**Supplementary Table 1.** Social network variables with responses on an ordinal scale.

|  |  |  |
| --- | --- | --- |
|  | Wave 1  | Wave 2 |
|  | N | % | N | % |
| **Number of relatives outside the household the respondent sees or hears from at least once a montha** |
|  0 | 88 | 6.8% | 76 | 5.8% |
|  1 | 92 | 7.1% | 74 | 5.4% |
|  2 | 176 | 13.5% | 132 | 10.1% |
|  3 to 4 | 323 | 24.8% | 322 | 24.7% |
|  5 to 8 | 347 | 26.6% | 350 | 26.8% |
|  9+ | 277 | 21.2% | 350 | 26.8% |
| **How often the respondent sees or hears from relatives outside the household with whom they have the most contactb** |
|  Never | 36 | 2.8% | 40 | 3.1% |
|  Seldom | 136 | 10.4% | 121 | 9.3% |
|  Sometimes | 237 | 18.2% | 217 | 16.6% |
|  Often | 428 | 32.8% | 444 | 34.0% |
|  Very often | 298 | 22.8% | 209 | 16.0% |
|  Always | 168 | 12.9% | 273 | 20.9% |
| **Number of friends the respondent sees or hears from at least once a month** |
|  0 | 138 | 10.6% | 126 | 9.7% |
|  1 | 66 | 5.1% | 80 | 6.1% |
|  2 | 151 | 11.6% | 163 | 12.5% |
|  3 to 4 | 315 | 24.2% | 363 | 27.8% |
|  5 to 8 | 251 | 19.3% | 244 | 18.7% |
|  9+ | 381 | 29.2% | 326 | 25.0% |
| **How often the respondent sees or hears from friends with whom they have the most contact** |
|  Never | 101 | 7.7% | 118 | 9.0% |
|  Seldom | 170 | 13.0% | 138 | 10.6% |
|  Sometimes | 295 | 22.6% | 297 | 22.8% |
|  Often | 379 | 29.0% | 436 | 33.4% |
|  Very often | 217 | 16.6% | 142 | 10.9% |
|  Always | 142 | 10.9% | 174 | 13.3% |
| **Attendance in community organizationsc** |
|  Not at all | 1061 | 81.3% | 986 | 75.6% |
|  Less than once a month | 108 | 8.3% | 154 | 11.8% |
|  Every month | 57 | 4.4% | 49 | 3.8% |
|  Every week | 62 | 4.8% | 92 | 7.1% |
|  Every day | 18 | 1.2% | 20 | 1.5% |
| **Attendance in religious services** |
|  Not at all | 315 | 24.1% | 342 | 26.2% |
|  Less than once a month | 429 | 32.9% | 376 | 28.9% |
|  Every month | 173 | 13.3% | 210 | 16.1% |
|  Every week | 254 | 19.5% | 242 | 18.5% |
|  Every day | 127 | 9.7% | 134 | 10.3% |

Note: Numbers shown are percentages. Percentages may not add up to 100% as responses of ‘Refused/Don’t Know’ are not shown.

a If individuals have 3 or more relatives they see or hear from at least once a month, it is highly likely that they are active in interacting with relatives/friends outside their immediate family members and can access and mobilize benefits embedded in such networks. In contrast, should 0 (7%) or 1 (14%) be set as a cut-off point to yield dichotomous indicators, we are less certain that the respondent has a beneficial socioemotional exchange with relatives/friends.

b In case “never (3% versus 97%)” is set as a cut-point, it would have no meaningful variation in LTA.

c The variable is highly positively skewed.

**Supplementary Table 2**. Measurement invariance test of the five-class model

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | AICa | BICb | SABICc | Loglikelihood | Free parameters | Scaling correctionFactor for MLR | Satorra and BentlerCorrected$χ$2 diff | df | P |
| MId | 23245 | 23520 | 23351 | -11570 (L0) | 53 (P0) | 1.37 (C0) |  |  |  |
| Non-MI | 23243 | 23750 | 23439 | -11523 (L1) | 98 (P1) | 1.02 (C1) | 153.67 | 45 | < 0.001 |

Note. a AIC: Akaike information criterion; b BIC: Bayesian information criterion; c SABIC: Sample size adjusted bayesian information criterion; d MI: Measurement Invariance

The log-likelihood values between the MI and non-MI models cannot be directly compared when using a robust estimator (MLR) in Mplus. Thus, we used Satorra and Bentler likelihood test with scaling correction for non-normality. The scaling correction, CD was calculated using the following formula,

CD = (P0 \* C0 – P1 \* C1) / (P0 – P1)

where P0 and P1 are free parameters and C0 and C1 are scaling correction factors for the nested (MI) and the comparison models (non-MI), respectively. Then the chi-square difference test (TRd) was conducted using log-likelihood values for the nested (L0) and the comparison (L1) models and the scaling correction, CD.

TRd = -2 \* (L0 – L1) / CD

**Supplementary Table 3**. Item response probabilities of five social network types, fixed at both waves (N=1305)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Total | Diverse | Unmarried and diverse | Extended family | Immediate family | Restricted |
| **Social network indicators** | % of a yes response |
| Live alone | 10.3% | 0.4% | 44.3% | 0.9% | 0.0% | 57.6% |
| Married | 69.2% | 93.4% | 0.0% | 80.0% | 83.5% | 0.0% |
| Have one or more alive child | 89.6% | 97.6% | 81.1% | 96.1% | 94.3% | 30.7% |
| Have three or more relatives to contact | 72.7% | 91.2% | 90.5% | 80.7% | 31.4% | 20.4% |
| Frequent contact with relatives | 68.6% | 88.0% | 86.3% | 84.5% | 0.0% | 21.0% |
| Have three or more friends to contact | 72.7% | 94.1% | 90.5% | 31.8% | 57.4% | 46.5% |
| Frequent contact with friends | 56.6% | 85.6% | 78.5% | 9.3% | 30.0% | 32.1% |
| Attend community organizations | 18.6% | 27.8% | 29.5% | 7.3% | 17.3% | 13.8% |
| Attend religious services weekly | 29.4% | 33.1% | 36.8% | 21.4% | 23.5% | 20.5% |

**Supplementary Table 4.** Association of baseline sociodemographic characteristics and health status with social network types at wave 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Model 1 | Model 2 | Model 3 | Model 4 |
|  | **Diverse**(Ref: Extended family) | **Unmarried and diverse**(Ref: Extended family) | **Immediate family**(Ref: Extended family) | **Restricted**(Ref: Extended family) |
|  | ORa | 95% CIb | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| **Sociodemographic characteristics at wave 1** |  |  |  |  |  |  |  |  |
| Age | 0.99 | [0.97,1.02] | 1.06\*\*\* | [1.03,1.10] | 1.00 | [0.97,1.03] | 1.02 | [0.98,1.06] |
| Female | 0.97 | [0.71,1.32] | 4.86\*\*\* | [3.14,7.53] | 0.63\* | [0.44,0.92] | 1.47 | [0.80,2.70] |
| Minority | 0.98 | [0.69,1.40] | 1.19 | [0.77,1.85] | 0.87 | [0.58,1.30] | 0.61 | [0.31,1.18] |
| Education | 1.26\*\* | [1.08,1.48] | 1.28\* | [1.05,1.57] | 1.26\* | [1.05,1.52] | 1.36\* | [1.02,1.82] |
| Working | 1.29 | [0.91,1.82] | 1.36 | [0.86,2.16] | 1.51\* | [1.01,2.24] | 1.21 | [0.65,2.24] |
| Small housing | 0.98 | [0.49,1.97] | 3.26\*\*\* | [1.63,6.51] | 2.09\* | [1.04,4.17] | 7.30\*\*\* | [3.41,15.63] |
| **Health status at wave 1** |  |  |  |  |  |  |  |  |
| Chronic conditions | 1.05 | [0.95,1.17] | 1.07 | [0.94,1.22] | 1.02 | [0.90,1.14] | 0.94 | [0.78,1.13] |
| Functional difficulties | 0.91 | [0.79,1.06] | 0.87 | [0.74,1.04] | 1.03 | [0.89,1.20] | 1.01 | [0.84,1.21] |
| Depressive symptoms | 0.92\*\* | [0.87,0.98] | 0.96 | [0.89,1.03] | 1.03 | [0.97,1.10] | 1.13\*\* | [1.05,1.22] |

Note. aOR: Odd Ratio, bCI: Confidence Interval. Results are based on 20 imputed data sets.
\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001

**Supplementary Text 1.** Sensitivity analyses using multiple imputations.

We have checked the robustness of our main findings using multiple imputations, assuming that the loss of participants due to random allocation of questionnaire versions at wave 1 and sample attrition between waves 1 and 2 can be inferred from the observed sociodemographic and health characteristics (i.e. a missing at random assumption) [1]. Applying the predictive mean matching method, which substitutes missing values with observed values whose regression-predicted estimates are nearest to the estimates of the missing values, to existing data on nine social network indicators, sociodemographic characteristics, and health status, we generated a number of multiply-imputed data sets [2]. We then extracted the last set from imputed data and replicate LTA and multivariable regressions in it. We were unable to conduct LTA with the entire multiply imputed data as the use of LTA with multiply imputed data has not been established.

Specifically, three sensitivity analyses were conducted. First, we imputed around 50% of the missing values, incurred due to random allocation of questionnaire versions, and replicated the analysis (Supplementary Table 5a and 5b). Second, we imputed around 40% of missing values from sample attrition and replicated the analysis (Supplementary Table 6a and 6b). Third, we imputed around 70% of missing values, generated by random allocation of questionnaire versions at wave 1 and sample attrition, and replicated the analysis (Supplementary Table 7a and 7b). These sensitivity analyses confirmed the robustness of our main findings: (1) the presence of five social network types at both waves, (2) a higher proportion of respondents transitioning into more diverse network types (network expansion) than transitioning into less diverse types (network contraction), and (3) the association between declining health and network contraction.

**References**

1. White IR, Royston P, Wood AM. Multiple imputation using chained equations: Issues and guidance for practice. Statistics in Medicine. 2011 2011;30(4):377-99.

2. Morris TP, White IR, Royston P. Tuning multiple imputation by predictive mean matching and local residual draws. BMC Medical Research Methodology. 2014;14(1):1–13.

**Supplementary Table 5a.** Prevalence and transition of social network types (N=2608a)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Diverse | Unmarried and diverse | Extended family | Immediate family | Restricted |
| Prevalence at wave 1 | 1022 (39%) | 320 (12%) | 726 (28%) | 356 (14%) | 184 (7%) |
| Prevalence at wave 2 | 1157 (44%) | 410 (16%) | 597 (23%) | 266 (10%) | 178 (7%) |
| **Network type at wave 1** | **Network type at wave 2b** |
| Diverse | Unmarried and diverse | Extended family | Immediate family | Restricted |
| Diverse  | 743 (73%) | 0 (0%) | 215 (21%) | 64 (6%) | 0 (0%) |
| Unmarried and diverse | 0 (0%) | 282 (88%) | 0 (0%) | 0 (0%) | 38 (12%) |
| Extended family | 291 (40%) | 53 (7%) | 291 (40%) | 84 (12%) | 7 (1%) |
| Immediate family | 123 (35%) | 24 (7%) | 91 (26%) | 118 (33%) | 0 (0%) |
| Restricted | 0 (0%) | 51 (28%) | 0 (0%) | 0 (0%) | 133 (72%) |

a Missing values due to random allocation of questionnaire at wave 1 (about 50%) are imputed based on the missing at random (MAR) assumption using predictive mean matching (PMM) methods. Results are based on the 50th imputed data set.

b Transitions in social network types – (1) Remain stable: N=1,567 (60%); (2) Transition to more diverse types: N=633 (24%); (3) Transition to less diverse types: N=408 (16%)

**Supplementary Table 5b.** Multinomial regression for the association of sociodemographic characteristics, and baseline and change in health status with transitions in network types (N=2608)

|  |  |  |
| --- | --- | --- |
|  | Model 1 | Model 2 |
|  | **Network contraction:** Transition toless diverse types(Ref: No transition) | **Network expansion:** Transition tomore diverse types(Ref: No transition) |
|  | RRa | 95% CIb | RR | 95% CI |
| **Change in health from wave 1 to wave 2**  |  |  |  |  |
| Change in the number of chronic diseases | 1.03 | [0.92,1.16] | 1.06 | [0.97,1.17] |
| Change in the number of functional difficulties | 1.09\* | [1.00,1.19] | 0.98 | [0.91,1.07] |
| Change in depressive symptoms | 1.07\*\*\* | [1.04,1.11] | 0.98 | [0.94,1.01] |
| **Health status at wave 1** |  |  |  |  |
| Chronic conditions | 0.99 | [0.92,1.07] | 1.05 | [0.99,1.12] |
| Functional difficulties | 0.98 | [0.88,1.09] | 1.04 | [0.96,1.14] |
| Depressive symptoms | 1.06\*\* | [1.02,1.11] | 1.00 | [0.96,1.04] |
| **Sociodemographic characteristics at wave 1** |  |  |  |  |
| Age | 1.01 | [0.99,1.02] | 1.00 | [0.98,1.01] |
| Female | 0.61\*\*\* | [0.48,0.78] | 0.70\*\*\* | [0.58,0.86] |
| Minority | 0.96 | [0.74,1.26] | 1.14 | [0.92,1.43] |
| Education | 0.88\* | [0.78,0.99] | 0.91 | [0.83,1.01] |
| Working | 1.50\*\* | [1.16,1.94] | 1.31\* | [1.06,1.61] |
| Small housing | 0.70 | [0.45,1.07] | 0.70\* | [0.49,0.99] |

Note. aRR: Risk Ratio, bCI: Confidence Interval. Results are based on the 50th imputed data set.
\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001

**Supplementary Table 6a.** Prevalence and transition of social network types (N=2003a)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Diverse | Unmarried and diverse | Extended family | Immediate family | Restricted |
| Prevalence at wave 1 | 722 (36%) | 341 (17%) | 423 (21%) | 381 (19%) | 136 (7%) |
| Prevalence at wave 2 | 776 (39%) | 420 (21%) | 392 (20%) | 291 (15%) | 124 (6%) |
| **Network type at wave 1** | **Network type at wave 2b** |
| Diverse | Unmarried and diverse | Extended family | Immediate family | Restricted |
| Diverse  | 510 (71%) | 0 (0%) | 93 (13%) | 119 (16%) | 0 (0%) |
| Unmarried and diverse | 0 (0%) | 288 (84%) | 26 (8%) | 0 (0%) | 27 (8%) |
| Extended family | 112 (26%) | 46 (11%) | 200 (47%) | 65 (15%) | 0 (0%) |
| Immediate family | 154 (40%) | 47 (12%) | 73 (19%) | 107 (28%) | 0 (0%) |
| Restricted | 0 (0%) | 39 (29%) | 0 (0%) | 0 (0%) | 97 (71%) |

a Missing values due to sample attrition at wave 1 (about 40%) are imputed based on the missing at random (MAR) assumption using PMM methods. Results are based on the 50th imputed data set.

b Transitions in social network types – (1) Remain stable: N=1,202 (60%); (2) Transition to more diverse types: N=471 (24%); (3) Transition to less diverse types: N=330 (16%)

**Supplementary Table 6b.** Multinomial regression for the association of sociodemographic characteristics, and baseline and change in health status with transitions in network types (N=2003)

|  |  |  |
| --- | --- | --- |
|  | Model 1 | Model 2 |
|  | **Network contraction:** Transition toless diverse types(Ref: No transition) | **Network expansion:** Transition tomore diverse types(Ref: No transition) |
|  | RRa | 95% CIb | RR | 95% CI |
| **Change in health from wave 1 to wave 2**  |  |  |  |  |
| Change in the number of chronic diseases | 0.93 | [0.81,1.06] | 1.05 | [0.94,1.17] |
| Change in the number of functional difficulties | 1.08 | [0.98,1.20] | 0.98 | [0.89,1.07] |
| Change in depressive symptoms | 1.06\*\* | [1.02,1.10] | 0.97 | [0.93,1.01] |
| **Health status at wave 1** |  |  |  |  |
| Chronic conditions | 0.99 | [0.91,1.08] | 1.01 | [0.93,1.08] |
| Functional difficulties | 0.90 | [0.80,1.01] | 0.97 | [0.89,1.06] |
| Depressive symptoms | 1.07\*\* | [1.02,1.12] | 1.04 | [1.00,1.09] |
| **Sociodemographic characteristics at wave 1** |  |  |  |  |
| Age | 1.00 | [0.98,1.02] | 1.01 | [0.99,1.02] |
| Female | 0.51\*\*\* | [0.40,0.67] | 0.70\*\* | [0.56,0.88] |
| Minority | 1.35\* | [1.02,1.79] | 1.21 | [0.94,1.56] |
| Education | 0.89 | [0.79,1.01] | 0.95 | [0.85,1.06] |
| Working | 1.23 | [0.93,1.65] | 1.39\* | [1.08,1.79] |
| Small housing | 0.66 | [0.39,1.10] | 0.89 | [0.60,1.32] |

Note. aRR: Risk Ratio, bCI: Confidence Interval. Results are based on the 50th imputed data set.
\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001

**Supplementary Table 7a.** Prevalence and transition of social network types (N=4004a)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Diverse | Unmarried and diverse | Extended family | Immediate family | Restricted |
| Prevalence at wave 1 | 1,613 (40%) | 443 (11%) | 1,099 (27%) | 576 (14%) | 273 (7%) |
| Prevalence at wave 2 | 1,895 (47%) | 534 (13%) | 905 (23%) | 385 (10%) | 285 (7%) |
| **Network type at wave 1** | **Network type at wave 2b** |
| Diverse | Unmarried and diverse | Extended family | Immediate family | Restricted |
| Diverse  | 1,194 (74%) | 0 (0%) | 320 (20%) | 99 (6%) | 0 (0%) |
| Unmarried and diverse | 0 (0%) | 375 (85%) | 0 (0%) | 0 (0%) | 68 (15%) |
| Extended family | 469 (43%) | 64 (6%) | 435 (40%) | 115 (10%) | 16 (1%) |
| Immediate family | 232 (40%) | 23 (4%) | 150 (26%) | 171 (30%) | 0 (0%) |
| Restricted | 0 (0%) | 72 (26%) | 0 (0%) | 0 (0%) | 201 (74%) |

a Missing values due random allocation of questionnaire at wave 1 and sample attrition between wave 1 and 2 (about 70%) are imputed based on the MAR assumption using PMM methods. Results are based on the 100th imputed data set.

b Transitions in social network types – (1) Remain stable: N=2,376 (60%); (2) Transition to more diverse types: N=1,010 (25%); (3) Transition to less diverse types: N=618 (15%)

**Supplementary Table 7b.** Multinomial regression for the association of sociodemographic characteristics, and baseline and change in health status with transitions in network types (N=4004)

|  |  |  |
| --- | --- | --- |
|  | Model 1 | Model 2 |
|  | **Network contraction:** Transition toless diverse types(Ref: No transition) | **Network expansion:** Transition tomore diverse types(Ref: No transition) |
|  | RRa | 95% CIb | RR | 95% CI |
| **Change in health from wave 1 to wave 2**  |  |  |  |  |
| Change in the number of chronic diseases | 0.99 | [0.89,1.09] | 0.99 | [0.91,1.08] |
| Change in the number of functional difficulties | 1.08\* | [1.01,1.15] | 0.98 | [0.91,1.04] |
| Change in depressive symptoms | 1.08\*\*\* | [1.05,1.12] | 0.96\*\* | [0.93,0.99] |
| **Baseline health at wave 1** |  |  |  |  |
| Chronic conditions | 1.01 | [0.95,1.07] | 1.02 | [0.97,1.07] |
| Functional difficulties | 1.03 | [0.96,1.11] | 1.03 | [0.97,1.09] |
| Depressive symptoms | 1.04\* | [1.00,1.07] | 1.04\*\* | [1.01,1.07] |
| **Sociodemographic characteristics at wave 1** |  |  |  |  |
| Age | 1.00 | [0.99,1.02] | 1.00 | [0.99,1.02] |
| Female | 0.67\*\*\* | [0.55,0.81] | 0.79\*\* | [0.67,0.92] |
| Minority | 1.01 | [0.82,1.25] | 1.03 | [0.87,1.23] |
| Education | 0.93 | [0.84,1.02] | 0.90\*\* | [0.83,0.97] |
| Working | 1.36\*\* | [1.10,1.68] | 1.19 | [1.00,1.42] |
| Small housing | 0.84 | [0.60,1.17] | 0.56\*\*\* | [0.42,0.75] |

Note. aRR: Risk Ratio, bCI: Confidence Interval. Results are based on the 100th imputed data set.
\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001

**Supplementary Figure 1.** Flow chart of analytic samples

Random allocation of questionnaire version (n=2277)

Proxy respondents who were not asked key variables (n=138)

Sample attrition between waves

(n=829)

1,305 participants in both waves

1,443 participants in wave 1 and 2

2,272 participants in wave 1

4,549 participants in wave 1