van Tilburg, T.G. (1998). Changes over time in the personal networks and health of older adults. In D.J.H. Deeg, A.T.F. Beekman, D.M.W. Kriegsman & M. Westendorp-de Serière (Eds.), *Autonomy and well-being in the aging population II: Report from the Longitudinal Aging Study Amsterdam 1992-1996* (pp. 123-140). Amsterdam: VU University Press. ISBN 90-50383622-5

# Changes over Time in the Personal Networks and Health of Older Adults

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It is generally recognized that being old is not the same as being socially isolated. Considering one social isolation indicator, a lack of personal network members, can substantiate this view. The personal network consists of the group of people (i.e. spouse, children, relatives, neighbors, friends, fellow members of organizations and acquaintances) with whom the focal person has a direct personal relationship. These relationships are selected from a broader social context of latent relationships, for example, relationships which are not maintained, or relationships with new acquaintances which have not yet reached a personal level. There are undeniably some older adults with very small personal networks, but nearly all studies have shown that most older people have a significant number of relationships. In several studies, the modal network size of older adults has been assessed to range from approximately 5 to 10; higher averages were observed in some studies using deviating network delineation methods (see the overview by Broese van Groenou and Van Tilburg, 1996). Furthermore, old people in general are no more vulnerable to losses in their network than young people (Berkman, Oxman and Seeman 1992).

However, the question of whether the aging of old people results in losses in their personal network remains open for discussion. Decline and loss associated with advanced age (known as the deficit model) have been the primary focus of gerontology (Baltes and Carstensen 1996). The limitation of such personal resources as health may reduce the possibilities for maintaining relationships, resulting in the loss of network members (Morgan 1988). This is of particular importance with regard to vulnerable relationships, such as uniplex relationships in which people only share one type of activity (Tijhuis 1994). A second reason for the deterioration of relationships may be that people in poor health are in need of support, but are restricted in reciprocating this support (Dowd 1984). When support received within a relationship is not returned, it is less likely that the receipt of support will continue, and the balance of receiving and giving support within the relationship will be affected.

*Autonomy and Well-being in the Aging Population II,* edited by Dorly J.H. Deeg et al.
Amsterdam: VU University Press, 1998

In the long run it is to be expected that the relationship will end (Klein Ikkink and Van Tilburg 1998), despite the fact that the relationships of people who are ill are less affected by the norm of balance than other relationships (Gouldner 1960). Thus, there will be negative associations of poor health with network size and instrumental support given, and indirectly with instrumental support received, because support given and received is positively related.

However, losses may coincide with gains. Poor health increases demands, particularly for instrumental support (Brody 1985). These increased demands may result in the mobilization of helpers, and thus increase the support received (Broese van Groenou and Van Tilburg 1997, Miller and McFall 1991, Stoller and Pugliesi 1988). Due to this mobilization effect when illness is involved, there may also be positive effects of a decline in health on the size of the network and the instrumental support received.

In a meta-analysis of the effects of social relationships on self-reports of physical symptoms, Schwarzer and Leppin (1991) observed that there were positive effects on health, depending on various characteristics of the social relationships. Social integration, i.e. structural network characteristics, such as network size, and emotional support received, had positive effects on health, which were observed in all studies (weighted $r$ = 0.07 and 0.11, respectively). For instrumental support received, on average a stronger positive effect ($r_w$ = 0.18) was observed, but the direction of the effect differed across the studies. In studies in which the perceived availability of support was correlated with health, positive effects were observed, indicating a causal order of support on health. Negative effects of support were observed in studies in which it was observed that support was mobilized in response to a disease. Here, a causal order of health on support should be the case. Schwarzer and Leppin concluded that the association between health and the network might be under-estimated, since many studies did not control for changes over time.

In the present study, an analysis was made of the changes in the personal networks and the health of a general sample of Dutch older adults. Three characteristics of the network were studied: the network size, and the instrumental support received and given. Health was specified as functional ability, self-rated health and health-related limitations in functioning. The effects of health on the network were studied across three observations, with a total time span of four years. Negative effects of poor health on network size and instrumental support given were expected to be observed. Furthermore, due to the mobilization effect, a positive effect of poor health on the instrumental support received was also anticipated.

## Design of the study

### *Respondents*

Personal interviews were conducted in 1992 ($T_0$) with 3,805 respondents who participated in the 'Living arrangements and social networks of older adults' research program (Knipscheer et al. 1995). This program used a stratified random sample of men and women born between 1908 and 1937. The oldest individuals, and in particular the oldest men, were over-represented in the sample. The sample was taken from the population registers of eleven municipalities: the city of Amsterdam and two rural communities in the western region of the Netherlands, and two cities and six rural communities in the south and east. These three regions were considered to represent the current differences in culture, religion, urbanization and aging in the Netherlands. Of the 6,107 eligible individuals in the sample, 2,302 (37.7%) were unwilling to participate, due to a lack of interest or time; another 734 were ineligible because they had died or were too ill or cognitively impaired to be interviewed. The decision not to interview a person was made by the interviewer, based on information from a relative or a staff member of the institution in which the person lived. The interviews mainly covered demographics, the personal network, loneliness and history of life events.

During 1992–1993 ($T_1$), a follow-up was carried out in the context of the Longitudinal Aging Study Amsterdam (LASA; Deeg and Westendorp-de Serière 1994). The LASA interviews covered a wide range of topics relating to physical and cognitive health, and social and psychological functioning. Of the $T_0$ respondents, 3,107 (81.7%) participated in the follow-up. Of the 698 $T_0$ respondents who did not participate at $T_1$, 126 (3.3% of 3,805) had died and 134 (3.5%) were unable to participate in the study because of severe physical and/or mental health problems. Furthermore, 394 (10.4%) refused to be re-interviewed, and 44 (1.2%) could not be contacted. At $T_2$, within the context of LASA in 1995–1996, personal interviews were conducted with 2,302 respondents (74.1% of the $T_1$ respondents). A telephone interview, which did not include the network delineation, was conducted with the respondent (n= 165) or a proxy (the partner, another member of the household or a staff member of the institution in which the respondent lived) (n = 88). Of the other $T_1$ respondents, 417 (13.4%) had died, 38 (1.2%) were ineligible, 90 (2.9%) were unwilling to co-operate and 17 (0.5%) could not be contacted. In each wave, the interviews were carried out by interviewers who had received a four-day training and who were intensively supervised. The interviews were tape-recorded to monitor and enhance the quality of the data obtained. The interviews lasted between one-and-a-half and two hours.

In all observation cycles, there were various reasons for not delineating the networks for all the interviews, e.g. premature termination of an interview, refusal of a

respondent to participate for privacy reasons or lack of time, and, most frequently, an abridged version of the questionnaire was used in a specific wave for respondents who were too physically or cognitively frail to be interviewed on the basis of the full questionnaire. The networks of 2,096 respondents were delineated in all waves using the same method. Data on the $T_0$ and $T_1$ networks were obtained from an additional 723 respondents (662 of whom were not interviewed at $T_2$), and data on the $T_0$ and $T_2$ networks of an additional 44 respondents and the $T_1$ and $T_2$ networks of an additional 40 respondents were also obtained. In total, longitudinal data were available for 2,903 respondents. The average interval between $T_0$ and $T_1$ was 0.86 years (N= 2,819; SD= 0.18), between $T_1$ and $T_2$ it was 3.06 years (N= 2,136; SD= 0.16), and between $T_0$ and $T_2$ it was 3.92 years (N= 2,140; SD= .21; with a minimum of 3.16 and a maximum of 4.74 years).

The sample characteristics are presented in Table 6.1 (the characteristics of the 95 respondents who were interviewed three times, but for whom two or all three observations of the network were missing, are not shown). Using multivariate logistic regression, respondents from whom no longitudinal data were available (i.e. who had died or refused to be interviewed) and respondents from whom longitudinal data were available were compared with regard to sex, age, functional ability, educational level, income and household composition, all measured at $T_0$. Compared with the respondents from whom longitudinal data were not available and who had died or were ineligible at $T_1$ or $T_2$, the respondents on whom longitudinal data were available were more often female, younger, less often institutionalized, and had a better functional ability and a higher level of education ($p < 0.01$). Compared with the respondents from whom longitudinal data were not available and who refused to be interviewed at $T_1$ or $T_2$, the respondents from whom longitudinal data were available had a higher income. Compared to the respondents with only two network observations, the ones with three observations were more often female and younger, and had a better functional ability and a higher level of education. As a result, the study sample is a survivor sample. Furthermore, the sample is characterized by a relatively high socio-economic status. However, the stratified sampling frame and the sample size guarantees the inclusion of sufficient male respondents, respondents in the highest age-category, respondents with physical problems and chronic diseases, and respondents with a low socio-economic status. Maximal variation within the sample was retained by not restricting the study of change to respondents for whom three observations of network characteristics were available.

Table 6.1
Sample characteristicsa

| | Longitudinal network data not available | | | | Longitudinal network data available (N of observations) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Died or ineligible at $T_1$ or $T_2$ | | Refused at $T_1$ or $T_2$ | | 2[b] | | 3 | | 2 or 3 | |
| | N= 396 | | N= 411 | | N= 807 | | N= 2,096 | | N= 2,903 | |
| % Female | 44.4 | | 53.5 | | 48.2 | | 52.8 | | 51.5 | |
| Age (mean[c], range 55-85) | 75.6 | (7.7) | 70.1 | (8.4) | 72.7 | (8.3) | 68.2 | (8.5) | 69.5 | (8.7) |
| Functional ability (mean, range 6-30) | 24.1 | (6.5) | 28.2 | (3.3) | 27.1 | (4.7) | 28.5 | (3.0) | 28.1 | (3.6) |
| Self-rated health (mean, range 1-5) | 3.1 | (1.0) | 3.7 | (0.8) | 3.5 | (1.0) | 3.8 | (0.8) | 3.7 | (0.9) |
| Health-related limitations (mean, range 1-3) | 1.9 | (0.8) | 1.4 | (0.7) | 1.5 | (0.7) | 1.4 | (0.6) | 1.4 | (0.7) |
| % With one or more chronic diseases[d] | | | | | 79.7 | | 72.8 | | 74.5 | |
| Education (mean, range 5-18 years) | 7.6 | (3.0) | 8.2 | (3.0) | 8.3 | (3.2) | 9.1 | (3.4) | 8.8 | (3.3) |
| Income (median category, net Dutch guilders a month) | 1,750-2,000 | | 1,750-2,000 | | 1,750-2,000 | | 2,250-2,500 | | 2,000-2,250 | |
| Household composition (%) | | | | | | | | | | |
| – institutionalized | 17.6 | | 2.7 | | 5.0 | | 1.1 | | 2.2 | |
| – alone | 31.5 | | 23.4 | | 29.6 | | 27.7 | | 28.2 | |
| – with partner | 45.5 | | 67.8 | | 61.5 | | 67.1 | | 65.6 | |
| – no partner, but with children | 2.3 | | 4.4 | | 2.2 | | 2.5 | | 2.4 | |
| – other multi-person household | 3.1 | | 1.7 | | 1.7 | | 1.6 | | 1.7 | |
| Network size (mean, range 0-77)[e] | 10.9 | (7.8) | 12.7 | (8.7) | 13.0 | (8.8) | 15.1 | (10.0) | 14.5 | (9.8) |
| Instrumental support received (mean, range 0-36) | 13.1 | (7.2) | 12.3 | (6.4) | 12.6 | (6.8) | 13.1 | (6.5) | 13.0 | (6.6) |
| Instrumental support given (mean, range 0-36) | 9.9 | (6.2) | 11.2 | (6.0) | 11.1 | (6.5) | 13.1 | (6.7) | 12.6 | (6.7) |

a. Having a chronic disease was assessed at $T_1$, all the other characteristics were assessed at $T_0$; b. Among these, at $T_2$ 633 died or were ineligible and 73 refused to be interviewed; c. SD between parentheses; d. Too few cases with data for respondents without longitudinal network data; e. N= 257; 375; 767; 2,096 and 2,863, respectively

*Measurements*

In order to obtain adequate information on the networks of older adults, no questions were asked about aggregate characteristics (e.g. the number of friends, without identifying these people, or the frequency of contacts with friends in general). More detailed information was requested from the older adults on their relationships, and they were also asked to identify network members by name. According to Starker, Morgan and March (1993), this type of data is the minimum requirement for studying change in networks. The main objective was to identify a network that reflected the socially active relationships of the older adults in the core, as well as the periphery of the network. Several criteria were applied to the selection of a method for identifying the personal network, with regard to who was to be included in the network. First, the network composition had to be as diversified as possible, implying that all types of relationships deserved the same chance being included in the network. This criterion led to a domain-specific approach in the network identification. Seven formal types of relationships were defined: household members (including the spouse, if there was one), children (including step-children) and their partners, other relatives, neighbors, colleagues (including voluntary work or school), fellow members of organizations (e.g. athletic clubs, church, political parties), and others (e.g. friends and acquaintances). A second objective was to include all network members with whom the respondent had regular contact, thus identifying the socially active relationships. To avoid selecting individuals who were contacted frequently by definition (such as all members of a club), the importance of the relationship was added as a criterion.

This 'domain-contact approach' combines the various roles an individual plays in society, with the contact frequency and the importance of the relationships as criteria for the identification of network members, and differs from approaches in which *support* networks are delineated (e.g. Wenger 1986). The identification method was derived from the method used in the study carried out by Cochran et al. (1990). For each of the seven domains, the following question was asked: 'Name the people (e.g. in your neighborhood) you have frequent contact with and who are also important to you.' The interpretation of the criteria was left to the respondent. Only people above the age of 18 could be nominated. The maximum number of names was set at 80, but no one reached this limit. The design of the measurements for the three observations was the same, thus giving equal chances to network members identified in a previous observation, and others to be identified in later observations.

Information was gathered on all network members with regard to the type of the relationship with the respondent, gender and contact frequency. A maximum of ten members was selected on the basis of the highest contact frequency with the respondent. For instrumental support exchanges, two questions were asked about the rela-

tionships with these ten (or fewer, if fewer had been identified). One question was asked pertaining to support received: 'How often in the past year did X help you with daily chores in and around the house, such as preparing meals, cleaning, transportation, minor repairs, filling out forms?' For support given, the question was reversed. The answer categories were never, seldom, sometimes and often, and were assigned values ranging from 0 to 3. In this study, the supportive exchanges within a partner relationship were not taken into account, for two reasons. Firstly, there was little variation in support across these relationships, and secondly, the existence of a partner relationship will be reviewed separately.

To assess health status, three instruments were used. The first one consisted of six questions about having difficulty in performing the activities of daily living (functional ability): Can you walk up and down stairs? ... walk for five minutes outdoors without resting? .... sit down in a chair and get up again? ... get dressed and undressed? ... use your own or public transportation? ... cut your own toenails? The five possible answers were: without difficulty, with some difficulty, with a great deal of difficulty, only with help, and not at all. The six functional items constituted hierarchically homogeneous scales at the three observations (Loevinger's $H \geq 0.59$), which were reliably measured ($\rho \geq 0.86$). The scales for functional ability ranged from 6 (no problems) to 30 (numerous problems). The second instrument pertained to the respondents' perception of their own health (self-rated health): How is your health in general? Answers could be given on a five-point scale scored from 1 (excellent) to 5 (poor). Also for health-related limitations in functioning, one single question was asked: Are you limited in your daily activities due to chronic diseases, health disorders or handicaps? Answers could be given on a three-point scale from 1 (severe limitations) to 3 (no limitations).

*Procedure*

Firstly, over time, changes in health, network size and instrumental support exchanges are reported. The network size was computed as the number of individuals identified. The means of instrumental support exchanges across the relationships (partner relationships excluded) were aggregated for each respondent, and averaged again for the entire sample. In addition to the method based on multivariate analysis of variance for repeated measurements, three other methods were used to assess changes at individual level. Firstly, since for the measurement of functional ability the reliability was known, the Edwards-Nunnally method (Speer and Greenbaum 1995) could be applied to assess the significance of change for individual respondents. With this method, an asymmetric confidence interval is created around the $T_0$ score to take into account measurement errors and regression to the mean. From the individual $T_0$ score, the interval is larger in the direction of the mean $T_0$ score than

in the reversed direction. There is a significant individual change from the $T_0$ score when the $T_1$ or $T_2$ scores are located outside the confidence interval. Secondly, since the measurements of network size and instrumental support exchanges can be considered as quasi interval variables, individual growth curves could be computed (Francis et al. 1990, Rogosa et al. 1982, Speer and Greenbaum 1995). The curves were the linear regression lines, with time as an explanatory variable, and were used to estimate for each respondent the regression intercept, i.e. the initial value, and the regression slope of time, i.e. the direction and speed of linear change. The slope of time and the explained variance over time were used to categorize the respondents. The criterion of $R^2 \geq 40\%$ was chosen arbitrarily to distinguish upward or downward linear trends from other trends. If $R^2 < 40\%$, the distinctive categories were *no change at all* if the network size was equal in the three observations, *about stable* if there were minor differences (SD < 2 and SD < 0.5 for network size and instrumental support, respectively), and *no linear change* for the remaining respondents. Linear trends ($R^2 \geq 40\%$) were divided into *decrease* if the slope of time was negative and *increase* for positive estimates. Thirdly, for the ordinal variables self-rated health and health-related limitations in functioning, neither the Edwards-Nunnally method nor the technique of individual growth curves are applicable. Therefore, the number of respondents whose $T_1$ and $T_2$ scores differed from their $T_0$ score, with no statistical testing, were reported.

One drawback of all these methods is that they assume the availability of observations for all respondents at each point in time and equal observation intervals among the respondents. These conditions were not met in the study sample: on the network characteristics for 807 respondents, only two observations were available and there was a relatively large variation in the individual observation intervals. These conditions are not required in multilevel analysis (Snijders 1996). Using this method to assess change over time, two or three observations are nested in the respondents. The analyses will lead to regression equations with fixed effects which can be read as the product of an ordinary regression analysis. Fixed effects are the intercept and time (i.e. the interval between the first and following observations). Differences in the time-effect among individuals, and the covariance between the intercept and the slopes, were estimated by incorporating random effects into the model. In addition, the application of the method of multilevel analysis made it possible to investigate whether other characteristics of the respondents affect the dependent variable. Two, in particular, are of importance: the presence of a partner and whether the respondent lived independently or was institutionalized, both of which affect the network characteristics. It is known that people with a partner usually have larger networks and fewer supportive exchanges within other relationships than people without a partner. Furthermore, since institutions offer care arrangements, it is likely that living independently or being institutionalized will af-

fect the supportive exchanges with the personal network members. Stepwise regression analyses were conducted. In the first step, time entered the equation, followed by the time-specific measurements of health. In explaining the change in instrumental support exchanges, the network size was also entered into the equation. Since the support exchanges were measured for only a limited number of relationships, there may be an effect of selecting specific relationships (i.e. the more supportive ones) for respondents with large networks. All explanatory time-specific measurements were computed as the difference between actual score and initial level. It was thus possible to extend the regression equations with variables for the initial level. The effects of the initial level variables indicate the effects across time, and are constant over time.

The models were analyzed by means of ML3, a program for multilevel analysis (Prosser et al. 1991). There are two methods for evaluating the compatibility of models. The first focuses on the significance of the model change. Each model is characterized by the –2 log likelihood (deviance, i.e. the lack of correspondence between the model and the data). For each variable to be explained, the forward modeling approach was applied, using an empty model (containing only a constant) at the start, and the parameters were added in the subsequent steps. The difference between the deviance of the steps is $\chi^2$ distributed, with the number of added parameters as degrees of freedom. The second method involves the reduction of the unexplained variance (Snijders and Bosker 1994). In each step, the variability of the dependent variable is estimated at each level of analysis. The sum of these variance components in the empty model equals the variance of the variable. If explanatory variables are added to the model, the variance decreases for either one or two of the levels. The degree of decrease provides insight into the explanatory power of the model. $R^2$-like descriptions of the explained variance are available and take the changes in variance at both levels into account. $R_r^2$ indicates the explained variance at respondent level, and $R_m^2$ indicates the explained variance at observation level. Unlike ordinary regression analysis, the added variances explained may be negative. If they are strongly negative, the specification of the model should be questioned.

## Results

### *Changes in health*

At the first observation, according to the three indicators of health, most of the respondents were in good health. For functional ability, the average was 7.9 (range 6–30; SD= 3.5); 69% of the respondents had a perfect functional ability. For self-rated health, 15% reported excellent health, and another 51% reported good health; the

average score was 2.3 (range 1–5; SD = 0.9). Furthermore, 68% of the respondents reported they had no limitations in their daily activities due to health, another 21% reported slight limitations, and only 11% reported severe limitations. The inter-correlations between these three measurements were moderate: functional ability correlated 0.44 and 0.58 with self-rated health and limitations, respectively, and self-rated health and limitations correlated 0.54. For all three variables, a decrease in health was assessed between $T_0$ and $T_2$, although improvement was observed in a few respondents. For functional ability, the average scores increased from 7.5 (SD = 3.0) to 8.9 (SD = 4.7; N = 2,140; $t = 18.8$, $p < 0.001$). Based on the Edwards-Nunnally method, it was assessed that between $T_0$ and $T_2$, 26% (N = 2,223) had a decrease ($p < 0.05$; on average 6.2; SD = 3.3) in their functional ability and 3% had an increase (on average 5.0; SD = 2.3). For self-rated health, 29% of the respondents (N = 2,180) reported a decrease and 18% reported an increase between T0 and T2, but for most (24% and 16%, respectively) the change was only one point on the scale ranging from 1 to 5. For health-related limitations, 25% of the respondents (N = 2,180) reported a decrease (of whom 13% from no limitations to severe limitations) and 14% reported an increase between $T_0$ and $T_2$. For all three variables, non-linear patterns were rare, and changes between $T_0$ and $T_1$ and between $T_1$ and $T_2$ are therefore not reported.

### *Changes in network size and instrumental support received and given*

On average, a large number of network members was identified at all three observations. For the respondents for whom three observations were available (N= 2,096), the average network size at $T_0$ was 15.1 (SD = 10.0), at $T_1$ 14.3 (SD = 8.3) and at $T_2$ 14.5 (SD = 8.7). In the three waves, six, five and one respondents, respectively, could not identify any network members. The maximum numbers identified were 77, 75 and 73, respectively. Multivariate analysis of variance for repeated measurements showed that the decrease from $T_0$ to $T_1$ was significant ($F = 20.4$, $p < .001$), but that the difference between $T_0$ and $T_1$, on the one hand, and $T_2$ on the other hand, was not significant ($F = 0.6$).

However, the results of a multilevel analysis, based on data from all the respondents with two or three observations available (N = 2,903) showed a stable network size over time (details are reported in Van Tilburg, in press). In addition, a large variation surrounding the general stable trend was observed, which can be illustrated by categorizing the respondents for whom three observations were available on the basis of the individual regression lines (Table 6.2). The extent of linear change was arbitrarily distinguished into strong (three or more network members per year), moderate and small (less than one network member a year) on the basis of the slope of time. Non-linear change was distinguished from stability on the basis of the variance across the observations. A linear increase was observed for approximately one-

third of the respondents, and the proportions of the categories of linear decrease and no linear change were approximately equal. From the average intercept for each of the categories it can be derived that the effect of regression towards the mean was particularly strong for respondents with large $T_0$ networks. For example, the 144 respondents who lost 12 or more network members during the four-year interval between the first and third observations had an average intercept of 30.

Table 6.2
Categorization on the basis of individual regression lines of network size and instrumental support exchanges on time ('individual growth curve approach'); average intercept of network size for each category of change in network size

| | Network Size | | | | Instrumental Support Received | | Instrumental Support Given | |
|---|---|---|---|---|---|---|---|---|
| | | | Intercept | | | | | |
| | abs. | % | M | SD | abs. | % | abs. | % |
| Strong linear decrease | 144 | 6.9 | 30.1 | 9.5 | 19 | .9 | 12 | 0.6 |
| Moderate linear decrease | 353 | 16.8 | 17.8 | 6.7 | 112 | 5.4 | 134 | 6.4 |
| Minor linear decrease | 169 | 8.1 | 11.3 | 5.4 | 326 | 15.7 | 419 | 20.1 |
| No change at all | 21 | 1.0 | 8.0 | 5.6 | 116 | 5.6 | 270 | 13.0 |
| Roughly stable | 155 | 7.4 | 10.4 | 5.7 | 422 | 20.3 | 404 | 19.4 |
| No linear change | 583 | 27.8 | 16.4 | 8.2 | 336 | 16.1 | 309 | 14.9 |
| Minor linear increase | 171 | 8.2 | 9.6 | 6.2 | 469 | 22.5 | 358 | 17.2 |
| Moderate linear increase | 350 | 16.7 | 10.7 | 6.2 | 241 | 11.6 | 148 | 7.1 |
| Strong linear increase | 150 | 7.2 | 11.0 | 7.2 | 40 | 1.9 | 26 | 1.3 |
| Total | 2,096 | 100.0 | $F = 140$, $p < 0.001$ | | 2,081 | 100.0 | 2,080 | 100.0 |

On average, low levels of exchanges of instrumental support characterized the relationships of respondents. The averages for support received and given at $T_0$ were 0.69 (SD= 0.70; range 0–3; N= 2,081) and .69 (SD= 0.72; N= 2,080), respectively. The network size correlated 0.02 and 0.08 with the averaged instrumental support received and given, respectively, and the correlation between support given and received was 0.32. Instrumental support received increased over time. The averages were 0.79 (SD= 0.71) and 0.86 (SD= 0.72) for $T_1$ and $T_2$, respectively. Both of these increases from one observation to another were significant ($F = 32.2$, $p < 0.001$, and $F$

= 54.7, $p < 0.001$, respectively). No changes were observed for instrumental support given. The averages were 0.73 (SD = 0.73) and 0.70 (SD = 0.73) for $T_1$ and $T_2$, respectively. Effects of regression to the mean were not observed. Individual variation surrounding the general stable trend was observed, which can be illustrated by categorizing the respondents on the basis of the individual regression lines (Table 6.2).

*The association between changes in health and changes in network size and instrumental support exchanges*

The estimated effects of explanatory variables in the three multilevel regression analyses of network size and instrumental support received and given are presented in Table 6.3. The characteristics of the models are presented in Table 6.4. In all analyses, steps in which the same variables were entered were labeled with the same number.

In explaining the course of developments in personal network size, time did not improve the model (step 1), but adding parameters for the individual slope variation and the effect of regression to the mean (step 2) improved the model. Entering the time-specific observation of health into the equation (step 3) revealed that the model improved significantly. To compare the effects of the three health indicators, the theoretical range of these variables was changed to 0–1. For the time-specific observations, a value of –1 indicates that the health had improved maximally. The better the functional ability, the more network members were identified at each observation. The estimate was –1.80, indicating that when the functional ability increased maximally between two observations (–0.60), on average 1.08 network members were gained. When the functional ability decreased maximally between two observations, on average 1.40 network members were lost. However, the increase in explained variance was small (0.4% at respondent level and 0.3% at observation level). Self-rated health and health-related limitations had no significant effect. Of the time-specific control variables (step 5), the presence of a partner had no effect. Living independently had a positive effect, indicating that older adults who became institutionalized, lost on average two network members. Adding the initial scores for the health variables (step 6) showed that there were two positive effects. Across all observations, respondents with good functional ability and self-rated health had larger networks. Finally, respondents who had a partner and who lived independently had larger networks across the observations (step 8).

Table 6.3
Multilevel regression of network characteristics (N of respondents= 2,903)

| Step | Network Size | | | Instrumental Support Received | | | Instrumental Support Given | | |
|---|---|---|---|---|---|---|---|---|---|
| | B | $\beta$ | $t$ | B | $\beta$ | $t$ | B | $\beta$ | $t$ |
| Constant | 5.30 | | 4.3 *** | 1.26 | | 13.9 *** | –0.45 | | –4.9 *** |
| *Change over time* | | | | | | | | | |
| 1 Time (0 – 4.74 years) | 0.03 | 0.01 | 0.7 | 0.03 | 0.06 | 6.1 *** | 0.01 | 0.03 | 3.3 *** |
| 3 Functional ability (–.60 – +.78; maximum increase – decrease) | –1.80 | –0.02 | –2.3 * | 0.36 | 0.05 | 4.8 *** | –0.35 | –0.05 | –4.9 *** |
| Self-rated health (–1 – +1; maximum increase – decrease) | –0.91 | –0.02 | –1.8 | 0.21 | 0.05 | 4.2 *** | –0.06 | –0.01 | –1.3 |
| Health-related limitations (-1 – +1; maximum increase – decrease) | 0.06 | 0.00 | 0.2 | 0.04 | 0.02 | 1.4 | –0.04 | –0.02 | –1.6 |
| 4 Network size (-65 – 60; divided by 10; maximum decrease – increase) | | | | 0.03 | 0.02 | 2.1 * | 0.02 | 0.02 | 1.8 |
| 5 Partner (–1,0,+1; lost, no change, gained) | 0.31 | 0.01 | 0.7 | –0.25 | –0.06 | –6.0 *** | 0.06 | 0.01 | 1.5 |
| Living independently (–1,0; institutionalized, unchanged) | 2.05 | 0.02 | 2.3 * | –0.06 | –0.01 | –0.7 | 0.15 | 0.02 | 2.0 * |
| *$T_0$ measurements* | | | | | | | | | |
| 6 Functional ability (0–1; no problems – numerous problems) | –2.93 | –0.05 | –2.4 * | 0.48 | 0.09 | 5.3 *** | –0.74 | –0.15 | –8.1 *** |
| Self-rated health (0–1; excellent – poor) | –3.46 | –0.08 | –4.5 *** | 0.13 | 0.04 | 2.2 * | –0.21 | –0.06 | –3.6 *** |
| Health-related limitations (0-1; no limitations – severe limitations) | 0.42 | 0.02 | 0.7 | 0.07 | 0.03 | 1.6 | 0.04 | 0.02 | 0.9 |
| 7 Network size (0–77; divided by 10) | | | | 0.05 | 0.07 | 4.4 *** | 0.06 | 0.09 | 5.6 *** |
| 8 No partner vs. partner present (0,1) | 2.85 | 0.15 | 9.3 *** | –0.11 | –0.07 | –4.9 *** | 0.22 | 0.14 | 9.7 *** |
| Institutionalized vs. living independently (0,1) | 2.24 | 0.03 | 2.1 * | 0.10 | 0.02 | 1.3 | 0.08 | 0.01 | 1.1 |

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 6.4
Multilevel regression of network characteristics: improvement of the models and explained variance after each step

| | | Network Size | | | Instrumental Support Received | | | Instrumental Support Given | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Step | df | $\chi^2$ | $R_r^2$ | $R_m^2$ | $\chi^2$ | $R_r^2$ | $R_m^2$ | $\chi^2$ | $R_r^2$ | $R_m^2$ |
| 1 | 1 | 0 | –0.0 | –0.0 | 85 ** | –0.2 | 0.6 | 3 | 0.1 | 0.0 |
| 2 | 2 | 131 ** | 0.8 | 5.2 | 2 | 0.0 | 1.6 | 2 | 0.2 | 1.0 |
| 3 | 3 | 17 ** | 1.2 | 5.5 | 49 ** | 1.0 | 2.3 | 41 ** | 2.5 | 2.3 |
| 4 | 1 | | | | 0 | 1.0 | 2.3 | 0 | 2.4 | 2.3 |
| 5 | 2 | 10 * | 1.5 | 5.7 | 33 ** | 1.5 | 2.5 | 13 * | 2.7 | 2.5 |
| 6 | 3 | 71 ** | 3.7 | 7.3 | 96 ** | 4.5 | 4.4 | 209 ** | 9.2 | 6.9 |
| 7 | 1 | | | | 14 ** | 5.0 | 4.6 | 48 ** | 10.7 | 7.9 |
| 8 | 2 | 93 ** | 6.7 | 9.5 | 25 ** | 5.8 | 5.1 | 95 ** | 13.4 | 9.7 |

* $p < 0.01$; ** $p < 0.001$

Instrumental support received increased significantly over time. The time-specific observations of functional ability and self-rated health both had an effect, indicating that respondents received more help when their health decreased. There was a significant effect of network size at each observation: when the network size increased between two observations, more support was received across the relationships. This may indicate that when new members entered the network, they gave more support than the members who were included in the network at an earlier observation. When functional ability and self-rated health were initially poor, more support was received across the observations. For the initial observations of health, there was a substantial increase in explained variance (3.0% at respondent level and 1.9% at observation level). A larger network at $T_0$ resulted in more support received across the observations, probably because the ten or less relationships on which support data were collected were the most supportive relationships selected from the larger pool of potential supporters within the network. The presence of a partner resulted in less support received across the observations, probably because when there is a partner there is less need for support from others.

For instrumental support given, there was no significant general effect of time, as is indicated by the lack of significance of the improvement of the model in step 1. However, controlling for the time-specific observations of health, respondents appeared to give more instrumental support over time. When the functional ability between two observations decreased, or if the respondent became institutionalized,

less support was given to the network members. When a respondent initially had a better functional ability and better self-rated health, had a larger network or had a partner, more support was given across the observations. Both for the time-specific observations and for the initial observations of health, there was a substantial increase in the variance explained.

## Discussion

Associations between health and personal network size and instrumental support exchanges were observed over time, based on three observations. The better the health of the older people, the larger their personal network was, the less instrumental support was received from their network members other than the partner, and the more support was given. Of the three indicators of health, the findings were consistent for functional ability. For the assessment of self-rated health, the longitudinal effect was observed only on instrumental support received. No effects on network size and instrumental support exchanges were observed for limitations in functioning due to poor health. These differences between the effects of three health indicators may be related to the quality of the measurements. Self-rated health and health-related limitations in functioning were both measured on the basis of one single question, with a limited number of answering possibilities (five and three, respectively). Functional ability was measured on a scale, which had a high reliability and a broad range. It was therefore possible to determine relatively small differences between respondents and, within respondents, between observations as meaningful.

In accordance with the observations made by Schwarzer and Leppin (1991), the positive effect of poor health on instrumental support received can be considered as an effect of the mobilization of helpers. The negative effect of poor health on instrumental support given, reflects the fact that people in poor health have difficulty in actively maintaining their personal relationships. Both tendencies affect the network size in different directions, which might be a reason for the relatively small effect of health on the network size. The differential effects of health on the network, as observed in the current study, differ from the observations made by Mor-Barak and Miller (1991). They observed positive effects of the network at baseline on health, but baseline health did not affect the network. The researchers did not offer an explanation for the absence of the effects of health on these network. It is thought that there might be two explanations for this. Firstly, their study population was limited to frail, older adults, for whom changes in the network had already occurred. Secondly, the assessment of personal network in their study involved a composite measurement based on ten items concerning network size, composition and content, which covered effects in different directions for various network characteristics. These dif-

ferences between the two studies are particularly important, since the associations observed over time between health and network characteristics were weak, confirming the observations made by Schwarzer and Leppin.

For both instrumental support received and given, an explanation for the small effects of health might be the large variation in the exchanges of support among respondents who were in good health. Although many older adults in the present study had one or more chronic diseases, on average they reported good health at the first observation, and only a minority reported a major decrease in health after the initial observation. Furthermore, those in good health might have received more instrumental support in return for the support given, although no evidence was found for this indirect relationship. However, if this reciprocation takes place, the negative relationship between health and support received would be less strong. With regard to instrumental support received, in particular, it takes time to mobilize helpers, and this could cause a delay in the effect of decreasing health on increased help. Furthermore, no investigation was made of the amount of assistance received from formal sources, i.e. sources subsidized by the government, or privately financed sources. This type of assistance might have replaced support received within the personal relationships. The need for support from other network members might have been limited, in particular since many of the respondents lived with a partner. Finally, many older adults do not want to be dependent on their personal network. Since the ability of older adults in poor health to reciprocate the support received may be limited, the amount of instrumental support they are willing to accept from their personal network might be less than they may need.

In this study, only the effects of health on the network were analyzed. However, the reverse effects also need to be studied: network characteristics may affect a person's health (Cohen 1988, Tijhuis 1994). In a future study, the mutual dependency of the network and health will be investigated.

## Acknowledgements

This study is based on data collected in the context of the 'Living arrangements and social networks of older adults' and the 'Longitudinal Aging Study Amsterdam' research programs. These programs are being conducted at the Vrije Universiteit in Amsterdam and the Netherlands Interdisciplinary Demographic Institute in The Hague, and are supported by the Netherlands Program for Research on Aging (NESTOR) and the Dutch Ministry of Health, Welfare and Sports.

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