

# Transitions between care networks: A prospective study among older adults in the Netherlands

Maura K. M. Gardeniers MSc<sup>1</sup> (corresponding author), Martijn Huisman PhD<sup>2</sup>, Erik Jan Meijboom PhD<sup>1</sup>, and Marjolein I. Broese van Groenou PhD<sup>1</sup>

<sup>1</sup>Vrije Universiteit Amsterdam, Department Sociale Wetenschappen, De Boelelaan, 1081 Amsterdam, Nederland.

<sup>2</sup>Amsterdam UMC, Vrije Universiteit Amsterdam, Department Epidemiologie & Biostatistiek, Amsterdam Public Health research institute, De Boelelaan, 1117 Amsterdam, Nederland.

<sup>1</sup>Vrije Universiteit Amsterdam, Department of Sociology, De Boelelaan, 1081 Amsterdam, The Netherlands.

<sup>2</sup>Amsterdam UMC, Vrije Universiteit Amsterdam, Department of Epidemiology & Biostatistics, Amsterdam Public Health research institute, De Boelelaan, 1117 Amsterdam, Netherlands.

Correspondence to: m.k.m.gardeniers@vu.nl

## **Conflict of Interest**

"We have no conflict of interest to declare."

## **Abstract**

With increasing health impairment, older adults use care from multiple types of caregivers, but little is known about changes in the composition of care networks. We mapped transitions between care network types, thereby providing insight into which people develop care networks involving informal, privately and publicly paid care. We used three waves (2012-2015-2018) from the Longitudinal Aging Study Amsterdam, containing 1413 Dutch community-dwelling adults, aged 64-100. Network types were identified using six types of care-givers: 1) co-residential, 2) non-co-residential children, 3) other kin, 4) neighbours/friends/acquaintances, 5) publicly paid, 6) privately-paid, in a Latent Transition Analysis with mortality and moving to a care facility as missing states. Five types of care networks were identified: 1) no-care, 2) privately-paid, 3) mixed-informal, 4) mixed-publicly paid, 5) co-residential. The co-residential network was most unstable, with high transition rates to residential care facilities. Participants from the privately-paid care network often transitioned to mixed-informal, and rarely to mixed-publicly paid. From the no-care network, transitions to the privately-paid network were most likely, but other transitions occurred as well. The two mixed care networks were most stable, and transitions to a care facility were most likely to occur for these types. Transitions appeared to be strongest induced by deteriorating health. Strategies aimed at preventing transitions to (more) publicly paid forms of care should focus on the mixed-informal, mixed-publicly paid, and the co-residential network. These strategies could include the introduction of (more) informal or privately-paid caregivers.

## **Keywords:**

Latent Transition Analysis, formal care, informal care

## 74 Introduction

75 With increasing life expectancy and care policies aimed at 'ageing in place', more older adults with  
76 complex health needs will require care at home for a considerable number of years (Böcker et al.,  
77 2017; WHO, 2015). As the need for care increases, a network usually develops around the person in  
78 need of care, consisting of different types of caregivers. The caregivers can be informal caregivers  
79 from the social network (e.g. spouses, relatives, friends and neighbours or volunteers) or formal  
80 caregivers (professionals) who are either publicly or privately paid. The ratio between the number of  
81 informal, publicly and privately paid caregivers can vary over the course of the care trajectory.

82 Previous research on care arrangements can be broadly divided into two traditions. The first  
83 tradition examines care arrangements longitudinally and divides caregivers into the rather broad  
84 categories of formal, informal or a mixture of formal and informal care (Bonsang, 2009; Geerts et al,  
85 2012; Kjaer & Siren, 2019; Tennstedt et al, 1996). These studies show that most older adults receive a  
86 mixed care arrangement in the later stages of their care trajectory.

87 The other tradition uses a network approach (Wenger 1991, 1997; Jacobs et al. 2018; Keating  
88 et al. 2003; Keating and Dosman 2009) and distinguishes the different constellations of care  
89 arrangements in more detail, usually at a specific point in time. This network approach has the  
90 advantage that it makes it possible to zoom in on these mixed care arrangements and generate ideal-  
91 typical networks in which the simultaneous occurrence of formal and informal care is made visible.  
92 These ideal-typical networks generally have different needs; for example, in networks in which  
93 formal and informal caregivers are present, communication between the caregivers should be  
94 facilitated (Jacobs et al., 2016). Networks involving only informal caregivers can be facilitated by  
95 various ways of supporting caregivers. If these needs can be linked to demographic characteristics, it  
96 will be easier for policy makers to promote the appropriate forms of support when needed.

97 Previous studies on care networks (CNs) have identified between four and eight types of CNs  
98 (Bijnsdorp et al, 2018; Broese van Groenou et al, 2016; Fret et al, 2017; Jacobs et al, 2018; Keating &  
99 Dosman, 2009; Savla et al, 2016), which differ in terms of size and the ratio of formal and informal  
100 caregivers. These network types generally included: a co-resident or spousal network, an informal  
101 network without a co-resident caregiver, a network consisting mainly of publicly paid caregivers, a  
102 CN with only (one) privately paid caregiver(s), and mixed networks containing both informal and  
103 formal caregivers in varying proportions (e.g., largely informal or largely formal). In general, the  
104 differences between these types of CNs are related to the individual determinants of care use: the  
105 need for care (health impairment), the willingness to use care (related to gender, age and education)  
106 and the ability to access certain types of care (e.g. the presence of a spouse for spousal care) (Jacobs  
107 et al., 2018). These cross-sectional findings suggest that transitions in CNs are largely determined by  
108 changes in health and/or social resources. Cross-sectional findings can shed light on the relationships  
109 between determinants and transitions, as they shed light on what conditions need to be in place for  
110 a certain type of CN to form. We know from previous studies that the presence of a partner is highly  
111 associated with the coresidential network (Jacobs et al., 2018; Keating & Dosman, 2009), that higher  
112 levels of education are more common in privately paid CNs (Bijnsdorp et al., 2018; Broese van  
113 Groenou, 2020; Jacobs et al., 2018) and that older age and more severe health impairment are found  
114 in the publicly paid network due to eligibility requirements for publicly paid care.

115  
116 From a policy perspective, it is important to gain insights into which CNs are likely to include publicly  
117 paid carers over time. Such information provides evidence on how to prevent or delay the costly use  
118 of publicly paid care. However, to date, neither transitions in CNs nor the associated determinants  
119 have been investigated, as all studies on CNs used a cross-sectional design (e.g. Jacobs et al. 2018;  
120 Keating and Dosman 2009). In addition, the Dutch healthcare system was reformed in 2015, with a  
121 shift from institutional care to facilitating ageing in place. The 2015 reform entailed decentralisation  
122 to municipalities, which were expected to provide this type of care more efficiently. As a result,  
123 funding for the provision of long-term home care was significantly reduced, by 35% compared to the  
124 funding that central government had previously spent on it (Alders and Schut, 2019). Eligibility

125 criteria for institutional care were raised and initially payment for care was income-related, with  
126 higher incomes paying more for care (Alders and Schut, 2019). In the run-up to the reform, politicians  
127 were quick to suggest that citizens should make more use of informal care from their own social  
128 network (Ministry of Health, Welfare and Sport, 2013).

129 A look at the welfare state also sheds light on what factors might enable certain CNs and  
130 transitions. Before the reform, the Dutch long-term care system for older adults had a high degree of  
131 defamilisation (Saraceno and Keck, 2010), so that responsibility for care lay primarily with the state.  
132 However, the transition involved a shift to a system with a higher degree of familialization and  
133 marketization, as it was pointed out that older adults are increasingly dependent on informal and  
134 privately paid care. Considering this, one would expect fewer transitions to publicly paid care after  
135 2015. At the same time, the increased eligibility criteria for institutional care following the reform  
136 may have led to more people making use of publicly paid care at home.

137  
138 In this study, we examine CNs using a prospective design covering an observation period of (2x3) six  
139 years. We investigate what types of CNs exist, what transitions between types of CNs take place,  
140 which CNs are most stable and what health and socioeconomic characteristics of care recipients are  
141 associated with these CNs.

## 142 Materials & Methods

### 143 Study sample and design

144 We used data from the Longitudinal Aging Study Amsterdam (LASA), an ongoing population-based  
145 longitudinal study of older adults (aged 55+) in the Netherlands (Hoogendijk et al., 2016, 2020). The  
146 baseline sample was stratified by age and gender from urban and rural regions of the Netherlands in  
147 1992/93 and comprised 3107 respondents aged 55 to 84 years. In 2002 and 2012, two additional  
148 cohorts of 55-64 year olds were added with 1002 and 1023 respondents respectively from the same  
149 sample but later birth cohorts. The baseline cooperation rates were 62% for the first and second  
150 cohorts and 63% for the third cohort. Data were collected through face-to-face interviews and self-  
151 completed questionnaires. If respondents refused or were unable to participate in the standard  
152 interview, they (or a proxy) were interviewed by telephone or in an abbreviated face-to-face  
153 interview. Additional measurement waves were conducted every three years. The present study  
154 included all participants living in a community at baseline who were 65 years or older in the 2012/13  
155 wave (N=1413), and covered the three measurement waves 2012/13, 2015/16 and 2018/19. The  
156 survey was administered in person to 871, 842 and 742 respondents in the first, second and third  
157 waves, by telephone to 34, 43 and 86 respondents, and by proxy to 17, 37 and 92 respondents.

158

### 159 Dependent variables

#### 160 *Care Network*

161 Respondents were asked whether and from whom they receive help in the following areas: personal  
162 care, home care, nursing care, transportation, and administrative tasks. We categorised six types of  
163 caregivers: 1) co-resident (spouse, co-resident children and/or others), 2) non-co-resident children,  
164 3) other relatives, 4) neighbours/friends/acquaintances, 5) publicly paid (community nurse, help at  
165 home), 6) privately paid (private help or in-home staff). For the follow-ups, we included two  
166 absorbing states: 1) moved to a care facility, 2) deceased, for which we used data from the municipal  
167 register (GBA).

168 Independent variables

169 We selected potential determinants based on the three dimensions of Andersen and Newman's  
170 (2005) behavioural model of health service use: Need, predisposing, and enabling factors. Need  
171 factors include all factors that increase the need for care, such as chronic illness, functional  
172 limitations and cognitive decline. Predisposing factors are factors such as demographic  
173 characteristics and attitudes towards care that indicate a willingness to ask for help. Enabling factors  
174 facilitate the use of care, e.g. the presence of potential caregivers in the social network.

175

176 *Need variables*

177 Functional limitations are measured as the respondents' ability to perform the following six activities  
178 of daily living: 1) dress or undress themselves, 2) get up from a chair or sit down, 3) cut their own  
179 toenails, 4) use their own or public transportation, 5) climb stairs, and 6) walk outside for five  
180 minutes without resting. Responses were summed and ranged from 6 to 30, with higher scores  
181 indicating a higher level of functioning (Pluijm et al., 2005).

182 Cognitive functioning was measured using a shortened version of the Mini-Mental State  
183 Examination (sMMSE) (Folstein et al., 1975; Tombaugh & McIntyre, 1992). The scale ranges from 0 to  
184 16, with higher scores indicating better cognitive functioning. For respondents who were unable to  
185 complete this questionnaire, cognitive functioning was assessed in a proxy interview and measured  
186 using a shortened version of the IQCODE (Jorm & Korten, 1988). To make the measures of cognition  
187 comparable over time, IQCODE scores were converted to sMMSE scores using cut-off points based  
188 on an earlier LASA study by Comijs, Dik, Deeg, and Jonker (2004).

189 Chronic diseases were recorded as the sum of seven types of chronic diseases (range 0-7):  
190 Lung disease, heart disease, arterial disease, diabetes, cardiovascular accidents, rheumatic diseases,  
191 and cancer.

192 The change scores for these variables were calculated by subtracting the previous wave's score from  
193 the current wave's score, resulting in one baseline score and two change scores per variable.

194

195 *Predisposing factors*

196 These include age at baseline (in years), sex (1=female) and education level, which was  
197 categorised into three groups: low (elementary school), medium (secondary school or lower  
198 vocational education) and high (higher vocational education or higher).

199

200 *Enabling factors*

201 Partner status with three categories (partner/no partner/lost partner compared to previous wave)  
202 was assessed at each wave to differentiate between the effects of losing a partner and not having a  
203 partner.

204

205 Method of data analysis

206 We calculated descriptive statistics using SPSS 27. We used a method that allowed for co-modelling  
207 of non-random dropouts such as death and moving to a care facility. This is important in longitudinal  
208 studies of older adults, as there is a strong association between high care needs and dropping out  
209 due to mortality or moving to a care facility. The exclusion of these departed respondents likely leads  
210 to the exclusion of respondents with high care needs. Thus, this co-modelling led to more accurate  
211 estimates of the groups that are typically of most interest to policy makers. We conducted a latent  
212 transition analysis (LTA) using MPLUS 8.6 (Muthén and Muthén, 1998-2020), together with the  
213 extension provided by Sterba (2016) in the form of a late-state-dependent nonignorable missingness  
214 LTA model (MNAR-PP LTA), which allows for co-modelling of censoring due to death and moving to a  
215 nursing facility. LTA is a longitudinal form of Latent Class Analysis (LCA) in which the classes (called  
216 states in LTA) consist of the CNs that form around an older adult. In this model (see Figure 1 for the

217 conceptual representation), the probability of moving into one of the identified latent states or  
 218 missing states is assessed at each time point.  
 219 Using the paper by Sterba (2016) as a guide, we tested several LTA models with different numbers of  
 220 states for the outcome variables and missingness. We chose the appropriate number of states based  
 221 on the lowest Bayesian information criterion (BIC), lowest log-likelihood, entropy, and qualitative  
 222 assessment of an additional state that is structurally different from the states identified in the N-1  
 223 state solution, favouring the simplest number of latent states.  
 224 Because of power issues, we did not model the predictors and provided the descriptives instead.  
 225  
 226

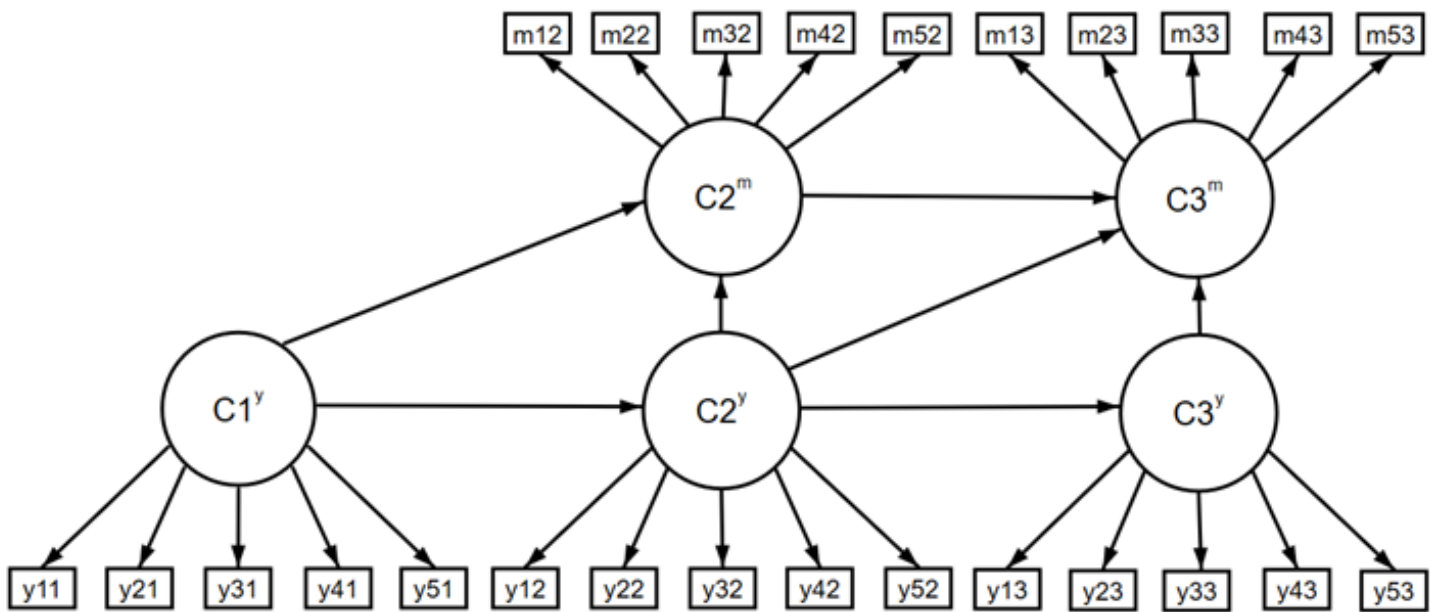


Figure 1. Conceptual view of the parallel-process missing-not-at-random (MNAR-PP) Latent Transition Analysis (LTA). Shown for Time=3, and number of groups J=5.  
 Notes Circles represent latent classification variables, arrows represent regression paths, squares represent measured variable indicators of the latent classification variables (Sterba, 2016)

227  
 228  
 229 [table 1 about here]  
 230  
 231

## 232 Results

233 In the first wave, the average age was 74.9 years, 56% were female and 67% had a partner. In the  
 234 second wave, 4% had moved into a nursing home and 13% had died. In the third wave, 5% of all  
 235 participants had moved into a care home and 24% had died.

236  
 237 The adjustment statistics of our LTA models were inconclusive. A five-state solution with two states  
 238 for missingness in wave 2 and wave 3 fit the data best, for several reasons: The BIC between models  
 239 did not differ substantially, the entropy was lowest for this number, and the five-state solution

240 identified the coresidential network as one of the networks, i.e., a network we expected based on  
 241 previous studies. The details of this procedure can be found in Supplementary File 1.  
 242 Figure 2 shows the item response probabilities for each response category within the five-state  
 243 solution. It is assumed that the types of CNs are similar across all waves. Table 2 also shows the  
 244 overall probabilities for each status at each time point (columns) and the transition probabilities  
 245 given latent status membership at each time point (rows). Figure 3 shows these transition  
 246 probabilities in an alluvial plot.

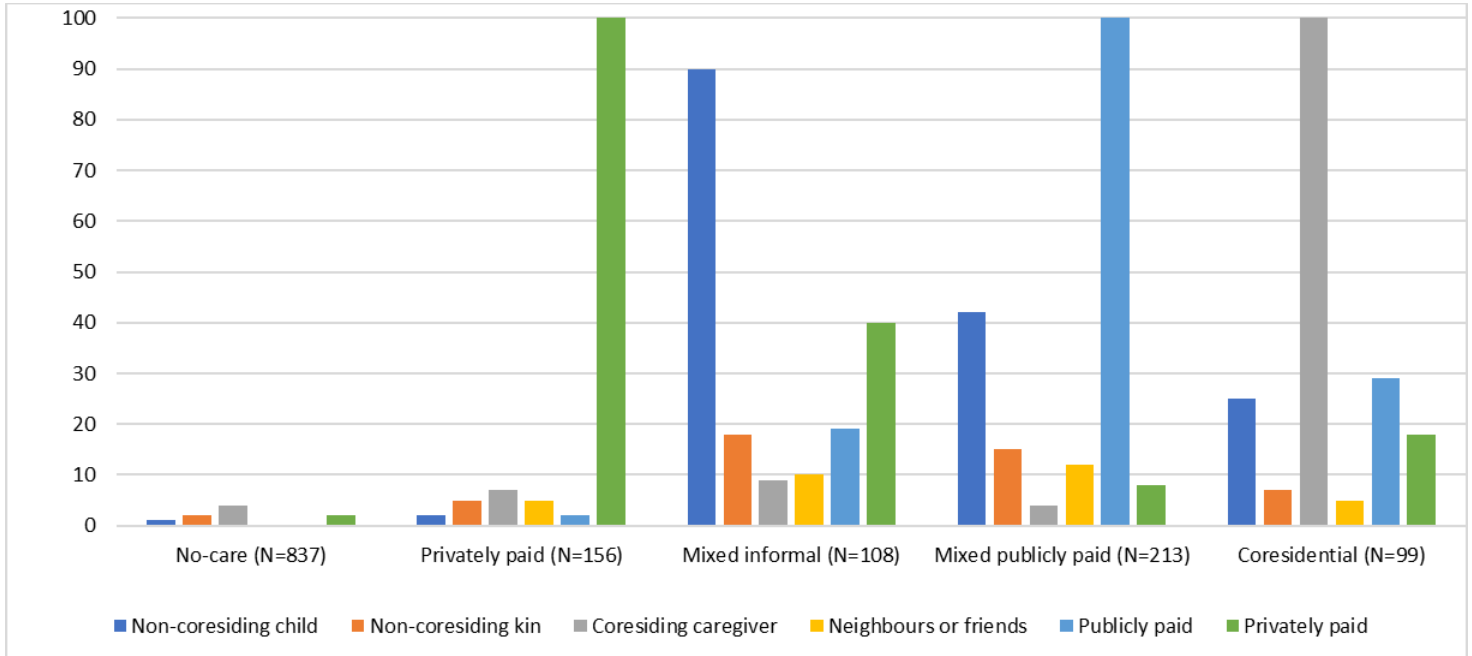


Figure 2. Percentages of types of caregivers in the five identified care network states, among 1413 Dutch older adults aged 65 and older. Care network types were assumed to be measurement invariant, and were assessed at T1 (2012/13), and held constant for 2015/16, and 2018/19.

247  
 248  
 249  
 250 [table 2 about here]

251  
 252  
 253 No care  
 254 Respondents in the first state 'No-CN' (59%<sub>T1</sub>) received hardly any care. As shown in Table 1,  
 255 respondents in this state were the youngest, with relatively high levels of functioning and few  
 256 chronic diseases. There were slightly more men in this network (52%), and respondents had a higher  
 257 level of education than the overall sample, 79% had a partner.  
 258 Most of these respondents remained in the network at time 2 (75%), and 5% died. Around 20%  
 259 moved to another network, with the largest proportions transitioning to the privately-paid (7%),  
 260 mixed-informal-CN (5%) and mixed-publicly-paid-CN (5%). At Time 3, these transition rates were  
 261 similar. Participants who transitioned to another network experienced function losses: ADL-scores  
 262 decreased on average by -2.7, sMMSE decreased by -0.5, and chronic conditions increased by 1.64,  
 263 compared with -0.5 ADL, -0.2 sMMSE, and 1.35 chronic conditions among those who remained  
 264 (calculations not shown). 13% of those who transitioned lost a partner, compared to 3% of those  
 265 who remained in the group.

266  
 267 Privately paid  
 268 These participants all received privately paid care (11%<sub>T1</sub>) and generally no other forms of care. There  
 269 were relatively many men in this group (37%). They had an average age, were less likely to have a

270 partner, and had a medium or high level of education, with high levels of functioning. At Time 2 most  
271 of these respondents remained in the privately-paid-CN (59.6%), 16.7% died, and about 25%  
272 transitioned: 12% to a mixed-informal, 9% to a mixed-publicly-paid, and 3% to a nursing home. About  
273 11% transitioned to mixed-informal-CN, indicating that informal caregivers supplemented the care  
274 already provided. The transition to a mixed-informal-CN was associated with a loss of function, as the  
275 average decline among participants that made this transition was -4.3 ADL score and -4.3 sMMSE  
276 points. Of those who transitioned at T2, 8% lost a partner compared to 6% of those who remained in  
277 the group. Mortality was high in this group at time 3: 40%.

#### 278 Mixed-informal

279 The mixed-informal-CN (7.6%<sub>T1</sub>) shows a wide variety of caregivers: 90% received help from non-  
280 resident children, 40% from a privately paid caregiver, and between 20% and 10% received help from  
281 non-resident kin, a co-resident caregiver, neighbours or friends, and/or a publicly paid caregiver. The  
282 care recipients were relatively old, women, with no partner, a lower level of education and  
283 moderately good physical and cognitive functioning.

284 At T2, 48.1% remained in this network and mortality was moderately high (24%), while 13.9%  
285 transitioned to a mixed-publicly-paid-CN and 11% to a nursing home. This was likely due to severe  
286 loss of function, as the mean decline in ADL and sMMSE for these participants were 10 and 2.8  
287 points, respectively. Of all participants who transitioned, 9% lost their partner, compared to 12% of  
288 participants who remained in this network. In the last wave, 76% of participants remained in the  
289 network, 17.5% died, and 7% moved to a care facility. This network appears to be relatively stable,  
290 although it is not known whether more or different informal caregivers joined the CN. Of the  
291 participants who made a transition, 9% lost a partner at T2 and 0% at T3.

#### 292 Mixed-publicly-paid

293 In the mixed-publicly-paid-CN (15%<sub>T1</sub>), 100% of older adults were cared for by a publicly paid  
294 caregiver. They also received help from non-resident children (43%) and from co-resident caregivers  
295 (5%), neighbours or friends (10%), privately paid caregivers (8%) and non-resident kin (15%).  
296 Respondents in these network were: women, older, single, with a low level of education, and poor  
297 health (ADL=21.15, sMMSE=14.05, 2.11 chronic diseases).

300 Half of these participants remained in this state at time 2 (50%), and 29% died. Almost 9%  
301 moved to a nursing facility and 8% to a privately-paid-CN. The participants who moved to a nursing  
302 facility had severe functional decline (mean -5.7 ADL, -2.6 sMMSE), while the participants who  
303 moved to a privately-paid-CN had mild functional decline (mean -2.6 ADL, -1.2 sMMSE). At Time 3,  
304 participants were most likely to die (47%), and 42% remained in the network. The proportion of  
305 participants who moved to a care facility was highest in this group: 9%.

#### 306 Co-resident

307 In the co-resident network (7%<sub>T1</sub>), all respondents received help from a co-resident partner or kin.  
308 Some also received care from non-coresident children (25%), as well as from publicly paid (28%) or  
309 privately paid (20%) caregivers. The network consisted of 62% women who were not very old (76.7  
310 years), often had a partner (92%) and had a lower level of education. The participants had a low level  
311 of physical and mental functioning (ADL=20.15, sMMSE=13.6). Most participants remained at time 2  
312 (46.5%), relatively many died (32.3%), and 17.2% moved into privately-paid-CN. Of those who moved  
313 to privately-paid-CN 24% lost a spouse. Only 4% moved to a nursing home. At T3, 56.9% remained  
314 and 19% died. 13.8% transitioned to the mixed-publicly-paid-CN. Looking at this group in more detail,  
315 we find that none of them lost a partner, but all of them experienced a deterioration in their  
316 functioning (-3.6 ADL, -0.6 sMMSE). At T3, 6.2% moved to a nursing home.

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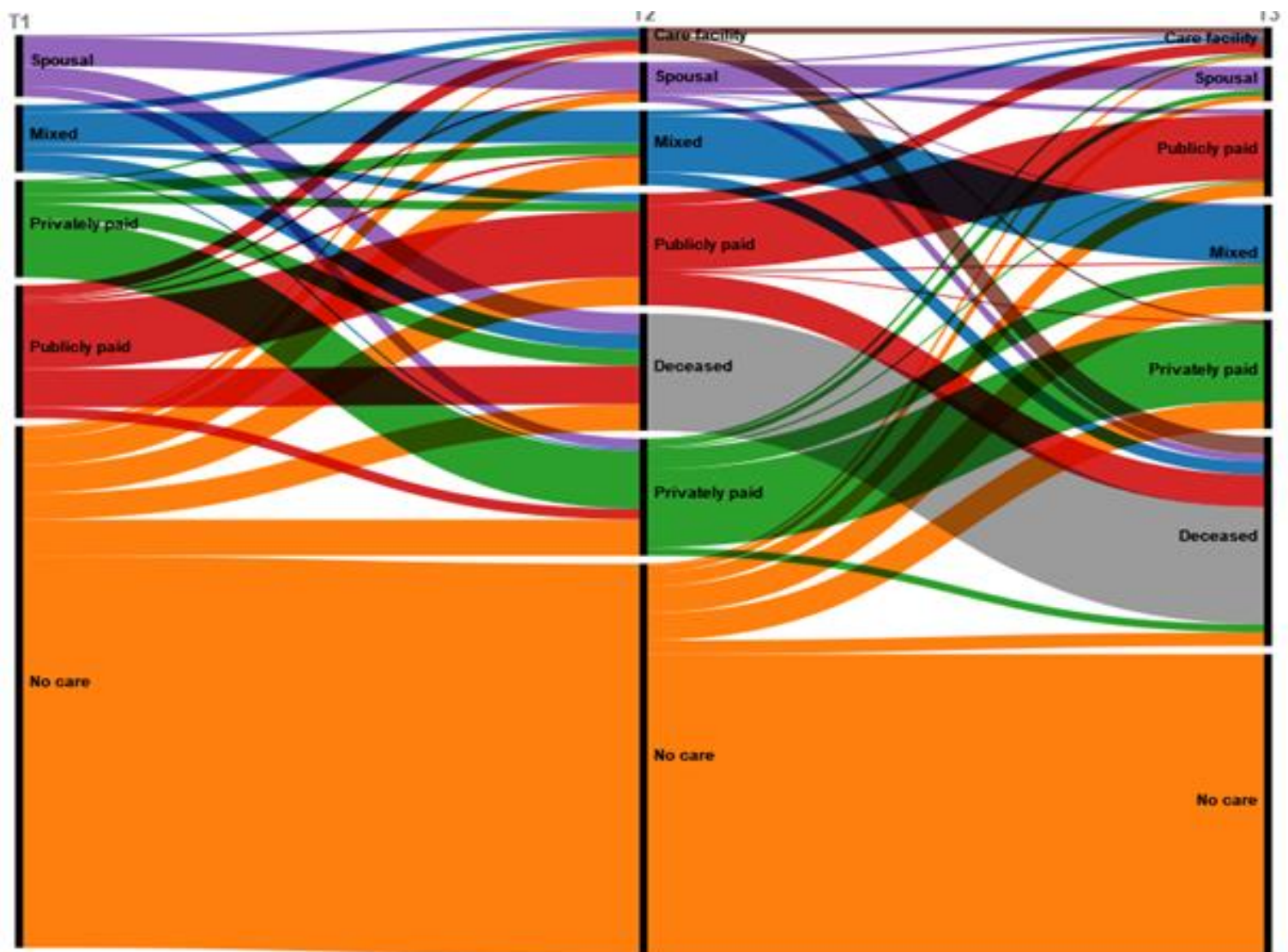


Figure 3. Transitions between the five CN types, from 2012/13 (T1), to 2015/16 (T2), and from 2015/16 to 2018/19 (T3). Colours represent the possible states, and the sizes are the proportions of participant in these states. The states are: the spousal or co-resident-CN, Mixed or Mixed-informal-CN, Privately paid or privately-paid-CN, Publicly Paid or mixed-publicly-paid-CN, No care or no-CN.

319

320 *Discussion*

321 To our knowledge, this study was the first to use CN typology among older adults in a longitudinal  
 322 perspective. We identified the following five types of CNs: the no-CN (59%<sub>T1</sub>), the privately-paid-CN  
 323 (11%<sub>T1</sub>), the mixed-informal-CN (8%<sub>T1</sub>), the mixed-publicly-paid-CN (15%<sub>T1</sub>), and the co-resident  
 324 network (7%<sub>T1</sub>). By accounting for non-random attrition we were able to include meaningful  
 325 information, such as transition rates to care facilities, and include deceased participants who were  
 326 likely to have the highest care needs. The mixed-publicly-paid-CN and the mixed-informal-CN had  
 327 relatively high numbers of deceased respondents, and were relatively stable. This seems to indicate  
 328 that these networks are only present in the late stages of the care trajectory. In addition, the low  
 329 transition rates between these two networks may indicate the existence of two separate and distinct  
 330 care trajectories, with either the mixed-publicly-paid-CN or the mixed-informal-CN serving as the end  
 331 point.

332 Both network types contained more older women with low levels of education and low functioning.  
333 Differences between them could be due to social or psychological resources (Jacobs et al., 2018),  
334 which were not considered in this study. Mortality was lower in the privately-paid-CN and the no-CN,  
335 but also not negligibly low. Although most participants in the no-CN and privately-paid CN were likely  
336 to be at the beginning of their care trajectory, some of them died before ever using any form of  
337 publicly paid care. It is likely that these participants suffered a sudden unexpected death, which is  
338 related to the fact that more men are represented in these groups and men have a higher risk of  
339 sudden death (Lewis et al., 2016; van Campen et al., 2013).

340 As the Dutch care reform mainly entailed overall budget cuts for publicly paid care and  
341 reduced availability of institutional care, we assume that other types of care, including informal and  
342 privately paid care, became more prominent after the care reform. After the care reform, a  
343 significantly lower percentage of older adults transitioned into a publicly paid network or care  
344 facility. Our results show what has changed over time, but as our study design did not include  
345 comparisons with other cohorts or time periods, it is possible that these results are due to changes  
346 caused by other processes.

347 Looking at transitions between the different types of CNs and neglecting transitions due to  
348 death, the more unstable networks (for survivors) were the privately-paid-CN (18%<sub>T1</sub>) and the no-CN  
349 (19%<sub>T1</sub>). In these two networks, the need for care was rather low to begin with. Their instability can  
350 therefore be attributed to an increasing need for care. Both network types contained more men,  
351 participants who were relatively young, had a medium or high level of education, and had high levels  
352 of cognitive and physical functioning, all of which are indicators of low care needs (Keating et al.,  
353 2003). Privately paid care is usually a (preferred) substitute for publicly paid care (Geerts et al., 2012;  
354 Swinkels et al., 2016). Therefore, previous studies also report that a medium or high level of  
355 education, which is associated with higher affluence, contributes to the use of privately paid care  
356 (Kemper, 1992; Pinquart & Sörensen, 2002).

357 The co-resident network (25%<sub>T1</sub>) was the least stable network and fell between the other  
358 four network types in terms of characteristics. It contained more men and younger participants, but  
359 also more participants with low and medium levels of education than the network without care and  
360 privately-paid-CN. The need for care was high, and the levels of functioning were equal to or worse  
361 than that of the mixed-publicly-paid-CN. This high need for care probably led to the higher transition  
362 rates. These high transition rates can probably also be explained by the fact that the co-resident  
363 network is highly dependent on a single caregiver, who also often tends to become frail or prefrail  
364 (Potier et al., 2018). As our descriptive study showed, the main reason for leaving the co-resident  
365 network was not the loss of a spouse, but was deteriorating health. It should be noted that we only  
366 considered whether the spouse was still alive or not, so this may not capture the full picture, as  
367 spouses can also become ill and no longer be able to act as a potential caregiver.

368  
369  
370 Our results are highly dependent on the structure of the Dutch healthcare system and the political  
371 context. As the healthcare systems in the various countries are very different (Geerts & Bosch, 2012),  
372 we cannot make any statements about the generalizability of the results. Our study took place in a  
373 policy context in which the eligibility criteria for transition to a care facility were very high (round-  
374 the-clock care needs). If these thresholds had been lower, the rate of transition to a care facility  
375 would very likely have been significantly higher (Alders et al., 2019). This notion is also supported by  
376 the fact that the level and type of care utilization in the Netherlands differs between decades (Abbing  
377 et al., 2021). In countries where the healthcare system is organized differently and where people  
378 have different norms regarding the use of care services, CNs are likely to look different from those  
379 identified in this study. The formation of CNs is also influenced by living arrangements, for example  
380 Velkoff, (2001) report that women in industrialized countries are more likely to live alone than men.  
381 This is consistent with our mixed-publicly-paid-CN and mixed-informal-CN containing more women,  
382 and the spousal CN containing more men. However, in non-industrialized countries, older adults tend  
383 to live with children (Velkoff, 2001), so the relative proportions of the different types of CNs are likely

384 to differ significantly from those in industrialized countries. In the Dutch context in particular, the  
385 proportion of older adults living alone or with a spouse is relatively high (United Nations, Department  
386 of Economic and Social Affairs, 2017). The proportion of older adults living with children is the lowest  
387 compared to other European countries (5%) (United Nations, Department of Economic and Social  
388 Affairs, 2017). It is therefore likely that informal CNs involving children are more prevalent in  
389 Mediterranean countries, where around 30% of older adults live with children (United Nations,  
390 Department of Economic and Social Affairs, 2017).

391 Similarly, it is likely that studies that have measured other types of care (e.g. without help with  
392 administrative tasks or transportation) also find different CNs with lower levels of informal care.  
393 These differences in both the data and the socio-cultural context could explain why a study looking at  
394 CNs in Belgium found more people with informal CNs (Fret et al., 2017). It could also explain that a  
395 Canadian study found an informal network consisting mainly of non-kin (Savla et al., 2016), while we  
396 did not identify such a network.

397  
398 Our results shed light on which CNs fit into a sustainable care system in which care for older adults  
399 includes low public expenditure alongside the use of informal and privately paid care. With this in  
400 mind, the No-CN, Privately-paid-CN, Co-resident-CN, and Mixed-informal-CN are likely to be the most  
401 sustainable when less publicly paid care is available. For these people, using only informal and/or  
402 privately paid care appears to be sufficient, even for those with high care needs. Some of them may  
403 move into CNs with publicly paid care in the future, as we only followed participants for six years.  
404 However, a sizable group never uses publicly funded care in their lifetime: these are the participants  
405 from the privately-paid-CN and the no-CN that died.

406 In terms of a sustainable care system, the policy aims for aging in place. This enables older  
407 adults to maintain social connections, a sense of independence and identity (Iecovich, 2014; Kendig  
408 et al, 2017). Secondly, aging in place is a policy goal because it is less costly than institutional care  
409 (Maarse and Jeurissen, 2016). Transitions to a care facility appear to occur from all CNs for those  
410 experiencing the most severe functional decline, which is consistent with the eligibility criteria for  
411 institutional care. These transitions occurred mostly from the networks with a high care need: the  
412 mixed-informal-CN, the mixed-publicly-paid-CN, and co-resident-CN. Consistent with other studies,  
413 the likelihood of transitioning to a nursing home were higher when informal care was provided by  
414 children than by spouses (Witvorapong, 2011). Nursing homes, especially with increased eligibility  
415 requirements, are a "final destination" where a large proportion of older adults never arrive.  
416 Transitions to a nursing facility were most likely for older women with low levels of education and  
417 poor health which were the characteristics associated with mixed-informal and the mixed-publicly  
418 paid-CN. This finding has been reported previously (Algera et al., 2004). However, other studies put  
419 this into perspective, as informal care delays institutionalization and leads to a (relatively) lower level  
420 of formal care (Van Houtven & Norton, 2004). In addition, Carvalho et al. (2019) report gender  
421 differences in the point where older adults consider their disability too severe to live at home and be  
422 cared for by a spouse, with women tending to prefer institutionalization at lower levels of disability.

423 Finally, our study shows the importance of targeting scarce publicly paid care services to  
424 older adults with high care needs and low social capital, as they are likely to be the most dependent  
425 on them.

426  
427 We demonstrated the robustness of the determinants of care use (Andersen & Newman, 2005;  
428 Babitsch et al., 2012) in a longitudinal perspective. Our longitudinal design showed that need factors,  
429 including declining functional and cognitive limitations and the number of chronic diseases, appear to  
430 have the strongest influence on transitions. This is similar to findings from studies on care  
431 arrangements (Dostie & Léger, 2005; Soldo et al., 1990; Witvorapong, 2011). The use of CN  
432 typologies in a longitudinal setting was not only novel, but linking them to determinants provides  
433 information for policy makers to anticipate what support is needed to promote the right CNs. Loss of  
434 a spouse did not often occur at the time when participants transitioned to another network, which  
435 could be explained by the fact that the spouse was already unable to provide care in the year before

436 death.

437         However, the methods we used were mainly descriptive. In addition, the determinants we  
438 examined were not theoretically exhaustive. We used longitudinal data with three-year waves, which  
439 had the limitation that certain significant transitions that occurred over a shorter period of time may  
440 not have been captured. As the frailest older adults move to a care facility, this may have led to an  
441 underestimation of the number of older adults who move to a care facility and an overestimation of  
442 those who die without ever moving to a care facility. Future studies could include determinants such  
443 as social capital, mastery and attitudes towards care, income, the type of formal and informal care  
444 available in the region (Blomgren et al., 2008; Broese van Groenou, 2020; Jacobs et al., 2018).

445

446 Conclusion

447

448 To learn more about the stability of CNs, we mapped transitions between CN types. We identified  
449 the following five types of CNs: 1) no care, 2) privately-paid, 3) mixed-informal, 4) mixed-publicly-  
450 paid, 5) co-resident. The co-resident network was the most unstable and had a high transition rate to  
451 nursing homes. The privately-paid-CN was moderately stable, with participants often transitioning to  
452 a mixed-informal, but rarely to a mixed-publicly-paid-CN. There were also moderately frequent  
453 transitions from the no-CN, with transitions to the privately-paid-CN being the most likely, but other  
454 transitions also occurred. The two mixed CNs were the most stable, and transitions to a care facility  
455 were most likely for these types. For all types of CNs, transitions appeared to be strongest induced by  
456 a deterioration in health.

457         The no-care, privately-paid-CN, co-resident-CN, and Mixed-Informal-CN were the least likely  
458 to use publicly paid care, and participants in the privately-paid-CN and the no-CN sometimes never  
459 used publicly paid care in their lives. Transitions to a care facility were highest in the co-resident-CN  
460 and ranged around 10% in the two mixed CNs.

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**Table 1**

Descriptive statistics of sample total and CN types at each wave

	At 2012/2013 (T1)						At 2015/2016 (T2)					At 2018/2019 (T3)				
	Total	(N=1413)					(N=1182)					(N=1027)				
		No care	Private	Mixed informal	Mixed Public	Co-residential	No care	Private	Mixed informal	Mixed Public	Co-residential	No care	Private	Mixed informal	Mixed Public	Co-residential
N	1413	837	156	108	213	99	629	188	120	180	65	484	175	172	140	56
% of total	100	59.24	11.04	7.64	15.07	7.00	53.21	15.91	10.15	15.23	5.50	47.13	17.04	16.75	13.63	5.45
Female %	0.56	0.48	0.63	0.7	0.72	0.62	0.48	0.61	0.79	0.65	0.68	0.44	0.59	0.78	0.67	0.68
Age in years	74.92	71.56	76.89	81.76	82.38	76.73	70.29	75.13	78.1	79.61	75.18	69.50	73.16	75.75	77.37	74.15
	(0.76)	(5.61)	(7.09)	(7.76)	(6.25)	(7.23)	(4.65)	(6.24)	(6.53)	(6.37)	(6.59)	(4.11)	(5.79)	(5.96)	(6.51)	(5.85)
Partner at T1 %	0.67	0.79	0.60	0.27	0.34	0.92	0.81	0.68	0.49	0.43	0.95	0.83	0.74	0.58	0.52	0.91
Partner at T2 %	0.63	0.74	0.50	0.13	0.29	0.94	0.79	0.60	0.30	0.29	0.95	0.82	0.69	0.44	0.43	0.91
Partner at T3 %	0.60	0.70	0.49	0.11	0.18	0.79	0.75	0.54	0.24	0.18	0.84	0.81	0.65	0.32	0.26	0.94
Moved to a care facility at T2 %	0.04	0.01	0.03	0.16	0.14	0.08										
Moved to a care facility at T3 %	0.05	0.03	0.06	0.11	0.19	0.15	0.03	0.06	0.11	0.19	0.15					
ADL-score at T1 <sup>a</sup>	25.59	27.7	26.13	22.11	21.15	20.15	27.97	26.66	23.41	22.62	22.89	28.06	26.72	26.43	23.76	23.73
	(5.82)	(4.46)	(5.08)	(6.11)	(5.90)	(6.05)	(4.36)	(5.06)	(4.28)	(6.18)	(5.90)	(4.31)	(5.06)	(5.83)	(5.97)	(6.03)
ADL-score at T2	25.11	27.06	25.17	20.65	19.48	18.57	27.82	26.43	25.35	20.84	19.45	28.14	26.82	24.69	22.92	21.98
	(6.15)	(4.83)	(5.73)	(6.46)	(6.04)	(6.85)	(4.13)	(4.77)	(5.11)	(5.77)	(6.73)	(3.96)	(5.17)	(5.41)	(5.76)	(6.87)
ADL-score at T3	24.12	25.62	23.75	19.66	18.5	18.05	26.3	24.66	22.92	19.35	18.66	26.96	25.5	22.34	20.38	20.36
	(6.48)	(5.77)	(6.35)	(6.75)	(5.45)	(7.06)	(5.46)	(5.88)	(5.95)	(5.78)	(6.51)	(5.17)	(5.60)	(6.15)	(5.82)	(6.08)
sMMSE-score at T1 <sup>b</sup>	14.82	15.15	15.17	14.36	14.05	13.63	15.19	15.23	20.78	14.68	14.09	15.23	15.25	15.12	14.93	14.34
	(1.69)	(1.24)	(1.32)	(1.94)	(2.13)	(2.68)	(1.19)	(1.19)	(6.28)	(1.71)	(2.44)	(1.14)	(1.12)	(1.21)	(1.45)	(2.07)
sMMSE-score at T2	14.44	14.94	14.38	13.57	12.83	12.85	15.04	14.91	15.08	13.60	13.45	15.11	15.07	14.87	14.41	13.70
	(2.23)	(1.53)	(2.17)	(2.81)	(3.21)	(3.46)	(1.26)	(1.51)	(1.22)	(2.68)	(3.19)	(1.16)	(1.49)	(1.34)	(1.82)	(2.76)
sMMSE-score at T3	14.29	14.71	14.37	13.05	12.42	12.62	14.89	14.59	14.41	12.97	12.87	15.05	14.88	14.2	13.79	12.89
	(2.51)	(1.91)	(2.36)	(3.61)	(3.60)	(3.87)	(1.57)	(1.90)	(1.93)	(3.43)	(3.90)	(1.28)	(1.83)	(2.09)	(2.52)	(3.62)
N Chronic diseases at T1 <sup>c</sup>	1.49	1.25	1.55	1.71	2.11	1.81	1.18	1.44	13.65	1.86	1.74	1.09	1.39	1.55	1.76	1.5
	(1.16)	(1.04)	(1.09)	(1.22)	(1.22)	(1.36)	(1.00)	(1.09)	(2.75)	(1.15)	(1.14)	(0.97)	(1.00)	(1.12)	(1.17)	(1.03)
N Chronic diseases at T2	1.53	1.41	1.55	1.81	1.99	1.64	1.35	1.49	1.59	2.02	1.75	1.25	1.42	1.65	1.88	1.71
	(1.13)	(1.07)	(1.09)	(1.16)	(1.29)	(1.23)	(1.043)	(1.07)	(1.16)	(1.23)	(1.14)	(1.03)	(1.01)	(1.17)	(1.17)	(0.92)
N Chronic diseases at T3	1.63	1.54	1.67	1.85	2.12	1.76	1.48	1.65	1.68	2.00	1.82	1.4	1.67	1.76	2.05	1.9
	(1.18)	(1.16)	(1.12)	(1.22)	(1.22)	(1.18)	(1.15)	(1.13)	(1.19)	(0.46)	(1.11)	(1.11)	(1.17)	(1.14)	(1.21)	(1.09)
Deceased at T2 %	0.13	0.05	0.17	0.24	0.29	0.32										
Deceased at T3 %	0.24	0.11	0.28	0.42	0.51	0.45	0.03	0.07	1.86	2.12	1.77					

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<sup>a</sup>*Activities of Daily Living, 6-30, with 30 indicating no problems in performing Activities of Daily Living*

<sup>b</sup>*short Mini Mental State Examination, 0-16, with 16 indicating no cognitive decline*

<sup>c</sup>*Number of chronic diseases, 0-7*

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**Table 2**

Transition probabilities between the five CN types, identified among 1413 Dutch older adults aged 65 and older. Rows show CN types at Time 1 and Time 2, and columns show CN types at Time 2 and Time 3.

CN at Time 1 (rows), CN at Time 2 (columns)							
	No-care	Private	Mixed informal	Mixed public	Coresidential	Care facility	Deceased
No-care	.751	.069	.053	.054	.018	.005	.050
Private	.000	.596	.122	.090	.000	.026	.167
Mixed informal	.000	.028	.481	.139	.000	.111	.241
Mixed public	.000	.080	.023	.498	.019	.089	.291
Coresidential	.000	.172	.000	0.00	.465	.040	.323

CN at Time 2 (rows), CN at Time 3 (columns)							
	No-care	Private	Mixed informal	Mixed public	Coresidential	Care facility	Deceased
No-care	.717	.065	.064	.034	.013	.009	.098
Private	.000	.426	.108	.010	.030	.030	.397
Mixed informal	.000	.000	.758	.000	.000	.067	.175
Mixed public	.000	.004	.012	.423	.000	.093	.468
Coresidential	.000	.015	.031	.138	.569	.062	.185

### Figure legends

#### Figure 1.

Notes Circles represent latent classification variables, arrows represent regression paths, squares represent measured variable indicators of the latent classification variables