (1.2 %)
Annual income before retirement or current	
< £20,000, <i>n (%)</i>	50 (58.8 %)
£20,000 - £35,000, <i>n (%)</i>	18 (21.2 %)
£35,000 - £45,000, <i>n (%)</i>	2 (2.4 %)
> £45,000, <i>n (%)</i>	2 (2.4 %)
Missing, <i>n (%)</i>	13 (15.3 %)

Self-reported disease

Diabetes, <i>n</i> (%)	10 (12.0%)
Cardiovascular disease, <i>n</i> (%)	53 (62.4%)
Musculoskeletal disease, <i>n</i> (%)	46 (54.1%)
Kidney/liver disease, <i>n</i> (%)	3 (3.5%)
Lung disease, <i>n</i> (%)	12 (14.1%)
Cancer, <i>n</i> (%)	8 (9.4%)
Parkinsons disease, <i>n</i> (%)	2 (2.4%)
Other, <i>n</i> (%)	16 (18.8%)

Table 2.

Descriptive statistics and bivariate correlation analyses

	<i>M</i>	<i>SD</i>	Skew	Kur	α	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. Wear time (min/day)	722.79	68.71	0.46	-0.84		.30**	-.30**	-.21	-.24*	-.05	-.13	.00	.16	.05	.10	-.09	.05	.01	.07
2. SB (%)	70.52	11.01	-0.08	0.23			-1.0**	-.64**	-.50**	-.30**	-.22*	.20	.56**	-.20	.38**	-.39**	.28*	.37**	.51**
3. Light PA (%)	28.11	10.20	0.02	0.00				.55**	.47**	.27*	.19	-.17	-.53**	.20	-.37**	.39**	-.27*	-.37**	-.49**
4. MVPA (%)	1.37	1.37	1.52	3.91					.48**	.35**	.29**	-.36**	-.50**	.10	-.35**	.21*	-.18	-.28**	-.43**
5. PCS-12	41.34	11.76	-0.30	-1.13	0.84					.37**	.08	-.38**	-.59**	.19	-.70**	.57**	-.43**	-.54**	-.66**
6. FEV ₁ (liter/m ²)	0.65	0.18	0.27	-0.07							.52**	-.06	-.49**	.27*	-.39**	.22*	-.35**	-.30**	-.37**
7. Grip (kg)	21.45	10.85	1.13	1.53								.11	-.34**	.02	-.07	.02	-.08	-.04	-.15
8. BMI (kg/m ²)	28.16	4.93	0.66	0.26									.12	.05	.20	-.07	.03	.09	.09
9. Mobility (seconds)	13.58	7.40	1.82	2.76										-.39**	.58**	-.47**	.36**	.52**	.59**
10. MCS-12	53.43	9.29	-1.40	2.20	0.80										-.38**	-.56**	-.46**	-.40**	-.63**
11. Vitality	4.23	1.40	-0.13	-0.39	0.92											-.50**	-.63**	-.69**	-.66**
12. Anxiety	4.82	3.50	0.54	-0.25	0.83												.65**	.55**	.60**
13. Depression	3.92	2.78	0.78	0.26	0.70													.65**	.70**
14. Fatigue	48.80	16.60	0.37	-0.07	0.57														.64**

15. QoL	21.78	6.34	0.61	$\bar{\alpha}$	0.82
				0.18	

Note. *<.05, **<.01, Skew = Skewness, Kur= Kurtosis, α = Cronbach’s alpha reliability coefficients, Light PA = Light physical activity, MVPA= Moderate-to-vigorous physical activity, PCS-12 = Physical health from SF-12, FEV₁ = Forced expiratory volume in 1 second, Grip = Grip strength, BMI = Body mass index, SB = Sedentary behavior, MCS-12 = Mental health from SF-12, QoL = Quality of life from the COOP Dartmouth chart, Descriptive statistics and bivariate correlation analyses were calculated after imputing missing data points.

Table 3.

Classes Identified via Latent Profile Analyses

Fit statistics	1 Class	2 Classes	3 Classes	4 Classes
AIC	1961.76	1648.78	1591.90	1550.80
BIC	2000.84	1729.38	1714.03	1714.46
SSA-BIC	1950.36	1625.28	1556.29	1503.09
Entropy	-	0.97	0.92	0.93
BLRT <i>p</i> -value	-	0.000	0.000	0.000
Percent of participants per class (%)	100	28.2, 71.8	27.1, 41.2, 31.8	29.4, 30.6, 27.1, 12.9

Note. AIC= Akaike information criterion, BIC= Bayesian information criterion, SSA-BIC= sample-size adjusted BIC, BLRT= Bootstrapped likelihood ratio test, Percent of participants per class (%)= the proportion of participants in each of the classes in the model.

Table 4.

Latent Profile Characteristics in the Three-Class Model (Unstandardized Scores)

	Class 1: ($n \approx 23$; 27.1%)		Class 2: ($n \approx 35$; 41.2%)		Class 3: ($n \approx 27$; 31.8%)		d_{2-1}	d_{3-1}	d_{3-2}
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
SB (%)	81.50	9.61	71.63	8.56	59.01	7.31	-1.04	-2.60	-1.57
Light PA (%)	17.40	9.56	27.09	8.80	38.43	6.71	1.06	2.58	1.42
MVPA (%)	0.09	0.08	1.29	1.02	2.56	1.64	1.50	2.05	0.96
PCS-12	30.87	8.69	40.46	10.87	51.28	9.11	0.95	2.29	1.07
FEV ₁	0.54	0.15	0.64	0.17	0.77	0.24	0.57	1.13	0.67
Grip	16.11	10.01	22.01	14.01	25.20	11.14	0.47	0.86	0.25
BMI	30.51	5.93	28.11	5.28	26.24	3.40	-0.43	-0.90	-0.41
Mobility	23.14	8.05	10.51	3.01	9.52	2.98	-2.27	-2.31	-0.33

Note. SB = Sedentary behavior, Light PA = Light physical activity, MVPA = Moderate-to-vigorous physical activity, PCS-12 = Physical health from SF-12, FEV₁ = Forced expiratory volume in 1 second, Grip = Grip strength, BMI = Body mass index, d = Cohen's d effect size statistic, Class 1: Low physical function and PA with a highly sedentary lifestyle, Class 2: Moderate physical function and PA with a moderate sedentary lifestyle, Class 3: High physical function and PA with an active lifestyle.

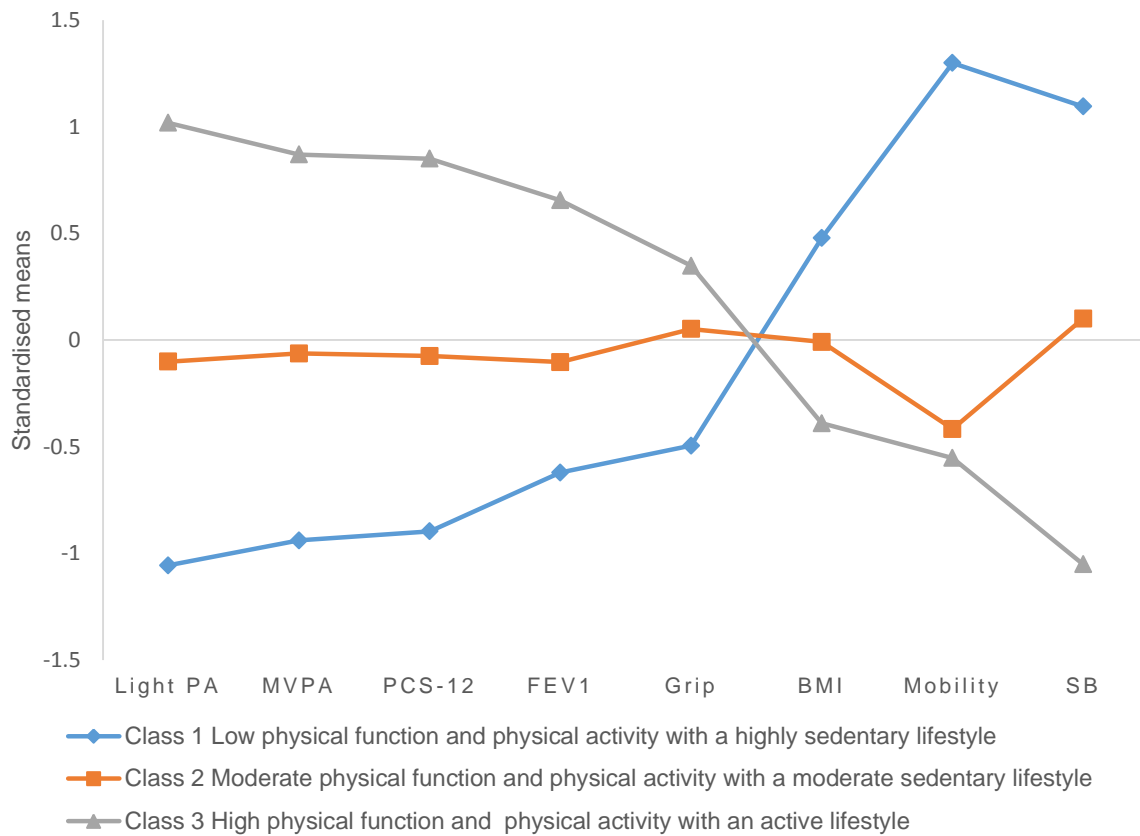
Table 5.

Description of the Three Latent Classes and χ^2 test for Differences Between the Classes in Mental Health

	MCS-12		Vitality		Anxiety		Depression		Fatigue		Quality of life	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Class 1	49.50	11.89	3.32	1.27	6.28	3.56	5.95	2.70	61.22	14.97	26.79	6.47
Class 2	54.42	8.40	4.36	1.47	5.20	3.72	3.93	2.75	50.68	14.75	20.92	5.59
Class 3	55.47	7.25	4.81	1.12	3.11	2.63	2.20	1.76	35.94	11.81	18.66	4.90
Class comparisons	χ^2	<i>p</i>	χ^2	<i>P</i>	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>	χ^2	<i>p</i>
Overall test	4.50	.108	19.40	.000	14.15	.001	34.08	.000	46.03	.000	24.58	.000
1 vs. 2	2.91	.088	8.07	.004	1.20	.273	7.49	.006	6.83	.009	12.48	.000
1 vs. 3	4.40	.036	19.07	.000	12.39	.000	32.61	.000	42.91	.000	24.42	.000
2 vs. 3	0.26	.610	1.71	.191	6.26	.012	8.45	.004	17.94	.000	2.69	.101
Cohen's <i>d</i> effect size												
<i>d</i> ₂₋₁	0.50		0.80		-0.30		-0.74		-0.71		-1.00	
<i>d</i> ₃₋₁	0.62		1.24		-1.02		-1.67		-1.89		-1.43	
<i>d</i> ₃₋₂	0.59		0.33		-0.63		-0.73		-1.09		-1.39	

NOTE. Vitality = MCS-12= Mental health from SF-12, QoL = Quality of life from the COOP Dartmouth chart, Vitality = Subjective vitality, Class 1: Low physical function and physical activity with a highly sedentary lifestyle (*n* = 23) 27.1%, Class 2: Moderate physical function and physical activity with a moderate sedentary lifestyle (*n* = 35) 41.2%, Class 3: High physical function and physical activity with an active lifestyle (*n*= 27) 31.8%.

Fig. 1.



Mean scores of profiles for the three-class model (standardized scores)

Note. Light PA= Light physical activity, MVPA= Moderate-to-vigorous physical activity, PCS-12= Physical health from SF-12, FEV₁= Forced expiratory volume in 1 second, Grip= Grip strength, BMI= Body mass index, SB= Sedentary behavior