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Social relationships and GP use of older adults in Europe: a moderator analysis

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3 **Title: Social relationships and GP use of older adults in Europe: a moderator analysis**
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Abstract

Objectives: This paper investigates (1) how social relationships (SR) relate to the frequency of general practitioners (GP) visits among older adults in Europe, (2) if SR moderate the association between health needs and GP visits, and (3) how the associations vary between subgroups of different employment status.

Methods: Data stem from the SHARE-project (wave 4, 56.989 respondents, 50 years or older). GP use was assessed by counting contacts with GPs in the last twelve months. Predictors were health needs (self-perceived health) and structural and functional aspects of SR (social integration index, contact frequency, emotional closeness). Regression models were used to measure the associations between GP use and those predictors. Sociodemographic and socioeconomic factors were used as covariates. Additional models were computed on subsets of the data, grouped by employment status.

Results: Functional and structural aspects of SR showed different associations with frequency of GP visits. Results revealed that people with a higher social integration index had a lower rate of GP visits, whereas individuals with frequent social contacts and emotionally close ties showed a higher GP use rate. Within moderator analyses, interactions were statistically insignificant. Subgroup analyses revealed an “employment effect”. For employed respondents, SR did not show statistically significant associations with GP use. However, SR did matter in diverse facets in the not-employed-group. For example, emotionally close ties were significantly associated with a higher GP use rate among retired and disabled individuals.

Conclusions: Different indicators of SR were associated with an increase (contact frequency, emotional closeness) or a decrease (social integration index) of GP visits. SR are relevant for investigating GP use behavior of older adults in Europe, especially if they are retired or

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3 unemployed. It is necessary to integrate information on SR and employment status into
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5 debates on needs-based access to health care and adequate levels of treatment.
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10 **Strengths and limitations of this study**

- 13 • This is one of the first studies to systematically analyze the associations between
14 health needs, SR and GP use of older adults in primary care in Europe by using
15 moderator analyses.
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- 18 • Applying a survey design to account for the stratification in the sample allows drawing
19 conclusions about non-institutionalized adults aged 50 years or older in 16 European
20 countries (111 million people).
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- 23 • In contrast to other studies, social relationships were assessed multi-dimensionally
24 focusing not only on structural, but also on functional aspects.
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- 27 • The cross-sectional design of the study does not allow drawing conclusions about
28 causalities.
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INTRODUCTION

According to the “Behavioral Model of Health Services Use”, utilization of health services is influenced by a variety of predisposing, enabling and need characteristics [1]. Existing literature has highlighted that health status, defined as a “need factor”, is the most powerful predictor of health services use in older age [2-6]. Furthermore, older adults within their fifties or older show more chronic illnesses and increased rates of health care use compared with younger cohorts [7]. Consequently, health care systems are challenged by increasing health needs and rising demands for health services in ageing societies [8]. In particular, the sector of primary health care is affected by these developments, since general practitioners (GPs) are the first contact to health care acting as gatekeepers and navigators.

Within Andersen’s model, social relationships are defined as “enabling resources” for health and the use of health services [1]. International studies suggest substantial impact of social relationships on morbidity and mortality [9, 10]. Moreover, research indicates the significance of social relationships by enhancing patient care, improving compliance with medical schemes, and fostering shorter hospital stays [11-13]. Social relationships can be divided into structural and functional elements [9]. Structural aspects of social relationships, e.g., the degree of social network integration, are assessed by quantitative measures (e.g. living arrangements, social network size, and frequency of social participation). Received and perceived social support is defined as a functional element, and includes aspects of financial, instrumental, informational or emotional support. The structure and function of social relationships can be subject to changed due to life events across the life span, especially in older age [14]. Namely, social relationships are affected and modified by life events, such as widowhood, unemployment or retirement [14-16].

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3 Up to now, studies on older adults' GP use have shown an ambiguous role of social
4 relationships [17-20]. In most cases, regression models were applied to show that various
5 aspects of social relationships are associated with the frequency of health services
6 consultations within a certain time span [21-24]. Though Andersen's model suggests a variety
7 of interactions between predisposing, enabling and need factors, none of the studies adopted
8 moderator analysis to capture the potential moderation of social relationships on the strong
9 link between health needs and health services use. The association between social
10 relationships, health needs and GP visits among older adults is still poorly understood.

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21 Focusing on adults 50 years or older, this paper investigates (1) how social relationships relate
22 to the frequency of GP visits and (2) if social ties moderate the association between health
23 needs and GP use. Since, social relationships are subject to change due to age-related life
24 events, such as retirement, unemployment and permanent disability, this study additionally
25 analyzes (3) how the associations vary through subgroups of different employment status.
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35 **DATA AND METHODS**

36 **Data**

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42 Analyses are based on data from the fourth wave of SHARE, the Survey of Health, Ageing,
43 and Retirement in Europe [25-28]. Data was collected in 2010 and 2011 from sixteen
44 European countries. Generally, SHARE uses probability samples within the countries and
45 includes non-institutionalized adults aged 50 years or older and their spouses. By focusing on
46 this age group, SHARE matches our research questions very well, since health needs increase
47 significantly and crucial changes in the life course occur (e.g., retirement). Furthermore,
48 SHARE offers a substantial sample size (wave four: 56.989 main interviews of respondents
49 aged 50 years or older in 39.807 households).
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3 SHARE uses an ex-ante harmonization regarding the survey design, which means that
4 questionnaires and field procedures are standardized across countries to maximize options for
5 cross-national comparisons [29]. To ensure the ex-ante harmonization of the survey, “[...]”
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9 SHARE employs three instruments: the SHARE Model Contract provides the legal
10 framework for standards and quality control; the SHARE Survey Specifications define the
11 quality standards of the survey ex ante; and the SHARE Compliance Profiles report adherence
12 to those standards ex post” [29]. In wave four, “[...]” contact rates of households were
13 satisfactory ($\geq 90\%$) in almost all countries, both in panel and refreshment samples. Refusal
14 rates ranged from 22% to 49% and were the prime reason for sampled households not
15 providing an interview” [29].
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24 25 **Measures**

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28 Interviews of the fourth SHARE wave included several items concerning health care. Before
29 asking explicitly for GP visits, the following more general question was asked: *‘During the*
30 *last twelve months, about how many times in total have you seen or talked to a medical doctor*
31 *about your health (exclude: dentist visits and hospital stays, include emergency room or*
32 *outpatient clinic visits)?’*. If respondents accounted for more than 98 contacts, the number 98
33 was entered. The dependent variable, GP visits, was assessed by counting contacts with
34 general practitioners or doctors at health care centers in the last twelve months prior to the
35 interview: *‘How many of these contacts were with a general practitioner or with a doctor at*
36 *your health care center?’*.
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48 Predictors were health needs and social relationships with a focus on structural (social
49 integration index, contact frequency in the social network) and functional (number of
50 emotionally close ties) dimensions.
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3 The Social Integration Index by Berkman et al. [30] was shown to be a reliable and robust
4 approach to represent the multidimensional construct of social integration. The index consists
5 of three domains (1: marital status and cohabitation, 2: contacts with friends and family, 3:
6 affiliation with voluntary associations; each scored from zero to two) ranging from zero to six,
7 with zero points meaning low and six points meaning high integration into their social
8 environment.
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16 First domain: if the respondent was single, divorced or widowed, zero points were given, and
17 two points, if the person was married or living with a partner. *'What is your marital status? 1.*
18 *Married and living together with spouse, 2. Registered partnership, 3. Married, living*
19 *separated from spouse, 4. Never married, 5. Divorced, 6. Widowed'*. This item was
20 dichotomized to having a partner or not. Second domain: the number of social ties to different
21 people was counted and transformed into three categories connected to different scores (0: 0
22 contacts, 1: 1-2 contacts, 2: 3 or more contacts). *'Please give me the first name of the person*
23 *with whom you often discuss things that are important to you'*. Respondents could name up to
24 seven people. Third domain: the affiliation with voluntary organizations and activities was
25 measured by membership in any of the six social groups: *'Which of the activities have you*
26 *done in the past twelve months? 1. Done voluntary or charity work, 2. Attended an*
27 *educational or training course, 3. Gone to a sport, social or other kind of club, 4. Taken part*
28 *in activities of a religious organization (church, synagogue, mosque etc.), 5. Taken part in a*
29 *political or community-related organization'*. Being part of no organization resulted in score
30 of zero, one organization meant one point and two or more memberships scored two points.
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49 Furthermore, the fourth wave of the survey included items on the characteristics of social
50 relationships, e.g. contact frequency and emotional closeness to people in the personal
51 network. Contact frequency was assessed by the following: *'During the past twelve months,*
52 *how often did you have contact with [person XY] either personally, by phone or mail? 1.*
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3 *Daily*, 2. *Several times a week*, 3. *About once a week*, 4. *About every two weeks*, 5. *About once*
4 *a month*, 6. *Less than once a month or never*'. The analyses include the average contact
5 frequency in the personal network. The question on emotional closeness to the personal
6 network members is: '*How close do you feel to [person XY]? 1. Not very close, 2. Somewhat*
7 *close, 3. Very close, 4. Extremely close*'. For the analyses, the number of very or extremely
8 close people in the personal network was counted (range: 0 to 7). Consequently, it represents
9 not only a structural, but also functional dimension of social relationships.
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18 In the current study, self-perceived health ('*Would you say your health is...?*') on a –five-
19 point-scale (1. *Excellent*, 2. *Very good*, 3. *Good*, 4. *Fair*, 5. *Poor*') is a proxy for health needs.
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23 Sociodemographic (gender, age) and socioeconomic (education, employment status, income:
24 make ends meet) factors were used as covariates. Education was based on the *International*
25 *Standard Classification of Education (ISCED 1997)* and ranged from 0 to 6 (low to higher
26 education). Employment status was split into a dichotomous variable (0 = *not employed*, 1 =
27 *employed*). The group of not employed individuals consisted of retired, unemployed,
28 permanently sick or disabled and homemaking respondents. Material well-being of
29 individuals was measured by the question: '*Thinking of your household's total monthly*
30 *income, would you say that your household is able to make ends meet...?*' (0 = *with great or*
31 *some difficulty*, 1 = *fairly easy or easy*).
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44 **Analyses**

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47 Regression models were used to analyze the associations between GP use and the predictors.
48 The dependent variable "number of GP visits" is a count variable. As the variance of the
49 dependent variable is greater than its mean, negative binomial regression was used to account
50 for the significant evidence of overdispersion. Furthermore, negative binomial regression
51 models include a parameter that reflects unobserved heterogeneity among observations [31].
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To adjust for the complex sample structure (individuals, households, countries), a survey design was implemented [25]. Sociodemographic (gender, age) and socioeconomic (education, employment status, make ends meet) factors were used as covariates. Since this study aimed to analyze potential moderation of social ties on the association between health needs and GP use, interaction terms were introduced [32]. Three interaction terms were calculated: 1) self-perceived health*social integration index, 2) self-perceived health*average of contact frequency in social network and 3) self-perceived health* number of very to extremely close people in social network. Finally, the models were computed on subsets of the data, grouped by employment status. The analyses were performed with Stata 12 and were replicated with R [33].

RESULTS

Our descriptive results are based on the unweighted sample (Table 1). The median of GP visits was three consultations in the last twelve months. More than half of the participants were female and the mean age was more than 66 years. 26% were employed and 39% had difficulty to make ends meet with regard to their income.

Table 1: Descriptive statistics of the sample (SHARE, wave four, 2011, 16 countries).

Variables	
GP visits ^a : Median / Mean (SD)	3 / 5.08 (7.38)
Female: N (%)	31.969 (56.10)
Age ^b : Mean (SD)	66.37 (10.05)
Education ^c (ISCED-1997 Coding): Mean (SD)	2.77 (1.44)
Job status ^d : N (%)	
<i>not employed</i>	41.518 (72.85)
<i>employed</i>	14.736 (25.86)
Income: make ends meet ^e : N (%)	
<i>with great or some difficulty</i>	22.319 (39.16)
<i>fairly easy or easy</i>	33.157 (58.18)
Self-perceived health ^f : Mean (SD)	1.74 (1.08)
Social integration index ^g : Mean (SD)	3.55 (1.39)
Average of contact frequency in social network ^h : Mean (SD)	4.07 (0.99)
Number of very to extremely close people in social network ⁱ : Mean (SD)	2.16 (1.45)

Unweighted sample	n = 56.989
Weighted sample	N = 144.269.529
<i>Missing values (out of 56.989):^a 7.296, ^b 5, ^c 1.244, ^d 735, ^e 1.513, ^f 277, ^g 1.024, ^h 4.451, ⁱ 3.385</i>	

The regression analysis of Model 1a (Table 2) shows that socially integrated people have a lower rate of GP visits, whereas frequent social contacts and emotionally close ties are associated with a slightly higher GP use rate. Moderator analysis in Model 1b demonstrates that the association with emotional closeness remains statistically significant, while other associations (social integration, contact frequency) and the interactions (health by social relationships) are statistically insignificant.

Table 2: Negative binomial regression models for GP use on full sample (SHARE, wave four, 2011, 16 countries).

GP visits	1a: Basic Model				1b: Interaction Model			
	IRR	95% CI			IRR	95% CI		
Gender: female (male = Ref.)	1.03	0.97	to	1.10	1.04	0.97	to	1.10
Age	1.01*	1.00	to	1.01	1.01**	1.00	to	1.01
Education (ISCED-1997 Coding: 0-6)	0.95***	0.92	to	0.97	0.95***	0.93	to	0.97
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.86***	0.81	to	0.92	0.86***	0.82	to	0.92
Job status: employed (not employed = Ref.)	0.78***	0.71	to	0.85	0.78***	0.72	to	0.85
Self-perceived health (0-4)	0.74***	0.70	to	0.78	0.70***	0.57	to	0.85
Social integration index (0-6)	0.97**	0.94	to	0.99	0.96	0.92	to	1.01
Average of contact frequency in social network (0-5)	1.04*	1.00	to	1.08	1.04	0.92	to	1.10
Number of very to extremely close people in social network (0-7)	1.03**	1.01	to	1.06	1.06**	1.01	to	1.12
Self-perceived health * social integration index					1.00	0.98	to	1.02
Self-perceived health * average of contact frequency in social network					1.02	0.98	to	1.07
Self-perceived health * number of very to extremely close people in social network					0.98	0.96	to	1.01
Intercept	7.13***	4.28	to	11.90	7.71***	3.98	to	1.49
alpha	0.61	0.55	to	0.66	0.60	0.56	to	0.66
n – unweighted	44.133							
N – weighted	111.010.910							
<i>Values in bold are significant (*p<0.05; **p<0.01; ***p<0.001)</i>								
<i>IRR = incidence-rate ratio</i>								
<i>Observations with missing values were dropped (listwise deletion).</i>								

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3 Subgroup analyses (employed vs. not employed) reveal an “employment effect” (Table 3).
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5 For employed respondents, social relationships do not show statistically significant
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7 associations with GP use (Models 1a and 1b). Whereas, social relationships are significantly
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9 associated in the not-employed-group (Models 2a and 2b). Model 2a (not employed older
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11 adults) shows that people with a higher social integration index have a lower rate of GP visits.
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13 Older adults with frequent social contacts and emotionally close ties are associated with a
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15 higher GP use rate. Moderator analysis (Model 2b) demonstrates that the interactions (health
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17 by social relationships) are statistically insignificant. The association with emotional
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19 closeness remains statistically significant, while other associations (social integration, contact
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21 frequency) are statistically insignificant.
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25 In Table 4, further differentiation of the not-employed-group (retired, unemployed,
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27 permanently sick, homemaker) show that retirees who are socially integrated have a lower
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29 rate of GP visits (model 1a). Retirees with emotionally close ties have a higher GP use rate,
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31 even though interaction terms are introduced (model 1b). Whereas, unemployed older adults
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33 who are socially integrated have a higher expected number of GP visits (Model 2a). The
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35 association is even stronger, when interactions were introduced (Model 2b). Moreover, the
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37 link between health needs and GP use is moderated by contact frequency (Model 2b). For
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39 permanently sick or disabled people, emotional closeness of their social ties is positively
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41 associated with the expected number of GP visits (Model 3a). Furthermore, the contact
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43 frequency is positively linked to GP use rates by homemakers (Models 4a).
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Table 3: Negative binomial regression models for GP use on employed and not employed older adults (SHARE, wave four, 2011, 16 countries).

GP visits	1a: Basic Model - employed				1b: Interaction Model - employed				2a: Basic Model – not employed				2b: Interaction Model – not employed			
	IRR	95% CI			IRR	95% CI			IRR	95% CI			IRR	95% CI		
Gender: female (male = Ref.)	1.13	1.01	to	1.26	1.13*	1.01	to	1.25	1.00	0.92	to	1.07	1.00	0.93	to	1.07
Age	1.00	0.99	to	1.01	1.00	0.99	to	1.01	1.01*	1.00	to	1.01	1.01*	1.00	to	1.01
Education (ISCED-1997 Coding: 0-6)	0.94**	0.90	to	0.98	0.94**	0.90	to	0.97	0.95**	0.92	to	0.98	0.95**	0.93	to	0.98
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.90	0.80	to	1.00	0.90	0.80	to	1.00	0.86***	0.80	to	0.92	0.86***	0.80	to	0.92
Self-perceived health (0-4)	0.70***	0.66	to	0.74	0.76	0.57	to	1.01	0.75***	0.70	to	0.80	0.67**	0.53	to	0.85
Social integration index (0-6)	1.02	0.98	to	1.06	0.99	0.88	to	1.12	0.95**	0.92	to	0.98	0.96	0.91	to	1.01
Average of contact frequency in social network (0-5)	1.01	0.96	to	1.07	1.08	0.94	to	1.25	1.05*	1.00	to	1.10	0.99	0.89	to	1.09
Number of very to extremely close people in social network (0-7)	1.01	0.98	to	1.05	1.01	0.92	to	1.10	1.04**	1.01	to	1.07	1.08*	1.02	to	1.14
Self-perceived health * social integration index					1.01	0.96	to	1.07			to		0.99	0.97	to	1.02
Self-perceived health * average of contact frequency in social network					0.97	0.92	to	1.02			to		1.04	0.98	to	1.11
Self-perceived health * number of very to extremely close people in social network					1.00	0.97	to	1.04			to		0.98	0.94	to	1.01
Intercept	6.86***	3.39	to	13.87	5.89***	2.38	to	1.46	7.42***	4.12	to	13.36	8.41***	4.12	to	17.15
alpha	0.47	0.40	to	0.54	0.46	0.40	to	0.54	0.64	0.58	to	0.71	0.64	0.59	to	0.70
n – unweighted	10.966								33.167							
N – weighted	31.478.523								79.532.388							

*Values in bold are significant (*p<0.05; **p<0.01; ***p<0.001)*
IRR = incidence-rate ratio
Observations with missing values were dropped (listwise deletion).

Table 4: Negative binomial regression models for GP use on retired, unemployed, permanently sick or disabled and homemaking older adults (SHARE, wave four, 2011, 16 countries).

GP visits	1a: Basic Model - retired				1b: Interaction Model - retired				2a: Basic Model - unemployed				2b: Interaction Model - unemployed			
	IRR	95% CI			IRR	95% CI			IRR	95% CI			IRR	95% CI		
Gender: female (male = Ref.)	0.97	0.89	to	1.06	0.98	0.90	to	1.06	1.02	0.84	to	1.25	1.04	0.86	to	1.26
Age	1.01	1.00	to	1.01	1.01	1.00	to	1.01	1.02	0.99	to	1.06	1.02	1.00	to	1.05
Education (ISCED-1997 Coding: 0-6)	0.95**	0.92	to	0.99	0.96**	0.93	to	0.99	0.94	0.87	to	1.03	0.94	0.87	to	1.02
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.84***	0.78	to	0.91	0.84***	0.78	to	0.91	0.92	0.76	to	1.12	0.96	0.80	to	1.16
Self-perceived health (0-4)	0.77***	0.71	to	0.83	0.68**	0.52	to	0.89	0.70***	0.62	to	0.80	0.47**	0.28	to	0.81
Social integration index (0-6)	0.94**	0.91	to	0.98	0.96	0.91	to	1.01	1.11***	1.05	to	1.17	1.18**	1.05	to	1.31
Average of contact frequency in social network (0-5)	1.04	0.99	to	1.10	0.97	0.86	to	1.09	1.02	0.93	to	1.12	0.84	0.68	to	1.04
Number of very to extremely close people in social network (0-7)	1.04**	1.01	to	1.07	1.07*	1.02	to	1.13	0.99	0.92	to	1.06	0.99	0.84	to	1.18
Self-perceived health * social integration index					0.99	0.97	to	1.01			to		0.96	0.90	to	1.02
Self-perceived health * average of contact frequency in social network					1.05	0.98	to	1.12			to		1.14*	1.01	to	1.29
Self-perceived health * number of very to extremely close people in social network					0.98	0.95	to	1.01			to		1.00	0.92	to	1.09
Intercept	7.51***	3.30	to	17.09	8.66***	3.4	to	22.03	1.80	0.34	to	9.64	2.87	0.55	to	1.50
alpha	0.62	0.56	to	0.70	0.62	0.56	to	0.69	0.47	0.36	to	0.62	0.45	0.35	to	0.59
n – unweighted	28.303								1.299							
N – weighted	64.576.091								3.787.831							
<i>Values in bold are significant (*p<0.05; **p<0.01; ***p<0.001)</i>																
<i>IRR = incidence-rate ratio</i>																
<i>Observations with missing values were dropped (listwise deletion).</i>																

GP visits	3a: Basic Model – permanently sick or disabled				3b: Interaction Model – permanently sick or disabled				4a: Basic Model - homemaker				4b: Interaction Model - homemaker			
	IRR	95% CI			IRR	95% CI			IRR	95% CI			IRR	95% CI		
Gender: female (male = Ref.)	1.13	0.84	to	1.52	1.11	0.83	to	1.47	2.67**	1.29	to	5.52	2.76**	1.35	to	5.63
Age	1.02	0.98	to	1.06	1.02	0.98	to	1.06	1.00	0.97	to	1.02	1.00	0.98	to	1.02
Education (ISCED-1997 Coding: 0-6)	0.89	0.78	to	1.02	0.90	0.80	to	1.01	0.93*	0.86	to	1.00	0.93*	0.86	to	0.99
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	1.02	0.77	to	1.36	1.02	0.77	to	1.34	0.79*	0.65	to	0.94	0.78**	0.65	to	0.94
Self-perceived health (0-4)	0.77*	0.63	to	0.94	0.70	0.39	to	1.25	0.66***	0.59	to	0.75	0.60	0.27	to	1.33
Social integration index (0-6)	0.88	0.76	to	1.03	0.82	0.66	to	1.02	0.97	0.89	to	1.05	0.93	0.77	to	1.13
Average of contact frequency in social network (0-5)	1.07	0.94	to	1.22	1.08	0.90	to	1.30	1.13*	1.01	to	1.26	1.13	0.88	to	1.44
Number of very to extremely close people in social network (0-7)	1.16*	1.01	to	1.32	1.19	0.97	to	1.46	0.98	0.92	to	1.04	0.95	0.82	to	1.12
Self-perceived health * social integration index					1.07	0.90	to	1.28			to		1.02	0.93	to	1.11
Self-perceived health * average of contact frequency in social network					0.99	0.90	to	1.10			to		1.00	0.89	to	1.12
Self-perceived health * number of very to extremely close people in social network					0.96	0.84	to	1.11			to		1.02	0.95	to	1.09
Intercept	3.45	0.31	to	3.85	4.09	0.41	to	4.11	1.69	0.16	to	1.79	1.90	0.13	to	2.77
alpha	0.84	0.67	to	1.06	0.84	0.66	to	1.05	0.68	0.57	to	0.82	0.68	0.57	to	0.81
n – unweighted	1.562								1.757							
N – weighted	4.318.499								5.905.349							
<i>Values in bold are significant (*p<0.05; **p<0.01; ***p<0.001)</i>																
<i>IRR = incidence-rate ratio</i>																
<i>Observations with missing values were dropped (listwise deletion).</i>																

DISCUSSION

Summary

Focusing on older adults in Europe, this study aimed to investigate (1) how social relationships are associated with the frequency of GP visits, (2) if social ties moderate the association between health needs and GP use, and (3) how these associations vary in subgroups of different employment status.

Regarding the first research question, the structural (social integration, contact frequency) and functional (number of emotionally close contacts) dimensions of social relationships under investigation are associated differently with GP use frequency. Analyses indicate that socially integrated people have a lower rate of GP visits, whereas individuals with frequent social contacts and more emotionally close relationships show a higher GP use rate. Referring to the “Behavioral Model of Health Services Use” [1], social relationships do not only enable GP visits, but also disable or buffer GP use.

The negative association between social integration (partnership, size of social network, volunteering) and the number of GP visits indicates the buffer function of social integration. Socially integrated older adults may receive alternate resources of care through their partnership, social networks and volunteering. They may have a feeling of social cohesion and are being cared of their needs (e.g., psychosocial), which may lead to less GP visits compared to older adults who are socially isolated. In other words, socially isolated people have higher rates of GP visits, which supports the interpretation of compensatory use of health services [34].

Until now, empirical results referring to structural measures of social ties are inconsistent. Various studies on outpatient care use showed that older people living alone are more likely to consult a physician [21, 35, 36]. Studies showed that married older people have a lower

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3 probability of using GP services [22]. Others demonstrated that older people living in a
4 marriage or with their kids present a higher frequency of physician consultations [23, 24].
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6 With regard to the size of the social network, studies found negative associations [17, 18], and
7 others ambiguous [19] or positive associations [20]. Moreover, Kim & Konrath [37] did not
8 find a statistically significant association between volunteering and the frequency of doctor
9 visits. A possible explanation for these inconsistent empirical patterns can be seen in the
10 quality dimension of social relationships to partners, family and social network members. For
11 instance, Foreman et al. [24] found a negative association between harmonious family
12 relationships and the number of physician visits.
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23 The analyses show that the rate of using GPs increases, if the average contact frequency in the
24 social network or the number of emotionally close relationships is high. The positive
25 association between emotionally close relationships (= functional dimension) and GP use
26 corresponds to the results of other international studies. They demonstrated that different
27 aspects of received social support (e.g., material, instrumental and informational support) is
28 positively linked with GP use [3, 38, 39]. Within an active and close social network older
29 people are more likely to get relevant information on health and health services and to
30 experience material, instrumental and informational support for using health services at all
31 (e.g., recommendations of GPs, transport to health care, GP appointments, dealing with
32 waiting times, financial help for out-of-pocket payments). Otherwise, frequent and close
33 social contacts are not only a potential source of social support, but also for psychological
34 distress and physical discomfort, conceivably leading to higher GP use rates [40, 41].
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49 Regarding the second research question, the analyses show hardly any moderating effects of
50 different aspects of social relations on the link between health needs and frequency of GP
51 visits. Only for older adults with poor self-perceived health, an increase of the number of
52 emotionally close members in the social network is associated with a growing rate of GP
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3 visits. Consequently, emotional closeness within social networks enables and fosters the
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5 utilization of GP services, especially for those individuals that report high levels of health
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7 needs.

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10 Subgroup analyses regarding the third research question indicate employment status-specific
11
12 behavioral patterns with regard to social relationships and GP use. Social relationships are not
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14 associated with the frequency of consulting a GP and they do not interact with the link
15
16 between health needs and GP use among older employed adults. Subgroup analyses focusing
17
18 on older people who are not employed (retired, unemployed, permanently sick or disabled,
19
20 homemaker), show different results. With respect to not employed people, social integration
21
22 lowers the GP use rate and contact frequency and emotional closeness increase the expected
23
24 number of visits. Consequently, an “employment effect”, or to be more precise, a “not
25
26 employed effect” is observed.
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30 The group of older not employed adults includes retired, unemployed and permanently sick or
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32 disabled people and homemakers showing different patterns of associations. A higher level of
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34 social integration lowers the rate of GP use for retirees, but increases the frequency of visits
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36 for unemployed older adults, especially for unemployed older people with a poor self-
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38 perceived health. “Having a partner”, which is included in the social integration index,
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40 contributed the most to this association. Atkinson et al. [16] showed that unemployment has a
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42 negative effect on marital and family support and a positive effect on the utilization of
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44 external help including emotional support, information or advice and concrete assistance.
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46 Potentially, unemployed people struggle not only with their psychological well-being but also
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48 with their social relationships. Consequently, they use more external help including the
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50 consultation of GPs. The frequency of social contacts is positively associated with the rate of
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52 GP use of homemakers. For unemployed people with poor health, the rate of GP use is higher
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54 among older adults with frequent social contacts. The more emotionally close contacts are
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3 present, the higher is the use for GP services by retired and permanently sick or disabled
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5 people.

8 **Limitations**

10 When interpreting the results, some methodological limitations need to be taken into account.
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12 Firstly, our analyses were based on cross-sectional data, forbidding statements on causal
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14 directions and changes over time. The cross-sectional design was chosen due to the inclusion
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16 of social relationship variables from SHARE's "social networks" module which was applied
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18 only in wave four [25, 26, 42].
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22 Although SHARE is an international survey aiming for high methodological standards by
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24 using ex-ante harmonization to minimize "artifacts in cross-national comparisons that are
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26 created by country-specific survey design" [29], the schedule for data collection in wave 4
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28 was only partly synchronized and household response rates vary between countries (39% to
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30 63 %).
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34 The question used in SHARE to cover the use of GP services about 12 months is established
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36 in health services research [4, 18, 19, 43]. Nevertheless, the time span is quite long, and
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38 considering the older age of the interviewed individuals, risk of memory bias is existent with
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40 regard to self-reported utilization data [44]. The limited level of information of self-reported
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42 data holds also true on all other variables in our analyses, especially on the variable "self-
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44 perceived health" which is culturally sensitive [45]. On the one hand, self-perceived health is
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46 a suitable summary of health. On the other hand, it may be sensitive to cultural contexts.
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48 Consequently, caution is needed drawing conclusions from analyses using self-perceived
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50 health.
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3 Furthermore, SHARE data did not provide information on the reasons for using health
4 services or the quality and adequacy of health care services. Consequently, the rate of visiting
5 a GP represents a proxy for “realized access” [1] only.
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10 Finally, and though SHARE strived to combine the indirect and direct approach of social
11 network analysis [42], it does not offer sufficient and longitudinal data on functional and
12 quality aspects of social relationships [46]. The synthesis of the indirect approach (referring
13 on socio-demographic proxies) and the direct approach (linking meaningfulness and
14 importance to social relations) still lacks valuable information about the quality of social
15 relationships and perceived support.
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26 27 **CONCLUSIONS**

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30 Our results demonstrate that different indicators of social relationships can increase
31 (frequency of contacts, number of emotionally close contacts) or decrease (social integration
32 index) the frequency of GP visits. Furthermore, social relationships are relevant for
33 investigating GP use behavior of older adults in Europe, especially if they are retired or
34 unemployed. Future surveys should aim at assessing functional and quality dimensions of
35 social relationships linked to health services use to shed more light on the underlying
36 mechanisms. Since, social ties influence patient’s motives for visits and the patient’s
37 compliance with regard to future visits for treatment, prevention and rehabilitation [47, 48],
38 GPs should take “employment status” and “social relationships” of their patients into account.
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40 Finally, our results indicate the necessity to integrate information on social relationships and
41 employment status into debates on needs-based access to health care and adequate levels of
42 treatment.
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28 contribution to data analyses and interpretation, drafting the manuscript, and critically revised
29 and approved the final manuscript. OvdK and NV substantially contributed to interpreting the
30 data, drafting the manuscript, and critically revised and approved the final manuscript.
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For peer review only

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5, 8-9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5-6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	5-6, 8-9
Study size	10	Explain how the study size was arrived at	5, 9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8-9
		(b) Describe any methods used to examine subgroups and interactions	8-9
		(c) Explain how missing data were addressed	9-10, 12-14
		(d) If applicable, describe analytical methods taking account of sampling strategy	8-9
		(e) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5, 9
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	9
Outcome data	15*	Report numbers of outcome events or summary measures	9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-14
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	15-17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18-19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15-17, 19
Generalisability	21	Discuss the generalisability (external validity) of the study results	19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Social relationships and GP use of middle-aged and older adults in Europe: a moderator analysis

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45
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47 *Supan et al. (2013) for methodological details.*

48
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Abstract

Objectives: This paper investigates (i) how social relationships (SR) relate to the frequency of general practitioners (GP) visits among middle-aged and older adults in Europe, (ii) if SR moderate the association between health needs and GP visits, and (iii) how the associations vary regarding employment status.

Methods: Data stem from the SHARE-project (wave 4, 56,989 respondents, 50 years or older). GP-use was assessed by frequency of contacts with GPs in the last 12 months. Predictors were health needs (self-rated health) and structural (social integration index (SII), contact frequency) and functional (emotional closeness) aspects of SR. Regressions were used to measure the associations between GP-use and those predictors. Sociodemographic and socioeconomic factors were used as covariates. Additional models were computed with interactions.

Results: Analyses did not reveal significant associations of functional and structural aspects of SR with frequency of GP visits (SII: IRR=0.988, $p=0.288$, contact frequency: IRR=1.035, $p=0.058$, emotional closeness: IRR=1.015, $p=0.193$). Moderator analyses showed that “high contact frequency people” with better health had statistically significant more GP visits than “low contact frequency people” with better health. Furthermore, people with poor health and an emotionally close network showed a significantly higher number of GP visits compared to people with same health, but less close networks. Three way interaction analyses indicated employment status-specific behavioral patterns with regard to SR and GP-use, but coefficients were mostly not significant. All in all, the not-employed groups showed a higher predicted number of GP visits.

Conclusions: Different indicators of SR showed statistically insignificantly associations with GP visits. Consequently, the relevance of SR may be rated rather low in quantitative terms for

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3 investigating GP-use behavior of middle-aged and older adults in Europe. Nevertheless,
4
5 investigating the two- and three-way interactions indicated potential inequalities in GP-use
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7 due to different characteristics of SR accounting for health and employment status.
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13 **Keywords:** middle-aged and older adults; social relationships; self-rated health; health
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15 services use; general practitioners; employment status
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21 **Strengths and limitations of this study**

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- 24 • This is one of the first studies to systematically analyze the associations between
25 health needs, SR, employment status and frequency of GP use of middle-aged and
26 older adults in Europe.
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- 29 • Applying a survey design to account for the stratification in the sample allows drawing
30 conclusions about non-institutionalized adults aged 50 years or older in 16 European
31 countries.
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- 34 • In contrast to other studies, social relationships were assessed multi-dimensionally
35 focusing on both, structural and functional aspects.
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- 38 • The cross-sectional design of the study does not allow drawing conclusions about
39 causalities.
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INTRODUCTION

According to the “Behavioral Model of Health Services Use” by Andersen, utilization of health services is influenced by a variety of predisposing, enabling and need characteristics [1]. Existing literature has highlighted that health status, defined as a “need factor”, is the most powerful predictor of health services use in older age [2-6]. Furthermore, adults within their fifties or older show more chronic illnesses and increased rates of health care use compared with younger cohorts [7]. Consequently, health care systems are challenged by increasing health needs and rising demands for health services in ageing societies [8]. In particular, the sector of primary health care is affected by these developments, since general practitioners (GPs) are the first contact to health care acting as gatekeepers and navigators.

Within Andersen’s model, social relationships are defined as “enabling resources” for health and the use of health services [1]. International studies suggest substantial impact of social relationships on morbidity and mortality [9-12]. Moreover, research indicates the significance of social relationships by enhancing patient care, improving compliance with medical schemes, and fostering shorter hospital stays [13-15]. Social relationships can be divided into structural and functional elements [9]. Structural aspects of social relationships, e.g., the degree of social network integration, are assessed by quantitative measures (e.g. living arrangements, social network size, and frequency of social participation). Received and perceived social support is defined as a functional element, and includes aspects of financial, instrumental, informational or emotional support. Both aspects of social relationships can be subject to change due to life events across the life span, especially in older age [16], as they are affected and modified by events, such as widowhood, unemployment or retirement [16-18].

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3 Up to now, studies on older adults' GP use have shown an ambiguous role of social
4 relationships [19-22]. In most cases, regression models were applied to show that various
5 aspects of social relationships are associated with the frequency of health services
6 consultations within a certain time span [23-26]. Though Andersen's model suggests a variety
7 of interactions between predisposing, enabling and need factors on health services use, only a
8 few studies adopted analyses to capture potential moderating or mediating action [27-33]. As
9 mentioned before, health needs are strongly associated to the frequency of using health
10 services, on the one hand. On the other hand, social relationships are closely linked to health
11 needs. Consequently, social relationships might influence the scope of action, such as using
12 GP services, depending on varying health status. Do social relationships have an impact on
13 the strong link between health needs and health services use? And, if applicable, does that
14 implicate anything for public health policy and health care providers? So far, the association
15 between social relationships, health needs and GP visits among middle-aged and older adults
16 is poorly understood.

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19 Focusing on adults 50 years or older, this paper investigates (i) how social relationships relate
20 to the frequency of GP visits and (ii) if social relationships moderate the association between
21 health needs and GP visits (Figure 1). Since, social relationships are subject to change due to
22 age-related life events, such as retirement, unemployment and permanent disability, this study
23 additionally analyzes (iii) how the associations vary through subgroups of different
24 employment status. Hence, this study may contribute to a better understanding of the
25 behavioral patterns of using GP services within the middle-aged and older¹ European
26 population.

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57 ¹ Due to the readability, we refer to "middle-aged and older adults" or "adults 50 years or older" when we
58 write about "older adults" in this paper.

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3 **Figure 1: Conceptual model of research questions (i), (ii) and (iii)**
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8 **DATA AND METHODS**

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11 **Data**

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14 Analyses are based on data from the fourth wave of SHARE, the Survey of Health, Ageing,
15 and Retirement in Europe [34-37]. “SHARE has been submitted to, and approved by, the
16 ethics committee at the University of Mannheim which was the legally responsible entity for
17 SHARE during wave four” [37]. Data was collected in 2010 and 2011 from sixteen European
18 countries (Austria, Germany, Sweden, Netherlands, Spain, Italy, France, Denmark,
19 Switzerland, Belgium, Czech Republic, Poland, Hungary, Portugal, Slovenia and Estonia).
20 Based on population registers, SHARE uses probability samples within the countries and
21 includes non-institutionalized adults aged 50 years or older and their partners. Further
22 exclusion criteria are being incarcerated, moved abroad, unable to speak the language of
23 questionnaire, deceased, hospitalized, moved to an unknown address or not residing at
24 sampled address [35, 37]. By focusing on an older age group, SHARE matches our research
25 questions very well, since health needs increase significantly and crucial changes in the life
26 course occur (e.g., retirement). Furthermore, SHARE offers a substantial sample size (wave
27 four: 56,989 main interviews of respondents aged 50 years or older in 39,807 households).
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45 SHARE uses an ex-ante harmonization regarding the survey design, which means that
46 questionnaires and field procedures are standardized across countries to maximize options for
47 cross-national comparisons [38]. To ensure the ex-ante harmonization of the survey, “[...]”
48 SHARE employs three instruments: the SHARE Model Contract provides the legal
49 framework for standards and quality control; the SHARE Survey Specifications define the
50 quality standards of the survey ex ante; and the SHARE Compliance Profiles report adherence
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3 to those standards ex post” [38]. In wave four, “[...] contact rates of households were
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5 satisfactory ($\geq 90\%$) in almost all countries, both in panel and refreshment samples. Refusal
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7 rates ranged from 22% to 49% and were the prime reason for sampled households not
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9 providing an interview” [38]. To handle possible selection and participation biases, SHARE
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11 offers sample design weights [34, 37] (for further details please see analyses section).
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13 14 **Measures**

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17 Interviews of the fourth SHARE wave included several items concerning health care. Before
18
19 asking explicitly for GP visits, the following more general question was asked: *‘During the*
20
21 *last twelve months, about how many times in total have you seen or talked to a medical doctor*
22
23 *about your health (exclude: dentist visits and hospital stays, include emergency room or*
24
25 *outpatient clinic visits)?’ . If respondents accounted for more than 98 contacts, the number 98*
26
27 *was entered. The dependent variable, GP visits, was assessed by counting contacts with*
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29 *general practitioners or doctors at health care centers in the last twelve months prior to the*
30
31 *interview: ‘How many of these contacts were with a general practitioner or with a doctor at*
32
33 *your health care center?’ .*
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38 Predictors were health needs and social relationships with a focus on structural (social
39
40 integration index, contact frequency in the social network) and functional (number of
41
42 emotionally close ties) dimensions.
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45 The Social Integration Index by Berkman et al. [39] has been shown to be a reliable and
46
47 robust approach to represent the multidimensional construct of social integration. The index
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49 consists of three domains (1: marital status and cohabitation, 2: contacts with friends and
50
51 family, 3: affiliation with voluntary associations; each scored from zero to two) ranging from
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53 zero to six, with zero points meaning low and six points meaning high integration into their
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55 social environment.
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3 First domain: if the respondent was single, divorced or widowed, zero points were given, and
4 two points, if the person was married or living with a partner. *'What is your marital status? 1.*
5 *Married and living together with spouse, 2. Registered partnership, 3. Married, living*
6 *separated from spouse, 4. Never married, 5. Divorced, 6. Widowed'*. This item was
7 dichotomized to having a partner or not. Second domain: the number of social ties to different
8 people was counted and transformed into three categories connected to different scores (0: 0
9 contacts, 1: 1-2 contacts, 2: 3 or more contacts). This categorization is based on the answers to
10 the following question: *'Please give me the first name of the person with whom you often*
11 *discuss things that are important to you'*. Respondents could name up to seven people. Third
12 domain: the affiliation with voluntary organizations was measured by activities in any of the
13 five social groups: *'Which of the activities have you done in the past twelve months? 1. Done*
14 *voluntary or charity work, 2. Attended an educational or training course, 3. Gone to a sport,*
15 *social or other kind of club, 4. Taken part in activities of a religious organization (church,*
16 *synagogue, mosque etc.), 5. Taken part in a political or community-related organization'*.
17 Being part of no organization resulted in a score of zero, one organization meant one point
18 and two or more memberships scored two points.
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38 Furthermore, the survey included items on the characteristics of social relationships, e.g.
39 contact frequency and emotional closeness to people in the personal network. This module
40 was based on other similar studies, such as the National Social Life, Health, and Aging
41 Project (NSHAP) [40], the American General Social Survey and the Longitudinal Aging
42 Study Amsterdam [41-43]. Contact frequency was assessed by the following question:
43 *'During the past twelve months, how often did you have contact with [person XY] either*
44 *personally, by phone or mail? 1. Daily, 2. Several times a week, 3. About once a week, 4.*
45 *About every two weeks, 5. About once a month, 6. Less than once a month or never'*. The
46 analyses include the average contact frequency in the personal network. The question on
47 emotional closeness to the personal network members is: *'How close do you feel to [person*
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3 XY]? 1. *Not very close*, 2. *Somewhat close*, 3. *Very close*, 4. *Extremely close*'. For the
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5 analyses, the number of very or extremely close people in the personal network was counted
6
7 (range: 0 to 7). Consequently, it represents not only a structural, but also functional dimension
8
9 of social relationships.

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12 In the current study, self-rated health ('*Would you say your health is...?*') on a five-point-scale
13
14 ('0. *Poor*, 1. *Fair*, 2. *Good*, 3. *Very good*, 4. *Excellent*') is a proxy for health needs.

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16
17 Sociodemographic (gender, age) and socioeconomic (education, employment status, income:
18
19 make ends meet) factors were used as covariates (Supplement Table 1). Education was based
20
21 on the *International Standard Classification of Education (ISCED 1997)* and ranged from 0 to
22
23 6 (low to higher education). Employment status was split into five categories (0 = *employed*,
24
25 1 = *retired*, 2 = *unemployed*, 3 = *permanently sick or disabled* and 4 = *homemaking*
26
27 *respondents*). Material well-being of individuals was measured by the question: '*Thinking of*
28
29 *your household's total monthly income, would you say that your household is able to make*
30
31 *ends meet...?*' (0 = *with great or some difficulty*, 1 = *fairly easy or easy*).

32 33 34 35 **Analyses**

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38 Regression models were used to analyze the associations between GP use and the predictors.
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40 The dependent variable "number of GP visits" is a count variable. As the variance of the
41
42 dependent variable is greater than its mean, negative binomial regression was used to account
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44 for the significant evidence of overdispersion. Furthermore, negative binomial regression
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46 models include a parameter that reflects unobserved heterogeneity among observations [44].

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49 Due to the complex sample structure, including individual level, household level and country
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51 level, a survey design was implemented [34, 45]. To account for within-household correlations
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53 and between-country differences, households were defined as primary sampling unit and
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55 countries as strata. Furthermore, to adjust for variation in selection probabilities by design and
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for variation in participation probabilities caused by non-response, sample design weights were used [37]. Consequently, the Stata survey command, respectively the survey-package in R were used to handle weighted and stratified data adequately [46-48].

Since this study aimed to analyze potential moderation of social ties on the association between health needs and GP use, interaction terms were introduced [49]. Three different two-way interaction terms were calculated: 1) self-rated health*social integration index, 2) self-rated health*average of contact frequency in social network and 3) self-rated health*number of very to extremely close people in social network. Finally, three-way interactions were computed to elaborate the role of the employment status within the interaction between health and social relationships (health*social relationship*employment status). The analyses were performed with Stata 12 and were replicated with R [50].

RESULTS

Our descriptive results are based on the unweighted sample (Table 1). The median of GP visits was three consultations in the last twelve months. More than half of the participants were female and the mean age was about 66.4 years. 26% were employed and 39% had difficulty to make ends meet with regard to their income.

Table 1: Descriptive statistics of the sample (SHARE, wave four, 2011, 16 countries).

Variables	
GP visits ^a : Median / Mean (SD)	3 / 5.08 (7.38)
Female: N (%)	31,969 (56.10)
Age in years ^b : Mean (SD)	66.37 (10.05)
Education ^c (ISCED-1997 Coding: 0=low – 6=high): Mean (SD)	2.77 (1.44)
<i>none</i>	1,682 (2.95)

<i>ISCED-1997 Code 1</i>	10,943 (19.20)
<i>ISCED-1997 Code 2</i>	10,804 (18.96)
<i>ISCED-1997 Code 3</i>	18,751 (32.90)
<i>ISCED-1997 Code 4</i>	2,597 (4.56)
<i>ISCED-1997 Code 5</i>	10,514 (18.45)
<i>ISCED-1997 Code 6</i>	454 (0.80)
Job status ^d : N (%)	
<i>employed</i>	14,736 (25.86)
<i>retired</i>	35,207 (61.78)
<i>unemployed</i>	1,821 (3.20)
<i>permanently sick or disabled</i>	1,863 (3.27)
<i>homemaker</i>	2,265 (3.97)
Income: make ends meet ^e : N (%)	
<i>with great or some difficulty</i>	22,319 (39.16)
<i>fairly easy or easy</i>	33,157 (58.18)
Self-rated health (0=poor – 4=excellent) ^f : Mean (SD)	1.74 (1.08)
<i>poor</i>	7,307 (12.82)
<i>fair</i>	16,841 (29.55)
<i>good</i>	19,754 (34.66)
<i>very good</i>	9,066 (15.91)
<i>excellent</i>	3,744 (6.57)
Social integration index (0=low – 6=high) ^g : Mean (SD)	3.55 (1.39)
Average of contact frequency in social network (0=less than once per month or never – 5=daily) ^h : Mean (SD)	4.07 (0.99)
Number of very to extremely close people in social network (0-7) ⁱ : Mean (SD)	2.16 (1.45)
Unweighted sample (= number of observations)	n = 56,989
Weighted sample (= population size based on survey design)	N = 144,269,529
<i>Missing values (out of 56,989):^a 7,296, ^b 5, ^c 1,244, ^d 1,097, ^e 1,513, ^f 277, ^g 1,024, ^h 4,451, ⁱ 3,385</i>	

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3 *i) Associations between social relationships and GP visits*
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6 To answer research question (i), Figure 2 shows the forest plots of incidence rate ratios of
7 negative binomial regression models for GP use, for the different social relationship indicators
8 (Model 1: social integration index, Model 2: average contact frequency in social network and
9 Model 3: number of emotionally very close contacts).
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18 **Figure 2 Forest plots of incidence rate ratios for GP use**
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22 The regression analysis of Model 1 (Figure 2, Supplement Table 2) shows that the social
23 integration index is not statistically significantly associated with the rate of GP visits
24 (IRR=0.988, p=0.288). Better self-rated health (IRR=0.741, p<0.001), easily making ends
25 meet (IRR=0.850, p<0.001) and higher educational status (IRR=0.944, p<0.001) are strongly
26 associated with lower frequency of GP visits. Older age shows a slightly positive association
27 with a higher rate of GP visits (IRR=1.006, p<0.05). Not-employed persons show higher
28 frequency of GP visits (employed: reference, retired: IRR=1.241, p<0.001, unemployed:
29 IRR=1.054, p<0.399, permanently sick or disabled: IRR=1.484, p<0.001, homemaker:
30 IRR=1.291, p<0.001). The regression analysis of Model 2 (Figure 2, Supplement Table 2)
31 shows that the contact frequency within a social network is not statistically significantly
32 associated with the rate of GP visits (IRR=1.035, p=0.058). The regression analysis of Model
33 3 (Figure 2, Supplement Table 2) indicates that being closely connected is not statistically
34 significantly associated with the rate of GP visits (IRR=1.015, p=0.193). In all three models,
35 social tie coefficients showed low magnitude and narrow confidence intervals.
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53 *ii) Moderation of social relationships on health and GP use*
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3 To answer research question (ii), Figure 3 shows the number of predicted GP visits depending
4 on the two way interaction between health status and social integration index (Supplement
5 Table 3). The blue line represents people with a mean level of social integration. The red line
6 is based on a lower level of social integration (mean minus one standard deviation), whereas
7 the green line stands for a higher level of social integration (mean plus one standard
8 deviation).
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19 **Figure 3 Predicted number of GP visits on health & social integration**
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23 Starting at nearly eight visits per year for people with poor health, the number of predicted
24 visits steadily decreases with better health status, ending at about two visits for people with
25 excellent self-rated health. This trend can be observed for all three levels of social integration,
26 but taking the confidence intervals into account, the divergence of the groups is not
27 statistically significant at any level of health status. Nevertheless, the largest slope is detected
28 for less socially integrated people and the smallest slope is documented for more socially
29 integrated people.
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39 Figure 4 shows the number of predicted GP visits in dependence of health and contact
40 frequency in social networks (Supplement Table 3).
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47 **Figure 4 Predicted number of GP visits on health & contact frequency**
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51 All in all, the line patterns are similar to Figure 3, but the slopes of the groups with lower and
52 higher contact frequencies are the other way round. The slope of predicted number of GP
53 visits on self-rated health is steeper for those with lower social contact frequency. This
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3 association is statistically significant for people with a very good and excellent health,
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5 although the slope differences are relatively small (approx. 0.5 GP visits per year).
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8 Figure 5 shows the number of predicted GP visits according to various levels of subjective
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10 health and the number of very close people in social networks (Supplement Table 3).
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16 **Figure 5 Predicted number of GP visits on health & emotional closeness**

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19 Again, we see the downward trend of predicted GP visits from poor to excellent health.
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21 Contrarily to Figure 4, group differences are only observable for people with poor health.
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23 People with poor health and an emotionally close network show a significantly higher number
24
25 of GP visits compared to people with poor health and less closeness.
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29 *iii) Moderation of social relationships and employment status on health and GP visits*

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32 To answer research question (iii), Figures 6-8 incorporate the three way interactions between
33
34 health, social relationships and employment status predicting the number of GP visits. Figure
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36 6 shows the number of predicted GP visits depending on the three-way interaction between
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38 health, social integration index and employment status (Supplement Table 4).
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44 **Figure 6 Predicted number of GP visits on health, social integration & employment status**

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48 The slopes of the different employment status groups are very diverse, in particular, when the
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50 disparate levels of social integration are taken into account. Retired, unemployed,
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52 permanently sick or disabled and homemaking people show higher numbers of GP visits on
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54 average compared to employed people. Furthermore, the diverging slopes of various social
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56 integration indices of those groups also indicate more between-group differences than
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3 employed people. Retired people with good, very good or excellent health, for instance, have
4 more GP visits if they are less integrated than retirees who are socially well integrated. This
5 association is inverse with regard to unemployed people with a lower health status.
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10 Considering the social contact frequency, group differences depending on employment status
11 and different grades of contact frequencies in social networks are similar to those seen for
12 social integration (Figure 7, Supplement Table 4).
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20 **Figure 7 Predicted number of GP visits on health, contact frequency & employment status**
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23
24 Retired people with good to excellent health, for example, show more GP visits if their
25 contact frequency in their social network is high on average compared to lower contact
26 frequencies. This association is also observable for homemaking people with an intermediate
27 health status.
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33 Figure 8 shows the number of predicted GP visits depending on the three-way interaction
34 between health, number of very close contacts and employment status (Supplement Table 4).
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41 **Figure 8 Predicted number of GP visits on health, closeness & employment status**
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45 The slopes in the group of retired people show statistically significant differences between
46 various levels of emotional closeness. A higher number of emotionally close contacts
47 increases the number of predicted GP visits, if retired people are characterized by poor or fair
48 self-rated health. This association is also shown within the group of permanently sick or
49 disabled people.
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DISCUSSION

Summary

Focusing on older adults in Europe, this was the first study to investigate (i) how social relationships are associated with the frequency of GP visits, (ii) if social ties moderate the association between health needs and GP use, and (ii) how these associations vary in subgroups of different employment status.

Regarding research question (i), the structural (social integration, contact frequency) and functional (number of emotionally close contacts) dimensions of social relationships under investigation are not statistically significantly associated with GP use frequency. On the one hand, our results are in line with a number of studies on structural and functional aspects of social ties [5, 24, 25, 51-53]. On the other hand, and with regard to structural measures of social relationships, empirical results are inconsistent until now. Various studies on outpatient care use showed that older people living alone are more likely to consult a physician [23, 54, 55]. One study showed that married older people have a lower probability of using GP services [24]. Others demonstrated that older people living in a marriage or with their kids present a higher frequency of physician consultations [25, 26]. With regard to the size of the social network, studies found negative associations [19, 20], and others ambiguous [21] or positive associations [22]. Moreover, Kim & Konrath [56] did not find a statistically significant association between volunteering and the frequency of doctor visits. A possible explanation for these inconsistent empirical patterns can be seen in the quality dimension of social relationships to partners, family and social network members. For instance, Foreman et al. [26] found a negative association between harmonious family relationships and the number

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2
3 of physician visits. International studies on functional dimensions of social ties demonstrated
4 that different aspects of received social support (e.g., material, instrumental and informational
5 support) are positively linked with GP use [3, 32, 57]. Though, frequent and close social
6 contacts are not only a potential source of social support, but also for psychological distress
7 and physical discomfort, conceivably leading to higher GP use rates [58, 59].
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14 Regarding research question (ii), the analyses show hardly any substantial and statistically
15 significant moderating effects of different aspects of social relations on the link between
16 health needs and frequency of GP visits. Only for older adults with poor self-rated health, an
17 increase of the number of emotionally close members in the social network is associated with
18 a growing rate of GP visits (Figure 5). Consequently, emotional closeness within social
19 networks enables the utilization of GP services, especially for those individuals that report
20 high levels of health needs. Furthermore, older adults with very good or excellent health show
21 a higher rate of GP visits with an increase of their contact frequency in the social network
22 (Figure 4), while contact frequency seems to play a less important role for people with poorer
23 health. Potentially, a higher density of social networks fosters the GP use by providing
24 support and resources, but only for people with better health. The differences are statistically
25 significant, but they have a lower magnitude.
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41 Three way interaction analyses regarding research question (iii) indicate employment status-
42 specific behavioral patterns with regard to social relationships and GP use, but coefficients
43 were mostly not significant. Analyses focusing on older people who are retired, unemployed,
44 permanently sick or disabled or homemakers, show various results. All in all, the groups of
45 retired, unemployed, permanently sick/disabled and homemaking people show a higher
46 predicted number of GP visits, especially, if they are unemployed, permanently sick/disabled
47 or homemakers. Comparing those groups with each other also presents diverging patterns of
48 associations. A higher level of social integration was associated with lower rates of GP use for
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3 retirees, but was associated with a higher frequency of visits for unemployed older adults,
4 especially for unemployed older people with a poor self-rated health (Figure 6). “Having a
5 partner”, which is included in the social integration index, contributed the most to this
6 association. Atkinson et al. [18] showed that unemployment has a negative effect on marital
7 and family support and a positive effect on the utilization of external help including emotional
8 support, information or advice and concrete assistance. Potentially, unemployed people
9 struggle not only with their psychological well-being but also with their social relationships.
10 Consequently, they use more external help including the consultation of GPs. Homemakers
11 use more GP visits, if their social contact frequency is higher, especially, if their health status
12 is rated as intermediate. This holds also true for retirees with a higher self-rated health status
13 (Figure 7). The more emotionally close contacts are present, the higher is the use for GP
14 services by retired and permanently sick or disabled people with lower health status (Figure
15 8).

31 **Limitations**

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34 When interpreting the results, some methodological limitations need to be taken into account.
35 Firstly, our analyses were based on cross-sectional data, forbidding statements on causal
36 directions and changes over time. The cross-sectional design was chosen due to the inclusion
37 of social relationship variables from SHARE’s “social networks” module which was applied
38 only in wave four [34, 35, 60]. Therefore, the postulated buffer function of social integration
39 (of retirees and homemakers) on GP visits, for instance, is only one possible explanation.
40 Another scenario may be the healthy user effect due to volunteering activities which are
41 included in the social integration index. Healthier people with less GP visits have more
42 resources to invest into their social integration.
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54 Although, SHARE is an international survey aiming for high methodological standards by
55 using ex-ante harmonization to minimize “artifacts in cross-national comparisons that are
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3 created by country-specific survey design” [38], the schedule for data collection in wave 4
4 was only partly synchronized and household response rates vary between countries (39% to
5 63 %). Due to unit non-response and panel attrition, sample selection bias is a potential
6
7 problem limiting the representativeness of the data and the generalizability of results [35].
8
9 However, non-response analyses taking various variables into account (gender, age, health,
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11 employment, number of children, and income) showed only little evidence for non-response
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13 bias (e.g., a slightly larger number of males among respondents than non-respondents) [37].
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18 The question used in SHARE to cover the use of GP services across 12 months is established
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20 in health services research [4, 20, 21, 61], but has some methodological drawbacks. The
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22 question is narrowed to contacting a GP or doctor in a health care center. Contacts with nurses
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24 at GP practices are not taken into account. Potentially, the level of using primary care is
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26 underestimated. The time span covering the GP contacts is quite long, and considering the
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28 older age of the interviewed individuals, risk of memory bias is existent with regard to self-
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30 reported utilization data [62]. Bhandari and Wagner found in their systematic review on self-
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32 reported utilization of health care services that “[...] age was the most consistent demographic
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34 factor associated with self-report inaccuracy [...]” by older adults underreporting their use
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36 [62]. Consequently, intercepts and age coefficients in our models could be potentially
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38 underestimated.
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43 The limited level of information of self-reported data holds also true for all other variables in
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45 our analyses, especially for the variable “self-rated health” which is culturally sensitive [63].
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47 Although, self-rated health status is based on a single item, it is a suitable summary of health
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49 [64]. Studies on several representative samples showed that health ratings can be used as valid
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51 measures of health regardless of different cultures and social conditions [65-67]. Furthermore,
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53 self-rated health is used as a substitute for health needs in this study. To predict need for and
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55 use of health care services, perceived health status corresponds well to the objective health
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3 status [68, 69]. Consequently, using self-perceived health only represents an approximation of
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5 health needs, since SHARE did not include items on (perceived) health needs. Ultimately,
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7 caution is needed drawing conclusions from analyses using self-rated health. The same holds
8
9 true for the variable of self-perceived economic status, even though the assessment of the ease
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11 with which households can “make ends meet” compared to income represents an adequate
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13 and direct measure of the economic situation of individuals, especially among older
14
15 individuals [70].
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18 Furthermore, SHARE data did not provide information on the reasons for using health
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20 services or the quality and adequacy of health care services. Consequently, the rate of visiting
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22 a GP represents a proxy for “realized access” [1] only.
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26 Finally, and though SHARE strived to combine the indirect and direct approach of social
27
28 network analysis [60], it does not offer sufficient and longitudinal data on functional and
29
30 quality aspects of social relationships [71]. The synthesis of the indirect approach (referring
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32 on socio-demographic proxies) and the direct approach (linking meaningfulness and
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34 importance to social relations) still lacks valuable information about the quality of social
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36 relationships and perceived support.
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43 **CONCLUSIONS**

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46 Our results demonstrate that different indicators of social relationships are not associated with
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48 higher or lower frequency of GP visits. The magnitude of the associations is relatively low
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50 and the minority of the investigated associations is statistically significant. Nevertheless, the
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52 investigation of the two- and three-way interactions showed a complex, but interesting
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54 picture. This study indicates potential inequalities in GP use due to different dimensions and
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3 characteristics of social relationships, especially considering health needs and employment
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5 status of older adults.
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8 Since, social ties influence patient's motives for visits and the patient's compliance with
9
10 regard to future visits for treatment, prevention and rehabilitation [72, 73], it may be helpful
11
12 for health care providers to assess information on the patient's "social background". A patient,
13
14 for instance, characterized by poor health and no emotionally close ties, visits a GP less
15
16 frequently than his/her counterpart with poor health and closely connected within a social
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18 network. Potentially, these differences may produce inequalities in medical care and
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20 treatments. In health care, it is obligatory, e.g. for treatment planning, to decide in line with
21
22 the patient on the adequacy of treatment and to incorporate the patient's needs and resources
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24 to reach that goal. Therefore, the GP may want to know if a patient is socially integrated or
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26 isolated, and may want to evaluate if a patient needs or wants more or less social support. It is
27
28 important to emphasize that the observed behavioral differences of GP use, within the limits
29
30 of the SHARE dataset, do not implicate inadequacies in GP services, such as over- or
31
32 underuse.
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36 Future surveys should aim at assessing functional and quality dimensions of social
37
38 relationships linked to health services use to shed more light on the underlying mechanisms.
39
40 Finally, to define potential improvements in health systems and to inform health policy
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42 makers and health practitioners adequately, health services research needs to integrate
43
44 information on the patient's motives for visits and on the levels, quality and outcomes of the
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46 treatments.
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55 10.6103/SHARE.w4.500), see Börsch-Supan et al. (2013) for methodological details. The
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46 **List of figures**

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11 **Supplement**

12 Supplement Table 1 Pairwise correlations

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14 Supplement Table 2 Models 1-3

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16 Supplement Table 3 Models 4-6

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18 Supplement Table 4 Models 7-9

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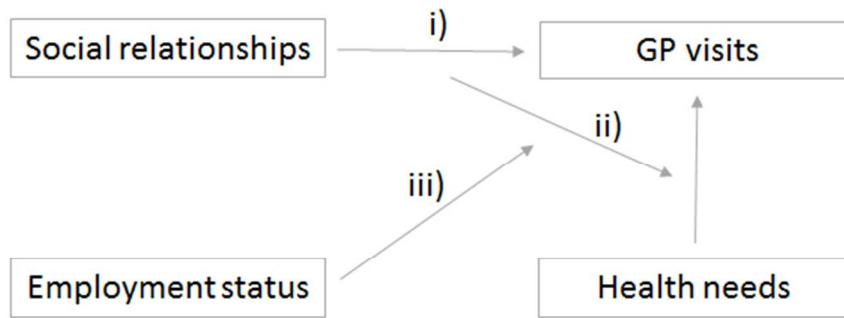


Figure 1: Conceptual model of research questions (i), (ii) and (iii)

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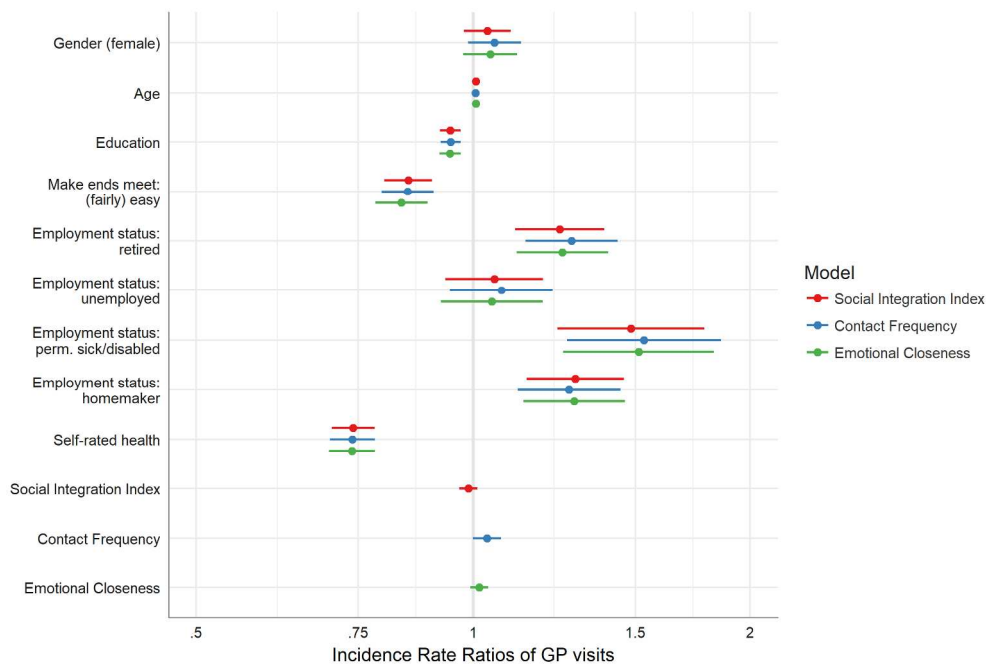


Figure 2 Forest plots of incidence rate ratios for GP use

228x152mm (300 x 300 DPI)

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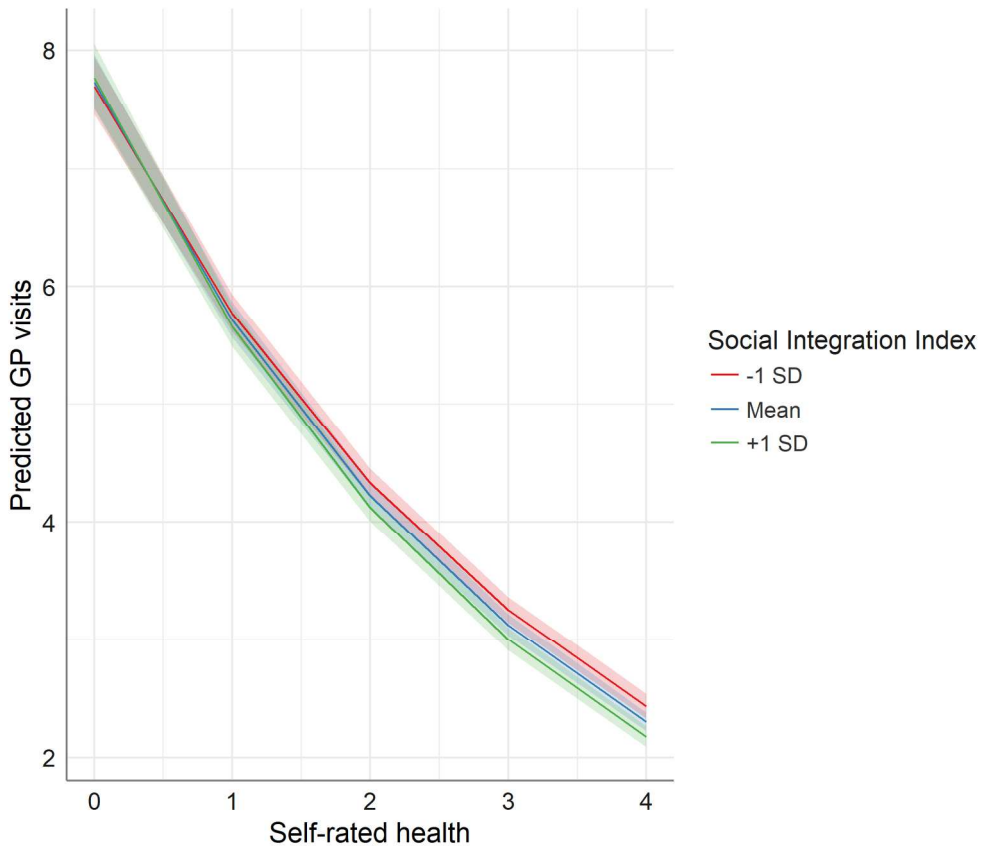


Figure 3 Predicted number of GP visits on health & social integration

177x152mm (300 x 300 DPI)

Only

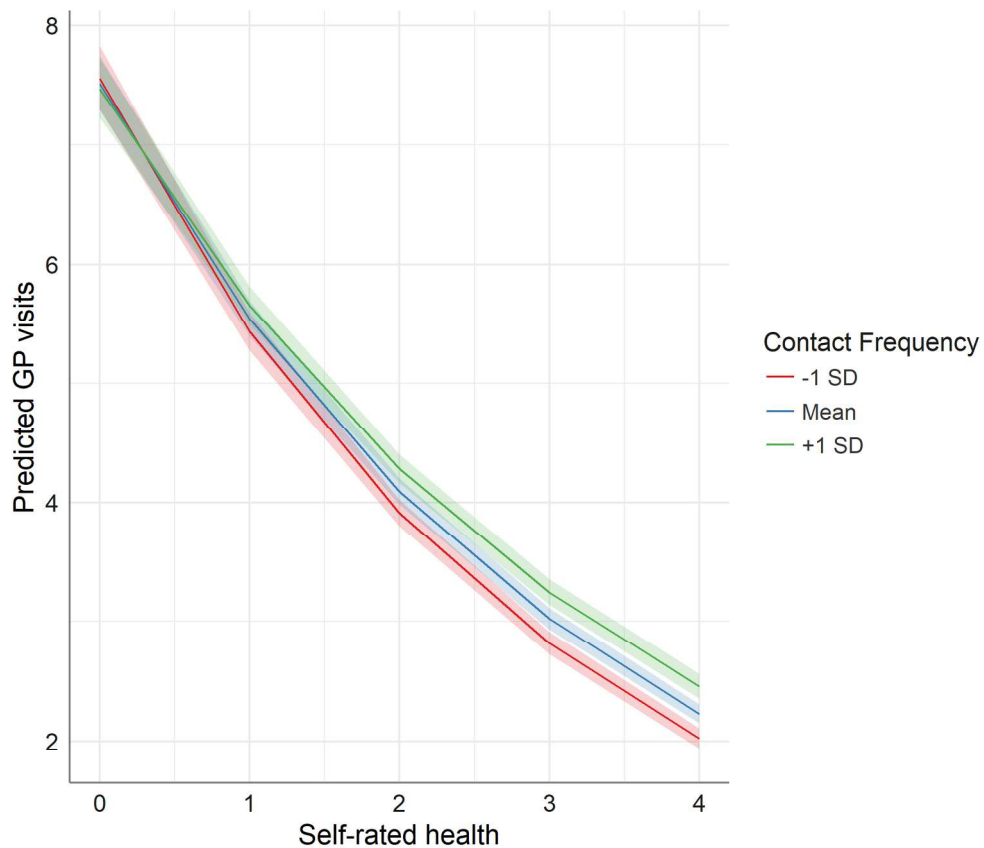


Figure 4 Predicted number of GP visits on health & contact frequency

177x152mm (300 x 300 DPI)

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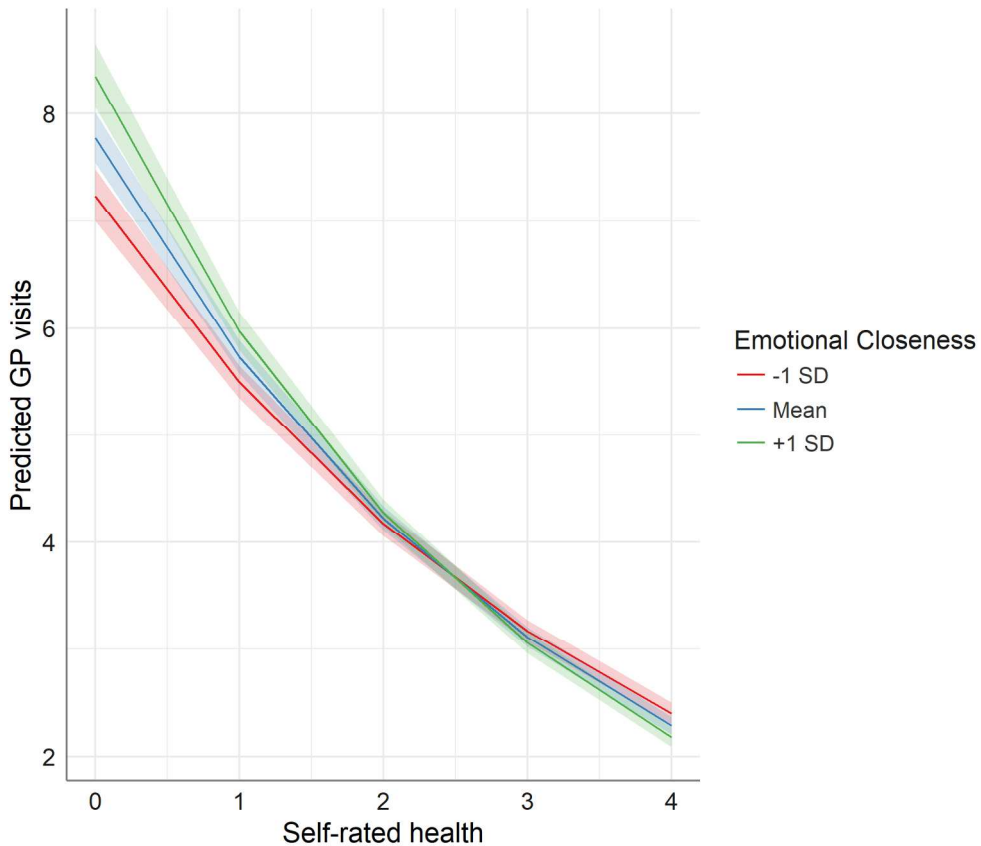


Figure 5 Predicted number of GP visits on health & emotional closeness

177x152mm (300 x 300 DPI)

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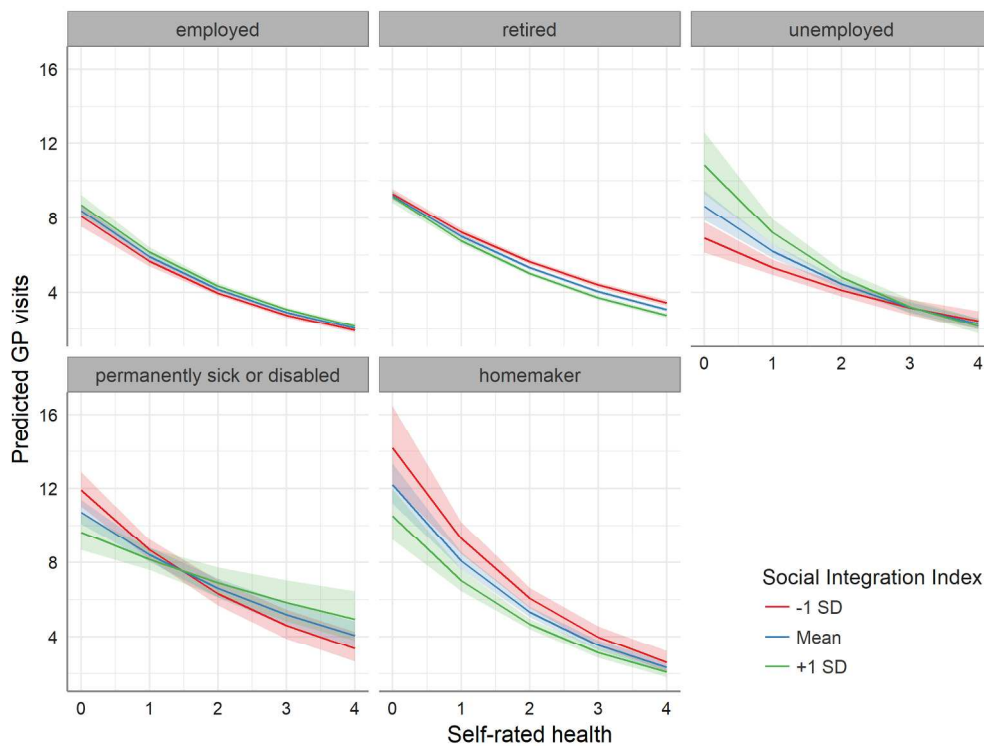


Figure 6 Predicted number of GP visits on health, social integration & employment status

203x152mm (300 x 300 DPI)

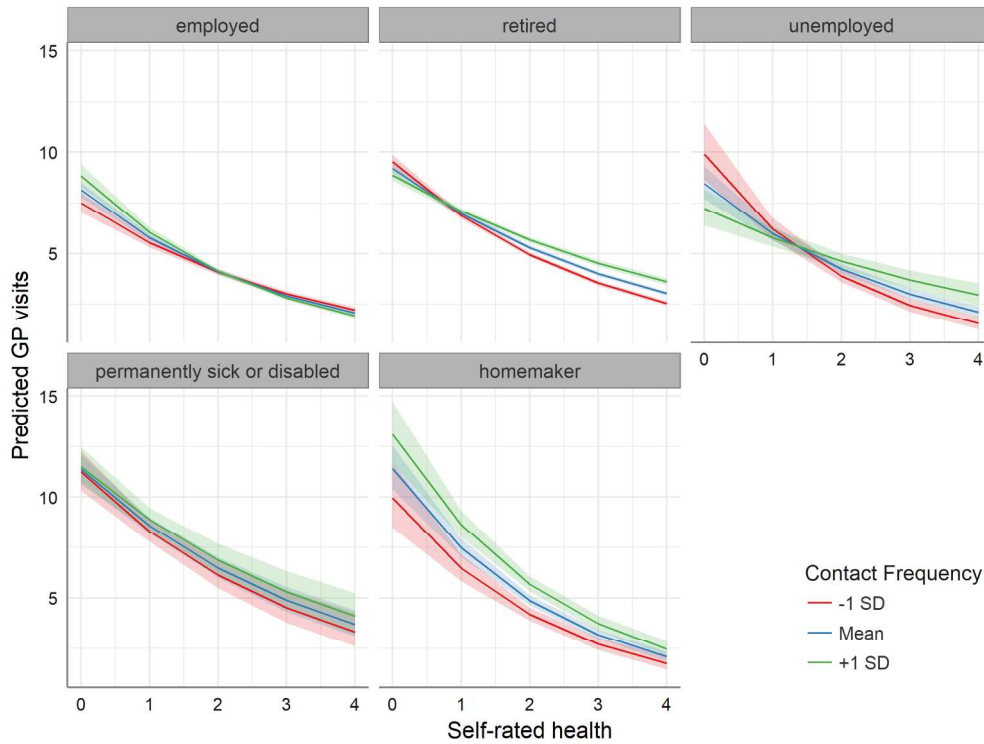


Figure 7 Predicted number of GP visits on health, contact frequency & employment status

203x152mm (300 x 300 DPI)

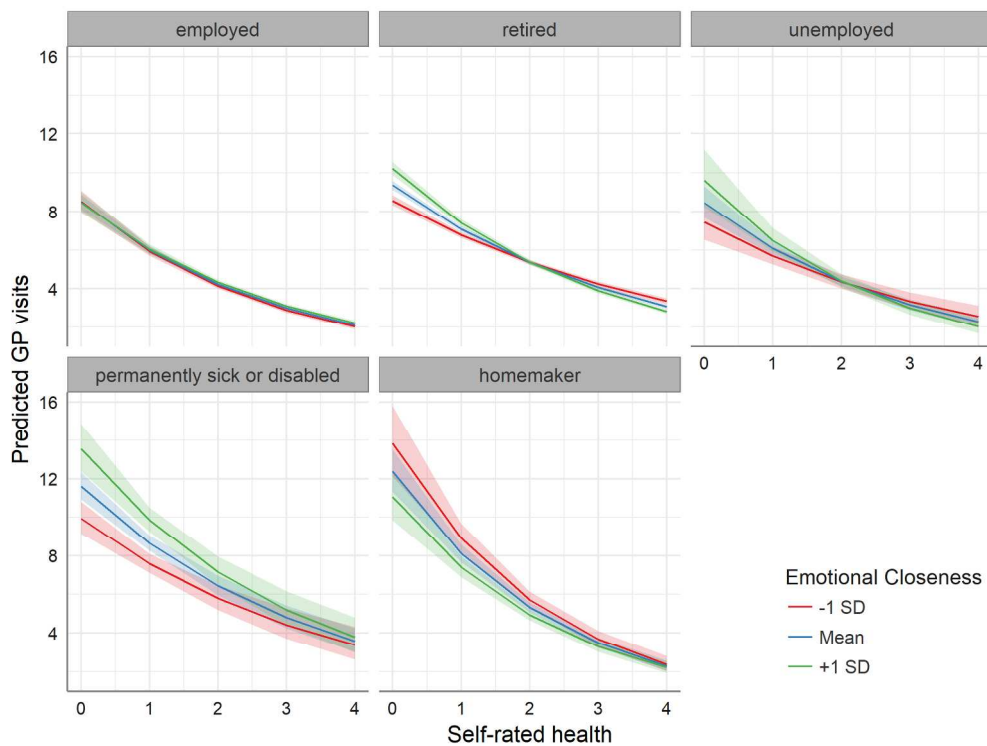


Figure 8 Predicted number of GP visits on health, closeness & employment status

203x152mm (300 x 300 DPI)

Supplement Table 1 pairwise correlations

	GP visits	gender	age	education	make ends meet	employment status	health	social integration	contact frequency
gender	0.0200								
age	0.1192	0.0089							
education	-0.1297	-0.0809	-0.2345						
make ends meet	-0.1231	-0.0414	0.0339	0.2156					
employment status	0.1044	0.1287	0.0709	-0.1895	-0.1304				
health	-0.2585	-0.0460	-0.2478	0.2496	0.2650	-0.1756			
social integration	-0.0984	-0.0917	-0.2636	0.2637	0.2119	-0.0692	0.2574		
contact frequency	0.0446	-0.0650	-0.0522	-0.1362	-0.1141	0.0216	-0.0594	-0.0631	
emotional closeness	-0.0098	0.1232	-0.0793	0.0962	0.0755	0.0008	0.1032	0.3924	-0.1698

SUPPLEMENT Table 2

Model 1 - Negative binomial regression models based on full sample (social integration index)

<i>Variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0362	0.0298	0.9773	1.0986	0.2338
Age	1.0064	0.0028	1.001	1.0119	0.0205
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9439	0.0132	0.9197	0.9687	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8499	0.0305	0.8006	0.9024	0.000
Employment status: retired (employed = Ref.)	1.2417	0.0567	1.111	1.3877	1e-04
Employment status: unemployed (employed = Ref.)	1.054	0.0622	0.933	1.1907	0.3982
Employment status: permanently sick or disabled (employed = Ref.)	1.4841	0.0938	1.2349	1.7836	0.000
Employment status: homemaker (employed = Ref.)	1.291	0.0623	1.1427	1.4586	0.000
Self-perceived health (0=poor – 4=excellent)	0.7405	0.0272	0.7021	0.781	0.000
Social integration index (0=low – 6=high)	0.9876	0.0118	0.965	1.0106	0.288
Intercept	8.9883	0.0626	7.9503	10.1618	0.000
Alpha	0.6091	0.0251	0.5618	0.6604	
n – unweighted			47,066		
N – weighted			119,390,189		
Number of strata (countries)			16		
Number of primary sampling units (households)			34,623		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

Model 2 - Negative binomial regression models based on full sample (contact frequency)

<i>variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0548	0.0341	0.9867	1.1276	0.1174
Age	1.0059	0.0029	1.0002	1.0116	0.041
Education (ISCED-1997 Coding: 0=low – 6=high)	0.945	0.013	0.9212	0.9694	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8487	0.0333	0.7951	0.9058	0.000
Employment status: retired (employed = Ref.)	1.2792	0.0588	1.1401	1.4353	0.000
Employment status: unemployed (employed = Ref.)	1.0731	0.0656	0.9436	1.2204	0.2821
Employment status: permanently sick or disabled (employed = Ref.)	1.5336	0.0984	1.2646	1.8599	0.000
Employment status: homemaker (employed = Ref.)	1.271	0.0657	1.1174	1.4457	3e-04
Self-perceived health (0=poor – 4=excellent)	0.7391	0.0286	0.6989	0.7817	0.000
Average of contact frequency in social network (0=less than once per month or never – 5=daily)	1.0351	0.0182	0.9988	1.0726	0.058
Intercept	8.7504	0.0655	7.696	9.9492	0.000
alpha	0.6055	0.0266	0.5556	0.6600	
n – unweighted			43,962		
N – weighted			110,219,002		
Number of strata (countries)			16		
Number of primary sampling units (households)			32,616		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

Model 3 - Negative binomial regression models based on full sample

(emotional closeness)

<i>variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0432	0.0344	0.9752	1.1158	0.219
Age	1.0064	0.0028	1.0009	1.012	0.0228
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9434	0.0136	0.9187	0.9689	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8354	0.0335	0.7823	0.8921	0.000
Employment status: retired (employed = Ref.)	1.2502	0.0587	1.1143	1.4028	1e-04
Employment status: unemployed (employed = Ref.)	1.0476	0.0648	0.9226	1.1896	0.4729
Employment status: permanently sick or disabled (employed = Ref.)	1.5124	0.0962	1.2524	1.8262	0.000
Employment status: homemaker (employed = Ref.)	1.2873	0.0649	1.1334	1.462	1e-04
Self-perceived health (0=poor – 4=excellent)	0.7381	0.0292	0.697	0.7817	0.000
Number of very to extremely close people in social network (0-7)	1.0151	0.0115	0.9925	1.0381	0.193
Intercept	9.0879	0.0635	8.0245	10.2921	0.000
alpha	0.6112	0.0270	0.5605	0.6666	
n – unweighted			44,840		
N – weighted			112,626,161		
Number of strata (countries)			16		
Number of primary sampling units (households)			33,160		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

SUPPLEMENT Table 3

Model 4 - Negative binomial regression models based on full sample – 2-way interaction

(social integration index)

<i>Variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0378	0.0301	0.9784	1.1008	0.2175
Age	1.0065	0.0028	1.001	1.0121	0.0208
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9441	0.0132	0.92	0.9688	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8492	0.0303	0.8002	0.9012	0.000
Employment status: retired (employed = Ref.)	1.2398	0.0572	1.1082	1.3869	2e-04
Employment status: unemployed (employed = Ref.)	1.0508	0.0616	0.9312	1.1856	0.4216
Employment status: permanently sick or disabled (employed = Ref.)	1.4829	0.094	1.2332	1.783	0.000
Employment status: homemaker (employed = Ref.)	1.2876	0.0626	1.139	1.4556	1e-04
Self-perceived health (0=poor – 4=excellent)	0.7391	0.0262	0.7022	0.778	0.000
Social integration index (0=low – 6=high)	1.0032	0.0215	0.9617	1.0464	0.8831
Self-perceived health * Social integration index	0.9902	0.0096	0.9716	1.0091	0.3059
Intercept	9.0466	0.0621	8.0092	10.2184	0.000
Alpha	0.6090	0.0250	0.5618	0.6601	
n – unweighted			47,066		
N – weighted			119,390,189		
Number of strata (countries)			16		
Number of primary sampling units (households)			34,623		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

Model 5 - Negative binomial regression models based on full sample 2-way interaction
(contact frequency)

<i>variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0568	0.0336	0.9895	1.1287	0.0997
Age	1.0062	0.0028	1.0007	1.0117	0.0268
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9458	0.0124	0.9231	0.969	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8498	0.0331	0.7965	0.9068	0.000
Employment status: retired (employed = Ref.)	1.2739	0.056	1.1416	1.4216	0.000
Employment status: unemployed (employed = Ref.)	1.068	0.0645	0.9411	1.2119	0.3082
Employment status: permanently sick or disabled (employed = Ref.)	1.5354	0.0977	1.2678	1.8596	0.000
Employment status: homemaker (employed = Ref.)	1.2687	0.0657	1.1154	1.4431	3e-04
Self-perceived health (0=poor – 4=excellent)	0.738	0.027	0.6999	0.7781	0.000
Average of contact frequency in social network (0=less than once per month or never – 5=daily)	0.9941	0.0441	0.9118	1.0839	0.8938
Self-perceived health * contact frequency	1.026	0.0248	0.9773	1.0771	0.3007
Intercept	8.7676	0.0642	7.7315	9.9425	0.000
alpha	0.6049	0.0259	0.5562	0.6579	
n – unweighted			43,962		
N – weighted			110,219,002		
Number of strata (countries)			16		
Number of primary sampling units (households)			32,616		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

Model 6 - Negative binomial regression models based on full sample 2-way interaction

<i>variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0444	0.0346	0.9761	1.1176	0.2083
Age	1.0063	0.0028	1.0008	1.0119	0.0253
Education (ISCED-1997 Coding: 0=low – 6=high)	0.944	0.0133	0.9198	0.9688	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8345	0.0332	0.782	0.8906	0.000
Employment status: retired (employed = Ref.)	1.2499	0.0595	1.1123	1.4045	2e-04
Employment status: unemployed (employed = Ref.)	1.0445	0.0642	0.9209	1.1847	0.4979
Employment status: permanently sick or disabled (employed = Ref.)	1.5056	0.0938	1.2528	1.8094	0.000
Employment status: homemaker (employed = Ref.)	1.2846	0.0658	1.1291	1.4615	1e-04
Self-perceived health (0=poor – 4=excellent)	0.7371	0.0279	0.6979	0.7785	0.000
Number of very to extremely close people in social network (0-7)	1.0486	0.0233	1.0017	1.0977	0.042
Self-perceived health * emotional closeness	0.9804	0.0137	0.9544	1.0072	0.1506
Intercept	9.118	0.0624	8.0685	10.3041	0.000
alpha	0.6105	0.0265	0.5607	0.6648	
n – unweighted			44,840		
N – weighted			112,626,161		
Number of strata (countries)			16		
Number of primary sampling units (households)			33,160		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

SUPPLEMENT Table 4

Model 7 - Negative binomial regression models based on full sample – 3-way interaction
(social integration index)

<i>Variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.033	0.029	0.9759	1.0935	0.263
Age	1.0061	0.0029	1.0003	1.0119	0.0377
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9441	0.0127	0.9209	0.9678	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.851	0.0293	0.8035	0.9014	0.000
Employment status: retired (employed = Ref.)	0.7027	0.0285	0.6645	0.7432	0.000
Employment status: unemployed (employed = Ref.)	1.0258	0.0564	0.9185	1.1456	0.6519
Employment status: permanently sick or disabled (employed = Ref.)	1.0986	0.1099	0.8857	1.3625	0.3923
Employment status: homemaker (employed = Ref.)	1.0305	0.1441	0.7769	1.3668	0.8349
Self-perceived health (0=poor – 4=excellent)	1.2763	0.1287	0.9917	1.6426	0.058
Social integration index (0=low – 6=high)	1.4546	0.1577	1.068	1.9813	0.0175
Self-perceived health * Social integration index	1.0028	0.0229	0.9587	1.0489	0.9033
Self-perceived health * retired	1.0807	0.0447	0.9901	1.1797	0.0823
Self-perceived health * unemployed	1.0201	0.0683	0.8922	1.1663	0.7708
Self-perceived health * permanently sick or disabled	1.1167	0.0874	0.9408	1.3254	0.207
Self-perceived health * homemaker	0.9394	0.0692	0.8202	1.0758	0.366
Social integration index * retired	0.9694	0.061	0.8602	1.0925	0.6107
Social integration index * unemployed	1.1323	0.0829	0.9626	1.3321	0.1337
Social integration index * permanently sick or disabled	0.908	0.1141	0.7261	1.1355	0.3977
Social integration index * homemaker	0.8828	0.1035	0.7206	1.0814	0.2284
Self-perceived health * social integration index * retired	0.9805	0.0251	0.9334	1.0299	0.4327
Self-perceived health * social integration index	0.9504	0.041	0.877	1.0299	0.2147

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4 * unemployed

5 Self-perceived health * social integration index 1.0483 0.0796 0.8969 1.2253 0.5532
6 * permanently sick or disabled

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9 Self-perceived health * social integration index 1.0033 0.0466 0.9157 1.0993 0.9438
10 * homemaker

11 Intercept 9.8174 0.0854 8.3046 11.6058 0.000

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14 alpha 0.6045 0.0240 0.5596 0.6539

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16 n – unweighted 47,066

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18 N – weighted 119,390,189

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20 Number of strata (countries) 16

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22 Number of primary sampling units (households) 34,623

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24 IRR = incidence rate ratio

25 95%-confidence interval

26 alpha = estimate of dispersion parameters

27 Age, social integration, contact frequency and closeness are centered at the mean

28 n = number of observations; N = population size based on survey design

29 Observations with missing values were dropped (listwise deletion).
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Model 8 - Negative binomial regression models based on full sample – 3-way interaction
(contact frequency)

<i>Variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0574	0.0326	0.992	1.1271	0.0867
Age	1.0066	0.0028	1.0011	1.0121	0.018
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9464	0.0117	0.9249	0.9684	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8477	0.0317	0.7966	0.9021	0.000
Employment status: retired (employed = Ref.)	0.7102	0.0284	0.6718	0.7509	0.000
Employment status: unemployed (employed = Ref.)	1.0848	0.0757	0.9352	1.2584	0.2823
Employment status: permanently sick or disabled (employed = Ref.)	1.1295	0.1135	0.9042	1.4108	0.2834
Employment status: homemaker (employed = Ref.)	1.0391	0.1435	0.7845	1.3765	0.7889
Self-perceived health (0=poor – 4=excellent)	1.3951	0.1594	1.0207	1.9067	0.0367
Average of contact frequency in social network (0=less than once per month or never – 5=daily)	1.4007	0.191	0.9633	2.0367	0.0777
Self-perceived health * Contact frequency	0.9626	0.0284	0.9104	1.0177	0.1796
Self-perceived health * retired	1.0681	0.0455	0.977	1.1676	0.1475
Self-perceived health * unemployed	0.9969	0.0685	0.8716	1.1402	0.9635
Self-perceived health * permanently sick or disabled	1.0637	0.1135	0.8516	1.3287	0.586
Self-perceived health * homemaker	0.9208	0.0822	0.7838	1.0817	0.3153
Contact frequency * retired	0.8891	0.0948	0.7384	1.0706	0.2149
Contact frequency * unemployed	0.7879	0.1516	0.5853	1.0605	0.1158
Contact frequency * permanently sick or disabled	0.9316	0.1271	0.7262	1.1952	0.5774
Contact frequency * homemaker	1.0568	0.1504	0.787	1.419	0.7134
Self-perceived health * Contact frequency * retired	1.0949	0.0464	0.9998	1.1992	0.0506
Self-perceived health * Contact frequency *	1.1731	0.0742	1.0144	1.3567	0.0314

unemployed

Self-perceived health * Contact frequency *
permanently sick or disabled 1.0632 0.0622 0.9412 1.2011 0.3242

Self-perceived health * Contact frequency *
homemaker 1.0475 0.0663 0.9199 1.1928 0.4838

Intercept 9.4885 0.0848 8.0361 11.2034 0.000

Alpha 0.6009 0.0245 0.5547 0.6509

n – unweighted 43,962

N – weighted 110,219,002

Number of strata (countries) 16

Number of primary sampling units (households) 32,616

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

Model 9 - Negative binomial regression models based on full sample – 3-way interaction
(emotional closeness)

<i>Variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0428	0.0338	0.9759	1.1143	0.2152
Age	1.0066	0.0029	1.0008	1.0124	0.0258
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9437	0.0126	0.9206	0.9673	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.834	0.032	0.7833	0.888	0.000
Employment status: retired (employed = Ref.)	0.7057	0.0287	0.6671	0.7465	0.000
Employment status: unemployed (employed = Ref.)	0.997	0.0447	0.9133	1.0884	0.9462
Employment status: permanently sick or disabled (employed = Ref.)	1.1027	0.1153	0.8797	1.3823	0.3964
Employment status: homemaker (employed = Ref.)	0.9959	0.1493	0.7433	1.3345	0.9781
Self-perceived health (0=poor – 4=excellent)	1.3689	0.1537	1.0128	1.8503	0.0411
Number of very to extremely close people in social network (0-7)	1.4595	0.1588	1.0691	1.9926	0.0173
Self-perceived health * Contact frequency	1.0089	0.016	0.9778	1.041	0.5778
Self-perceived health * retired	1.0726	0.0458	0.9804	1.1734	0.1264
Self-perceived health * unemployed	1.0202	0.0701	0.8891	1.1705	0.7758
Self-perceived health * permanently sick or disabled	1.0548	0.1132	0.845	1.3167	0.6374
Self-perceived health * homemaker	0.9282	0.0666	0.8145	1.0576	0.2632
Emotional closeness * retired	1.0632	0.0543	0.9558	1.1827	0.2594
Emotional closeness * unemployed	1.0921	0.1072	0.8851	1.3476	0.4111
Emotional closeness * permanently sick or disabled	1.1124	0.1122	0.8927	1.3861	0.3427
Emotional closeness * homemaker	0.931	0.0929	0.776	1.1168	0.4412
Self-perceived health * Emotional closeness * retired	0.963	0.0261	0.9151	1.0135	0.1483
Self-perceived health * Emotional closeness *	0.9513	0.05	0.8625	1.0493	0.3181

unemployed

Self-perceived health * Emotional closeness *
permanently sick or disabled 0.9751 0.0761 0.84 1.1318 0.7401

Self-perceived health * Emotional closeness *
homemaker 1.0038 0.0401 0.9279 1.086 0.9247

Intercept 9.9586 0.0854 8.4236 11.7733 0.000

alpha 0.6074 0.0255 0.5594 0.6595

n – unweighted 44,840

N – weighted 112,626,161

Number of strata (countries) 16

Number of primary sampling units (households) 33,160

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6-7, 9-10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-9
Bias	9	Describe any efforts to address potential sources of bias	6-7, 9-10
Study size	10	Explain how the study size was arrived at	6-7, 9-10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-9, 10-11, Table 1, Supplement Table 2-4
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9-10
		(b) Describe any methods used to examine subgroups and interactions	9-10
		(c) Explain how missing data were addressed	7, 9-10, Supplement Table 2-4
		(d) If applicable, describe analytical methods taking account of sampling strategy	9-10

		(e) Describe any sensitivity analyses	Supplement Table 1; Appendix 1
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-7, 10-11, Table 1
		(b) Give reasons for non-participation at each stage	6, 10-11, Table 1
		(c) Consider use of a flow diagram	Table 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-11, Table 1
		(b) Indicate number of participants with missing data for each variable of interest	10-11, Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	10-11, Table 1
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Figures 1-8, Supplement Tables 2-4
		(b) Report category boundaries when continuous variables were categorized	10-11, Table 1
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Appendix 1-3
Discussion			
Key results	18	Summarise key results with reference to study objectives	15-17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18-20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	20-21
Generalisability	21	Discuss the generalisability (external validity) of the study results	21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Social relationships and GP use of middle-aged and older adults in Europe: a moderator analysis

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45
46 *This paper uses data from SHARE Wave 4 (DOIs: 10.6103/SHARE.w4.500), see Börsch-*
47 *Supan et al. (2013) for methodological details.*

48
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57
58
59

Abstract

Objectives: This paper investigates (i) how social relationships (SR) relate to the frequency of general practitioners (GP) visits among middle-aged and older adults in Europe, (ii) if SR moderate the association between self-rated health and GP visits, and (iii) how the associations vary regarding employment status.

Methods: Data stem from the SHARE-project (wave 4, 56,989 respondents, 50 years or older). GP-use was assessed by frequency of contacts with GPs in the last 12 months. Predictors were self-rated health and structural (social integration index (SII), social contact frequency) and functional (emotional closeness) aspects of SR. Regressions were used to measure the associations between GP-use and those predictors. Sociodemographic and socioeconomic factors were used as covariates. Additional models were computed with interactions.

Results: Analyses did not reveal significant associations of functional and structural aspects of SR with frequency of GP visits (SII: IRR=0.99, 95%CI 0.97-1.01, social contact frequency: IRR=1.04, 95%CI 1.00-1.07, emotional closeness: IRR=1.02, 95%CI 1.00-1.04). Moderator analyses showed that “high social contact frequency people” with better health had statistically significant more GP visits than “low social contact frequency people” with better health. Furthermore, people with poor health and an emotionally close network showed a significantly higher number of GP visits compared to people with same health, but less close networks. Three way interaction analyses indicated employment status-specific behavioral patterns with regard to SR and GP-use, but coefficients were mostly not significant. All in all, the not-employed groups showed a higher number of GP visits.

Conclusions: Different indicators of SR showed statistically insignificantly associations with GP visits. Consequently, the relevance of SR may be rated rather low in quantitative terms for

1
2
3 investigating GP-use behavior of middle-aged and older adults in Europe. Nevertheless,
4
5 investigating the two- and three-way interactions indicated potential inequalities in GP-use
6
7 due to different characteristics of SR accounting for health and employment status.
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12

13 **Keywords:** middle-aged and older adults; social relationships; self-rated health; health
14
15 services use; general practitioners; employment status
16
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20

21 **Strengths and limitations of this study**

22
23

- 24 • This is one of the first studies to systematically analyze the associations between self-
25 rated health, SR, employment status and frequency of GP use of middle-aged and
26 older adults in Europe.
27
28
- 29 • Applying a survey design to account for the stratification in the sample allows drawing
30 conclusions about non-institutionalized adults aged 50 years or older in 16 European
31 countries.
32
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- 34 • In contrast to other studies, social relationships were assessed multi-dimensionally
35 focusing on both, structural and functional aspects.
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- 38 • The cross-sectional design of the study does not allow drawing conclusions about
39 causalities.
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INTRODUCTION

According to the “Behavioral Model of Health Services Use” by Andersen, utilization of health services is influenced by a variety of predisposing, enabling and need characteristics [1]. Existing literature has highlighted that health status, defined as a “need factor”, is the most powerful predictor of health services use in older age [2-6]. Furthermore, adults within their fifties or older show more chronic illnesses and increased rates of health care use compared with younger cohorts [7]. Consequently, health care systems are challenged by increasing health needs and rising demands for health services in ageing societies [8]. In particular, the sector of primary health care is affected by these developments, since general practitioners (GPs) are the first contact to health care acting as gatekeepers and navigators.

Within Andersen’s model, social relationships are defined as “enabling resources” for health and the use of health services [1]. International studies suggest substantial impact of social relationships on morbidity and mortality [9-12]. Moreover, research indicates the significance of social relationships by enhancing patient care, improving compliance with medical schemes, and fostering shorter hospital stays [13-15]. Social relationships can be divided into structural and functional elements [9]. Structural aspects of social relationships, e.g., the degree of social network integration, are assessed by quantitative measures (e.g. living arrangements, social network size, and frequency of social participation). Received and perceived social support is defined as a functional element, and includes aspects of financial, instrumental, informational or emotional support. Both aspects of social relationships can be subject to change due to life events across the life span, especially in older age [16], as they are affected and modified by events, such as widowhood, unemployment or retirement [16-18].

1
2
3 Up to now, studies on older adults' GP use have shown an ambiguous role of social
4 relationships [19-22]. In most cases, regression models were applied to show that various
5 aspects of social relationships are associated with the frequency of health services
6 consultations within a certain time span [23-26]. Andersen's model suggests a variety of
7 interactions between predisposing, enabling and need factors on health services use, but only
8 a few studies adopted analyses to capture potential moderating or mediating action [27-33].
9
10 As mentioned before, health status is strongly associated with the frequency of using health
11 services, on the one hand. On the other hand, social relationships are closely linked to health
12 [10, 12, 34]. Consequently, social relationships might influence the scope of action, such as
13 using GP services, depending on varying self-rated health status. Do social relationships have
14 an impact on the strong link between self-rated health and health services use? And, if
15 applicable, does that implicate anything for public health policy and health care providers? So
16 far, the association between social relationships, self-rated health and GP visits among
17 middle-aged and older adults is poorly understood.

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34 Focusing on adults 50 years or older, this paper investigates (i) how social relationships relate
35 to the frequency of GP visits and (ii) if social relationships moderate the association between
36 self-rated health and GP visits. Since, social relationships are subject to change due to age-
37 related life events, such as retirement, unemployment and permanent disability, this study
38 additionally analyzes (iii) how the associations vary through subgroups of different
39 employment status. Hence, this study may contribute to a better understanding of the
40 behavioral patterns of using GP services within the middle-aged and older¹ European
41 population.

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57 ¹ For the sake of readability, we refer to "middle-aged and older adults" or "adults 50 years or older" when we
58 write about "older adults" in this paper.

DATA AND METHODS

Data

Analyses are based on data from the fourth wave of SHARE, the Survey of Health, Ageing, and Retirement in Europe [35-38]. “SHARE has been submitted to, and approved by, the ethics committee at the University of Mannheim which was the legally responsible entity for SHARE during wave four” [38]. Following the SHARE conditions of use, the ethical approval for the SHARE study also applies to this analysis [39]. Data was collected in 2010 and 2011 from sixteen European countries (Austria, Germany, Sweden, Netherlands, Spain, Italy, France, Denmark, Switzerland, Belgium, Czech Republic, Poland, Hungary, Portugal, Slovenia and Estonia). Based on population registers, SHARE uses probability samples within the countries and includes non-institutionalized adults aged 50 years or older and, if available, their partners. Further exclusion criteria are being incarcerated, moved abroad, unable to speak the language of questionnaire, deceased, hospitalized, moved to an unknown address or not residing at sampled address [36, 38]. By focusing on an older age group, SHARE matches our research questions very well, since health needs increase significantly and crucial changes in the life course occur (e.g., retirement). Furthermore, SHARE offers a substantial sample size (wave four: 56,989 main interviews of respondents aged 50 years or older in 39,807 households).

SHARE uses an ex-ante harmonization regarding the survey design, which means that questionnaires and field procedures are standardized across countries to maximize options for cross-national comparisons [40]. To ensure the ex-ante harmonization of the survey, “[...] SHARE employs three instruments: the SHARE Model Contract provides the legal framework for standards and quality control; the SHARE Survey Specifications define the quality standards of the survey ex ante; and the SHARE Compliance Profiles report adherence

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3 to those standards ex post” [40]. In wave four, “[...] contact rates of households were
4
5 satisfactory ($\geq 90\%$) in almost all countries, both in panel and refreshment samples. Refusal
6
7 rates ranged from 22% to 49% and were the prime reason for sampled households not
8
9 providing an interview” [40]. To handle possible selection and participation biases, SHARE
10
11 offers sample design weights [35, 38] (for further details please see analyses section).
12

13 14 **Patient and Public Involvement**

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16
17 Patients and public were not involved in the development of the research question and the
18
19 selection of outcome measures. On the basis of the SHARE documentation there is no
20
21 detailed information available on the role of patients and the public designing and conducting
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23 the study [41, 42]. All in all, SHARE is based on the U.S. Health and Retirement Study
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25 (HRS) and the English Longitudinal Study of Ageing (ELSA) [41].
26
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28 29 **Measures**

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32 Interviews of the fourth SHARE wave included several items concerning health care. Before
33
34 asking explicitly for GP visits, the following more general question was asked: *‘During the*
35
36 *last twelve months, about how many times in total have you seen or talked to a medical doctor*
37
38 *about your health (exclude: dentist visits and hospital stays, include emergency room or*
39
40 *outpatient clinic visits)?’ . If respondents accounted for more than 98 contacts, the number 98*
41
42 *was entered. The dependent variable, GP visits, was assessed by the reported number of*
43
44 *contacts with general practitioners or doctors at health care centers in the last twelve months*
45
46 *prior to the interview: ‘How many of these contacts were with a general practitioner or with a*
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48 *doctor at your health care center?’ .*
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52 Predictors were self-rated health and social relationships with a focus on structural (social
53
54 integration index, social contact frequency in the social network) and functional (number of
55
56 emotionally close ties) dimensions.
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2
3 The Social Integration Index by Berkman et al. [43] has been shown to be a reliable and
4
5 robust approach to represent the multidimensional construct of social integration. The index
6
7 consists of three domains (1: marital status and cohabitation, 2: contacts with friends and
8
9 family, 3: affiliation with voluntary associations; each scored from zero to two) ranging from
10
11 zero to six, with zero points meaning low and six points meaning high integration into their
12
13 social environment.
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15

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17 First domain: if the respondent was single, divorced or widowed, zero points were given, and
18
19 two points, if the person was married or living with a partner. *'What is your marital status? 1.*
20
21 *Married and living together with spouse, 2. Registered partnership, 3. Married, living*
22
23 *separated from spouse, 4. Never married, 5. Divorced, 6. Widowed'*. This item was
24
25 dichotomized to having a partner or not. Second domain: the number of social ties to different
26
27 people was counted and transformed into three categories connected to different scores (0: 0
28
29 contacts, 1: 1-2 contacts, 2: 3 or more contacts). This categorization is based on the answers to
30
31 the following question: *'Please give me the first name of the person with whom you often*
32
33 *discuss things that are important to you'*. Respondents could name up to seven people. Third
34
35 domain: the affiliation with voluntary organizations was measured by activities in any of the
36
37 five social groups: *'Which of the activities have you done in the past twelve months? 1. Done*
38
39 *voluntary or charity work, 2. Attended an educational or training course, 3. Gone to a sport,*
40
41 *social or other kind of club, 4. Taken part in activities of a religious organization (church,*
42
43 *synagogue, mosque etc.), 5. Taken part in a political or community-related organization'*.
44
45 Being part of no organization resulted in a score of zero, one organization meant one point
46
47 and two or more memberships scored two points.
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51
52 Furthermore, the survey included items on the characteristics of social relationships, e.g.
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54 social contact frequency and emotional closeness to people in the personal network. This
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56 module was based on other similar studies, such as the National Social Life, Health, and
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3 Aging Project (NSHAP) [44], the American General Social Survey and the Longitudinal
4
5 Aging Study Amsterdam [45-47]. Social contact frequency was assessed by the following
6
7 question: *‘During the past twelve months, how often did you have contact with [person XY]*
8
9 *either personally, by phone or mail? 1. Daily, 2. Several times a week, 3. About once a week,*
10
11 *4. About every two weeks, 5. About once a month, 6. Less than once a month or never’*. The
12
13 analyses include the average social contact frequency in the personal network. The question
14
15 on emotional closeness to the personal network members is: *‘How close do you feel to*
16
17 *[person XY]? 1. Not very close, 2. Somewhat close, 3. Very close, 4. Extremely close’*. For the
18
19 analyses, the number of very or extremely close people in the personal network was counted
20
21 (range: 0 to 7). Consequently, it represents not only a structural, but also functional dimension
22
23 of social relationships.
24
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26
27 We used self-rated health (*‘Would you say your health is...?’*) on a five-point-scale (*‘0. Poor,*
28
29 *1. Fair, 2. Good, 3. Very good, 4. Excellent’*) to assess the peoples’ health status.
30
31

32 Sociodemographic (gender, age) and socioeconomic (education, employment status, income:
33
34 make ends meet) factors were used as covariates (Supplement Table 1). Education was based
35
36 on the *International Standard Classification of Education (ISCED 1997)* and ranged from 0 to
37
38 6 (low to higher education). Employment status was split into five categories (*0 = employed,*
39
40 *1 = retired, 2= unemployed, 3= permanently sick or disabled and 4 = homemaking*
41
42 *respondents*). Material well-being of individuals was measured by the question: *‘Thinking of*
43
44 *your household's total monthly income, would you say that your household is able to make*
45
46 *ends meet...?’ (0 = with great or some difficulty, 1 = fairly easy or easy).*
47
48
49

50 The correlation matrix of the covariates did not reveal strong or very strong associations
51
52 between similar variables (Supplement Table 1). The highest correlation was found between
53
54 education and financial distress ($r = 0.22$). Hence, the level of confounding within the
55
56 following analyses can be rated as low to moderate.
57
58
59

Analyses

Regression models were used to analyze the associations between GP use and the predictors. The dependent variable “reported number of GP visits in the last 12 months” is a discrete count variable following a Poisson distribution. As the variance of the dependent variable is greater than its mean, negative binomial regression was used to account for the significant evidence of overdispersion. Furthermore, negative binomial regression models include a parameter that reflects unobserved heterogeneity among observations [48].

Due to the complex sample structure, including individual level, household level and country level, a survey design was implemented [35, 49]. To account for within-household correlations and between-country differences, households were defined as primary sampling unit and countries as strata. Furthermore, to adjust for variation in selection probabilities by design and for variation in participation probabilities caused by non-response, sample design weights were used [38]. In the case of Stata the survey command and in R the survey-package were used to adequately handle weighted and stratified data [50-52].

Since this study aimed to analyze potential moderation of social relationships on the association between self-rated health and GP use, interaction terms were introduced [53]. Three different two-way interaction terms were calculated: 1) self-rated health*social integration index, 2) self-rated health*average of social contact frequency in social network and 3) self-rated health* number of very to extremely close people in social network. Finally, three-way interactions were computed to elaborate the role of the employment status within the interaction between health and social relationships (health*social relationship*employment status). The analyses were performed with Stata 12 and were replicated with R [54].

RESULTS

Our descriptive results are based on the unweighted sample (Table 1). The median of the reported number of GP visits in the last 12 months was 3. More than half of the participants were female and the mean age was about 66.4 years. 26% were employed and 39% had difficulty to make ends meet with regard to their income.

Table 1: Descriptive statistics of the sample (SHARE, wave four, 2011, 16 countries).

Variables	
GP visits ^a : Median / 25%-Percentile / 75%-Percentile / Mean (SD)	3 / 2 / 6 / 5.08 (7.38)
Female: N (%)	31,969 (56.10)
Age in years ^b : Mean (SD)	66.37 (10.05)
Education ^c (ISCED-1997 Coding: 0=low – 6=high): Mean (SD)	2.77 (1.44)
<i>Pre-primary</i>	1,682 (2.95)
<i>ISCED-1997 Code 1 (primary)</i>	10,943 (19.20)
<i>ISCED-1997 Code 2 (lower-secondary)</i>	10,804 (18.96)
<i>ISCED-1997 Code 3 (upper-secondary)</i>	18,751 (32.90)
<i>ISCED-1997 Code 4 (post-secondary and non-tertiary)</i>	2,597 (4.56)
<i>ISCED-1997 Code 5 (first stage of tertiary)</i>	10,514 (18.45)
<i>ISCED-1997 Code 6 (second stage of tertiary)</i>	454 (0.80)
Job status ^d : N (%)	
<i>Employed</i>	14,736 (25.86)
<i>Retired</i>	35,207 (61.78)
<i>Unemployed</i>	1,821 (3.20)
<i>permanently sick or disabled</i>	1,863 (3.27)
<i>Homemaker</i>	2,265 (3.97)
Income: make ends meet ^e : N (%)	
<i>with great or some difficulty</i>	22,319 (39.16)

<i>fairly easy or easy</i>	33,157 (58.18)
Self-rated health (0=poor – 4=excellent) ^f : Mean (SD)	1.74 (1.08)
<i>Poor</i>	7,307 (12.82)
<i>Fair</i>	16,841 (29.55)
<i>Good</i>	19,754 (34.66)
<i>very good</i>	9,066 (15.91)
<i>Excellent</i>	3,744 (6.57)
Social integration index (0=low – 6=high) ^g : Mean (SD)	3.55 (1.39)
Average of social contact frequency in social network (0=less than once per month or never – 5=daily) ^h : Mean (SD)	4.07 (0.99)
Number of very to extremely close people in social network (0-7) ⁱ : Mean (SD)	2.16 (1.45)
Unweighted sample (= number of observations)	n = 56,989
Missing values (out of 56,989): ^a 7,296, ^b 5, ^c 1,244, ^d 1,097, ^e 1,513, ^f 277, ^g 1,024, ^h 4,451, ⁱ 3,385	

i) Associations between social relationships and GP visits

To answer research question (i), Figure 1 shows the forest plots of incidence rate ratios of negative binomial regression models for GP use, for the different social relationship indicators (Model 1: social integration index, Model 2: average social contact frequency in social network and Model 3: number of emotionally very close contacts).

Figure 1 Forest plots of incidence rate ratios for GP use

The regression analysis of Model 1 (Figure 1, Supplement Table 2) shows that the social integration index is not statistically significantly associated with the rate of GP visits (IRR=0.99, 95%CI 0.97-1.01). Better self-rated health (IRR=0.74, 95%CI 0.70-0.78), easily making ends meet (IRR=0.85, 95%CI 0.80-0.90) and higher educational status (IRR=0.94,

95%CI 0.92-0.97) are strongly associated with lower frequency of GP visits. Older age shows a slightly positive association with a higher rate of GP visits (IRR=1.01, 95%CI 1.0-1.01). Not-employed persons show higher frequency of GP visits (employed: reference, retired: IRR=1.24, 95%CI 1.11-1.39, unemployed: IRR=1.05, 95%CI 0.93-1.19, permanently sick or disabled: IRR=1.48, 95%CI 1.24-1.78, homemaker: IRR=1.29, 95%CI 1.14-1.46). The regression analysis of Model 2 (Figure 1, Supplement Table 2) shows that the social contact frequency within a social network is not statistically significantly associated with the rate of GP visits (IRR=1.04, 95%CI 1.00-1.07). The regression analysis of Model 3 (Figure 1, Supplement Table 2) indicates that being closely connected is not statistically significantly associated with the rate of GP visits (IRR=1.02, 95%CI 0.99-1.04). In all three models, social relationship coefficients showed low magnitude and narrow confidence intervals.

ii) Moderation of social relationships on health and GP use

To answer research question (ii), Figure 2 shows the expected number of GP visits depending on the two way interaction between health status and social integration index (Supplement Table 3). The blue line represents people with a mean level of social integration. The red line is based on a lower level of social integration (mean minus one standard deviation), whereas the green line stands for a higher level of social integration (mean plus one standard deviation).

Figure 2 Number of GP visits on health & social integration

Starting at nearly eight visits per year for people with poor health, the estimated average number of visits steadily decreases with better health status, ending at about two visits for people with excellent self-rated health. This trend can be observed for all three levels of social integration, but taking the confidence intervals into account, the divergence of the groups is

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3 not statistically significant at any level of health status. Nevertheless, the largest slope is
4 detected for less socially integrated people and the smallest slope is documented for more
5 socially integrated people.
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10 Figure 3 shows the number of GP visits in dependence of health and social contact frequency
11 in social networks (Supplement Table 3).
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18 **Figure 3 Number of GP visits on health & social contact frequency**
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22 All in all, the patterns are similar to Figure 2, but the slopes of the groups with lower and
23 higher contact frequencies are the other way round. The slope of estimated number of GP
24 visits on self-rated health is steeper for those with lower social contact frequency. This
25 association is statistically significant for people with a very good and excellent health,
26 although the differences in the slopes are relatively small.
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33 Figure 4 shows the expected number of GP visits according to various levels of subjective
34 health and the number of very close people in social networks (Supplement Table 3).
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42 **Figure 4 Number of GP visits on health & emotional closeness**
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46 Again, we see the downward trend of estimated average number of GP visits from poor to
47 excellent health. In contrary to Figure 3, group differences are only observable for people
48 with poor health. People with poor health and an emotionally close network show a
49 significantly higher number of GP visits compared to people with poor health and less
50 closeness.
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57 *iii) Moderation of social relationships and employment types on health and GP visits*
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3 To answer research question (iii), Figures 5-7 incorporate the three way interactions between
4 health, social relationships and employment status in relation to the number of GP visits.
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7 Figure 5 shows the expected number of GP visits depending on the three-way interaction
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9 between health, social integration index and employment status based on the full sample
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11 (Supplement Table 4).
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17 **Figure 5 Number of GP visits on health, social integration & employment status**
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21 The slopes of the different employment status groups are very diverse, in particular, when the
22 disparate levels of social integration are taken into account. Retired, unemployed,
23 permanently sick or disabled and homemaking people show higher numbers of GP visits on
24 average compared to employed people. Furthermore, the diverging slopes of various social
25 integration indices of those groups also indicate more between-group differences than
26 employed people. Retired people with good, very good or excellent health, for instance, have
27 more GP visits if they are less integrated than retirees who are socially well integrated. This
28 association is inverse with regard to unemployed people with a lower health status.
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39 Considering the social contact frequency, group differences depending on employment status
40 and different grades of contact frequencies in social networks are similar to those seen for
41 social integration (Figure 6, Supplement Table 4).
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49 **Figure 6 Number of GP visits on health, social contact frequency & employment status**
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53 Retired people with good to excellent health, for example, show more GP visits if their social
54 contact frequency in their social network is high on average compared to lower contact
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3 frequencies. This association is also observable for homemaking people with an intermediate
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5 health status.
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8 Figure 7 shows the estimated average number of GP visits depending on the three-way
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10 interaction between health, number of very close contacts and employment status
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12 (Supplement Table 4).
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14 15 16 17 18 **Figure 7 Number of GP visits on health, closeness & employment status**

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22 The slopes in the group of retired people show statistically significant differences between
23
24 various levels of emotional closeness. A higher number of emotionally close contacts
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26 increases the expected number of GP visits, if retired people are characterized by poor or fair
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28 self-rated health. This association is also shown within the group of permanently sick or
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30 disabled people.
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32 33 34 35 36 37 **DISCUSSION**

38 39 40 41 **Summary**

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44 Focusing on older adults in Europe, this was the first study to investigate (i) how social
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46 relationships are associated with the frequency of GP visits, (ii) if social ties moderate the
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48 association between self-rated health and GP use, and (ii) how these associations vary in
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50 subgroups of different employment status.
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54 Regarding research question (i), the structural (social integration, social contact frequency)
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56 and functional (number of emotionally close contacts) dimensions of social relationships
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3 under investigation are not statistically significantly associated with GP use frequency. On the
4
5 one hand, our results are in line with a number of studies on structural and functional aspects
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7 of social relationships [5, 24, 55-57]. Studies on structural aspects of social relationships, e.g.
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9 marital status, living arrangements and family size, showed no statistically significant
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11 associations with the frequency of physician use [55-57]. Furthermore, studies on functional
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13 aspects of social relationships, e.g. social anchorage, social support and emotional,
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15 instrumental and informational support, demonstrated no statistically significant associations
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17 with regard to the use of primary care services [5, 24]. On the other hand, and with regard to
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19 structural measures of social relationships, empirical results are inconsistent until now.
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21 Various studies on outpatient care use showed that older people living alone are more likely to
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23 consult a physician [23, 58, 59]. One study showed that married older people have a lower
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25 probability of using GP services [24]. Others demonstrated that older people living in a
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27 marriage or with their children present a higher frequency of physician consultations [25, 26].
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29 With regard to the size of the social network, studies found negative associations [19, 20], and
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31 others ambiguous [21] or positive associations [22]. Moreover, Kim & Konrath [60] did not
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33 find a statistically significant association between volunteering and the frequency of doctor
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35 visits. A possible explanation for these inconsistent empirical patterns can be seen in the
36
37 quality dimension of social relationships to partners, family and social network members. For
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39 instance, Foreman et al. [26] found a negative association between harmonious family
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41 relationships and the number of physician visits. International studies on functional
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43 dimensions of social relationships demonstrated that different aspects of received social
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45 support (e.g., material, instrumental and informational support) are positively linked with GP
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47 use [3, 32, 61]. Frequent and close social contacts are not only a potential source of social
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49 support (e.g., material, instrumental and informational support) are positively linked with GP
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51 use [3, 32, 61]. Frequent and close social contacts are not only a potential source of social
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53 support, but also for psychological distress and physical discomfort, conceivably leading to
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55 higher GP use rates [62, 63].
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3 Regarding research question (ii), the analyses show hardly any substantial and statistically
4 significant moderating effects of different aspects of social relations on the link between self-
5 rated health and frequency of GP visits. Only for older adults with poor self-rated health, an
6 increase of the number of emotionally close members in the social network is associated with
7 a growing rate of GP visits (Figure 4). Furthermore, older adults with very good or excellent
8 health show a higher rate of GP visits with an increase of their social contact frequency in the
9 social network (Figure 3), while social contact frequency seems to play a less important role
10 for people with poorer health. Potentially, a higher density of social networks fosters the GP
11 use by providing support and resources, but only for people with better health. The
12 differences are statistically significant, but they have a lower magnitude.
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25 Three way interaction analyses regarding research question (iii) indicate employment status-
26 specific behavioral patterns with regard to social relationships and GP use, but coefficients
27 were mostly not significant. Analyses focusing on older people who are retired, unemployed,
28 permanently sick or disabled or homemakers, show various results. All in all, the groups of
29 retired, unemployed, permanently sick/disabled and homemaking people show a higher
30 estimated average number of GP visits. Comparing those groups with each other also presents
31 diverging patterns of associations. A higher level of social integration was associated with
32 lower rates of GP use for retirees, but was associated with a higher frequency of visits for
33 unemployed older adults, especially for unemployed older people with a poor self-rated health
34 (Figure 5). “Having a partner”, which is included in the social integration index, contributed
35 the most to this association. Atkinson et al. [18] showed that unemployment has a negative
36 effect on marital and family support and a positive effect on the utilization of external help
37 including emotional support, information or advice and concrete assistance. Potentially,
38 unemployed people struggle not only with their psychological well-being but also with their
39 social relationships. Consequently, they use more external help including the consultation of
40 GPs. Homemakers use more GP visits, if their social contact frequency is higher, especially, if
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3 their health status is rated as fair or good. This holds also true for retirees with a higher self-
4 rated health status (Figure 6). The more emotionally close contacts are present, the higher is
5 the use for GP doctors by retired and permanently sick or disabled people with lower health
6 status (Figure 7).
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10 11 12 **Limitations**

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15 When interpreting the results, some methodological limitations need to be taken into account.
16 Firstly, our analyses were based on cross-sectional data, forbidding statements on causal
17 directions and changes over time. The cross-sectional design was chosen due to the inclusion
18 of social relationship variables from SHARE's "social networks" module which was applied
19 only in wave four [35, 36, 64]. Therefore, the postulated buffer function of social integration
20 (of retirees and homemakers) on the reported number of GP visits in the last 12 months, for
21 instance, is only one possible explanation. Another scenario may be the healthy user effect
22 due to volunteering activities which are included in the social integration index. Healthier
23 people with less GP visits have more resources to invest into their social integration.
24 Furthermore, some of the differences between employment types may be related to temporary
25 resources, since employed people have less time available to consult their GP.
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40 SHARE is an international survey aiming for high methodological standards by using ex-ante
41 harmonization to minimize "artifacts in cross-national comparisons that are created by
42 country-specific survey design" [40], but the schedule for data collection in wave 4 was only
43 partly synchronized and household response rates vary between countries (39% to 63 %). Due
44 to unit non-response and panel attrition, sample selection bias is a potential problem limiting
45 the representativeness of the data and the generalizability of results [36]. However, non-
46 response analyses taking various variables into account (gender, age, health, employment,
47 number of children, and income) showed only little evidence for non-response bias (e.g., a
48 slightly larger number of males among respondents than non-respondents) [38].
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3 The question to assess the use of GP doctors across 12 months is established in health services
4 research [4, 20, 21, 65], but has some methodological drawbacks. The question is narrowed to
5 the reported number of GP or doctor visits in a health care center. Contacts with nurses at GP
6 practices are not taken into account. Potentially, the level of using primary care is
7 underestimated. The time span covering the GP contacts is quite long, and considering the
8 older age of the interviewed individuals, risk of memory bias is existent with regard to self-
9 reported utilization [66]. Bhandari and Wagner found in their systematic review on self-
10 reported utilization of health care services that “[...] age was the most consistent demographic
11 factor associated with self-report inaccuracy [...]” by older adults underreporting their use
12 [66]. Consequently, intercepts and age coefficients in our models could be potentially
13 underestimated.

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27 The limited level of information of self-reported data holds also true for all other variables in
28 our analyses, especially for the variable “self-rated health” [67]. Self-rated health status is
29 based on a single item, but it is considered a suitable summary of health status [68]. Studies
30 on several representative samples showed that self-rated health ratings can be used as valid
31 measures of health status regardless of different cultures and social conditions [69-71] and
32 that they may correspond well to the objective health status [72, 73]. Caution is needed
33 drawing conclusions from analyses using self-rated health. The same holds true for the
34 variable “make ends meet”, since the assessment of self-perceived financial distress compared
35 to income represents an adequate and direct measure of the economic situation of individuals,
36 especially among older individuals [74].

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50 Furthermore, SHARE data did not provide information on the reasons for using health
51 services or the quality and adequacy of health care services. Consequently, the reported
52 number of GP visits in the last 12 months represents a proxy for “realized access” [1] only.
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3 Another point that can be discussed is that one out of three domains of the social integration
4 index focused on marital and partnership status and cohabitation. That focus cannot capture
5 the whole variety of non-married or non-partner cohabiting household structures. Potentially,
6 this lack of information is buffered by the other two domains, and especially, by the second
7 domain of the social integration index by including the number of social ties. Nevertheless,
8 the level of social integration could be slightly higher than illustrated by our index. In
9 particular, this could be true for countries with a higher number of “non-traditional” living
10 arrangements.
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21 Finally, and though SHARE strived to combine the indirect and direct approach of social
22 network analysis [64], it does not offer sufficient and longitudinal data on functional and
23 qualitative aspects of social relationships [75]. The synthesis of the indirect approach
24 (referring on socio-demographic proxies) and the direct approach (linking meaningfulness and
25 importance to social relations) still lacks valuable information about the quality of social
26 relationships and perceived support.
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38 CONCLUSIONS

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41 Our results demonstrate that different indicators of social relationships are not associated with
42 higher or lower frequency of GP visits. The magnitude of the associations is relatively low
43 and most of the investigated associations are statistically insignificant. Nevertheless, the
44 investigation of the two- and three-way interactions showed a complex, but interesting
45 picture. This study indicates potential inequalities in GP use due to different dimensions and
46 characteristics of social relationships, especially considering self-rated health and
47 employment status of older adults.
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3 Since, social relationships influence patient's motives for visits and the patient's compliance
4 with regard to future visits for treatment, prevention and rehabilitation [76, 77], it may be
5 helpful for health care providers to assess information on the patient's "social background". A
6 patient, for instance, characterized by poor health and no emotionally close ties, visits a GP
7 less frequently than his/her counterpart with poor health and closely connected within a social
8 network. Potentially, these differences may produce inequalities in medical care and
9 treatments. In health care, it is obligatory, e.g. for treatment planning, to decide in line with
10 the patient on the adequacy of treatment and to incorporate the patient's needs and resources
11 to reach that goal. Therefore, the GP may want to know if a patient is socially integrated or
12 isolated, and may want to evaluate if a patient needs or wants more or less social support. It is
13 important to emphasize that the observed behavioral differences of GP use, within the limits
14 of the SHARE dataset, do not implicate inadequacies in GP doctor services, such as over- or
15 underuse.

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Future surveys should aim at assessing functional and quality dimensions of social relationships linked to health services use to shed more light on the underlying mechanisms. Finally, to define potential improvements in health systems and to inform health policy makers and health practitioners adequately, health services research needs to integrate information on the patient's motives for visits and on the levels, quality and outcomes of the treatments.

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40 **List of figures**

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46 Figure 6 Number of GP visits on health, social contact frequency & employment status

47 Figure 7 Number of GP visits on health, closeness & employment status
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Supplement

Supplement Table 1 Pairwise correlations

Supplement Table 2 Models 1-3

Supplement Table 3 Models 4-6

Supplement Table 4 Models 7-9

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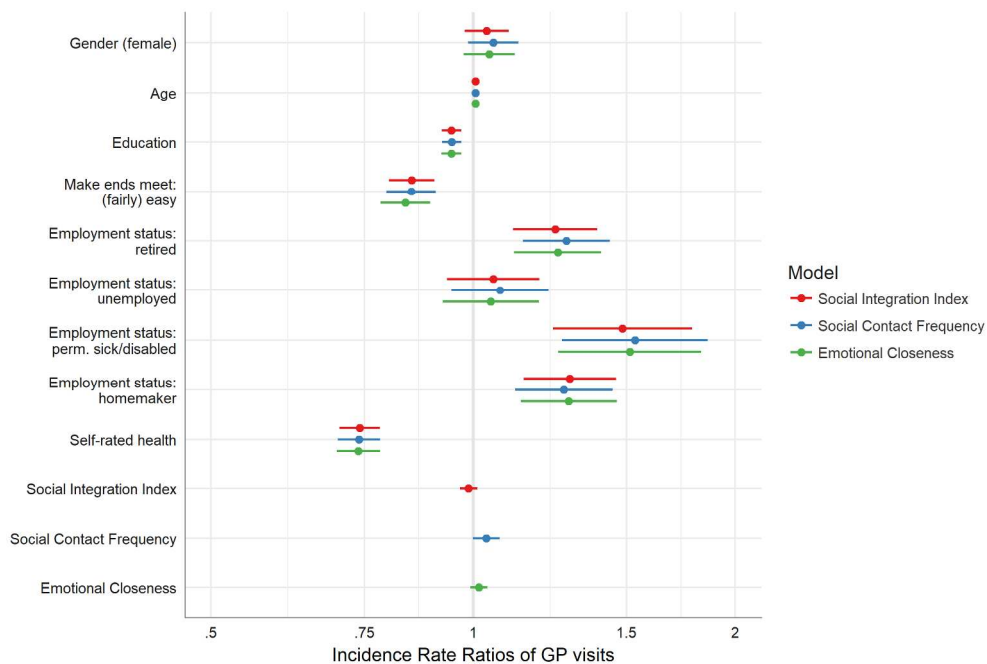


Figure 1 Forest plots of incidence rate ratios for GP use

228x152mm (300 x 300 DPI)

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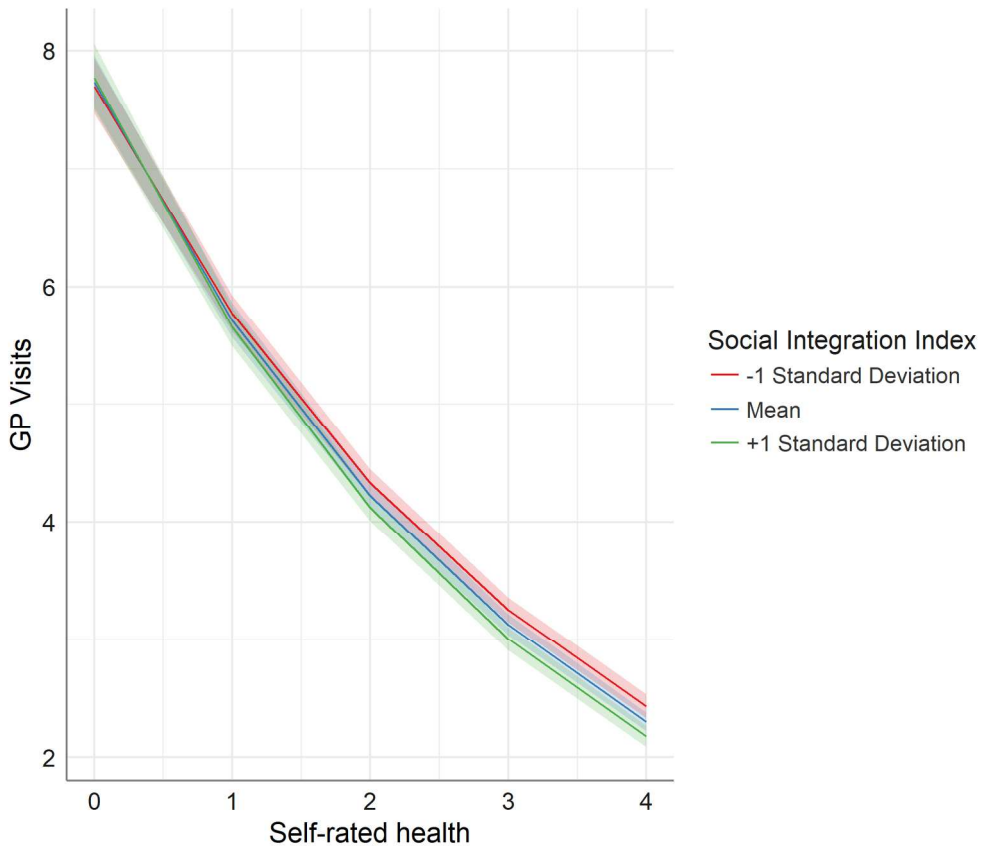


Figure 2 Number of GP visits on health & social integration

177x152mm (300 x 300 DPI)

only

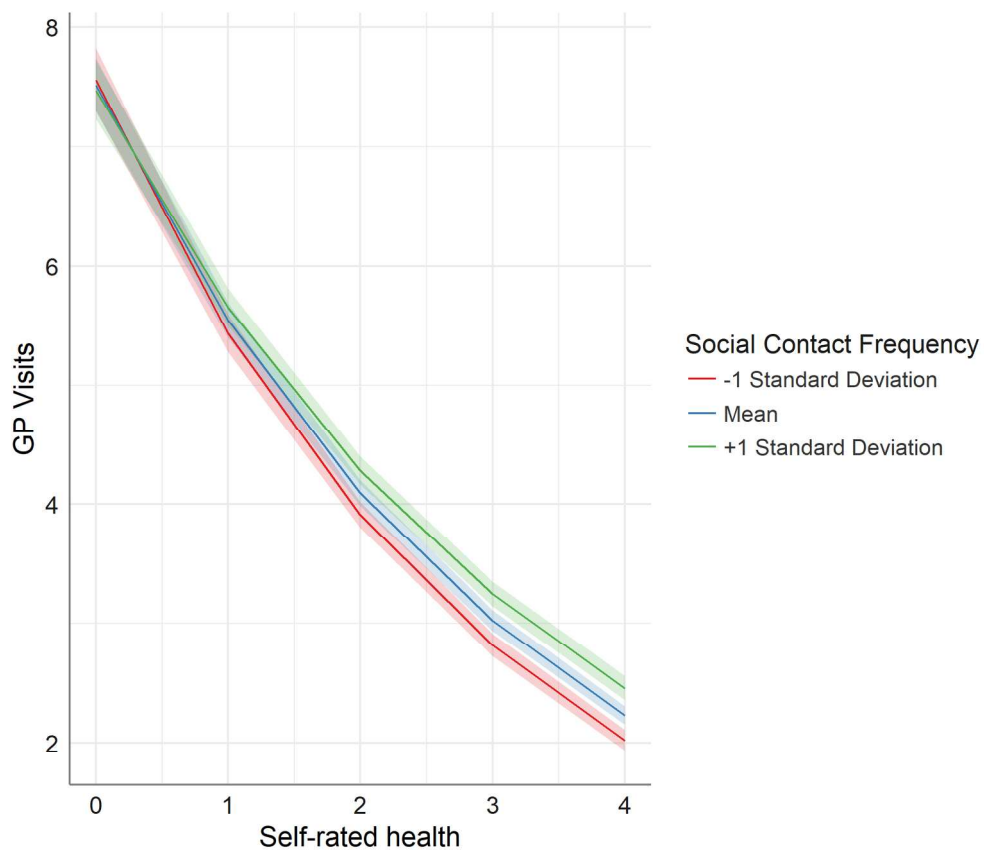


Figure 3 Number of GP visits on health & social contact frequency

177x152mm (300 x 300 DPI)

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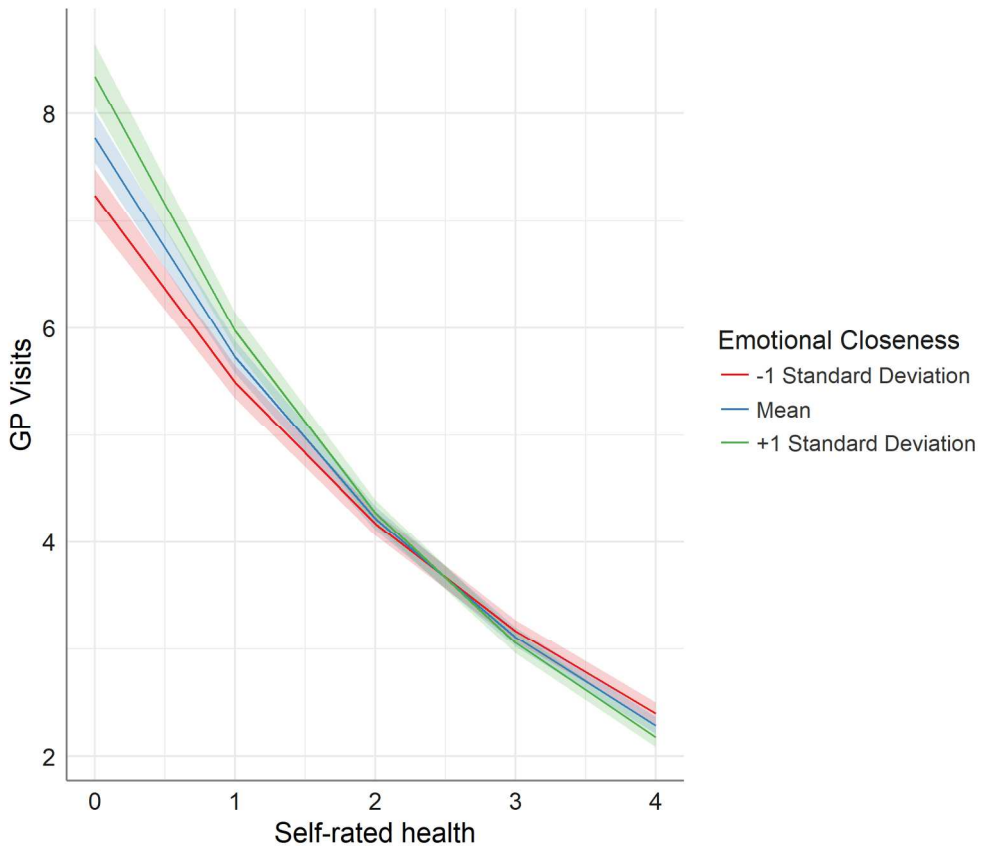


Figure 4 Number of GP visits on health & emotional closeness

177x152mm (300 x 300 DPI)

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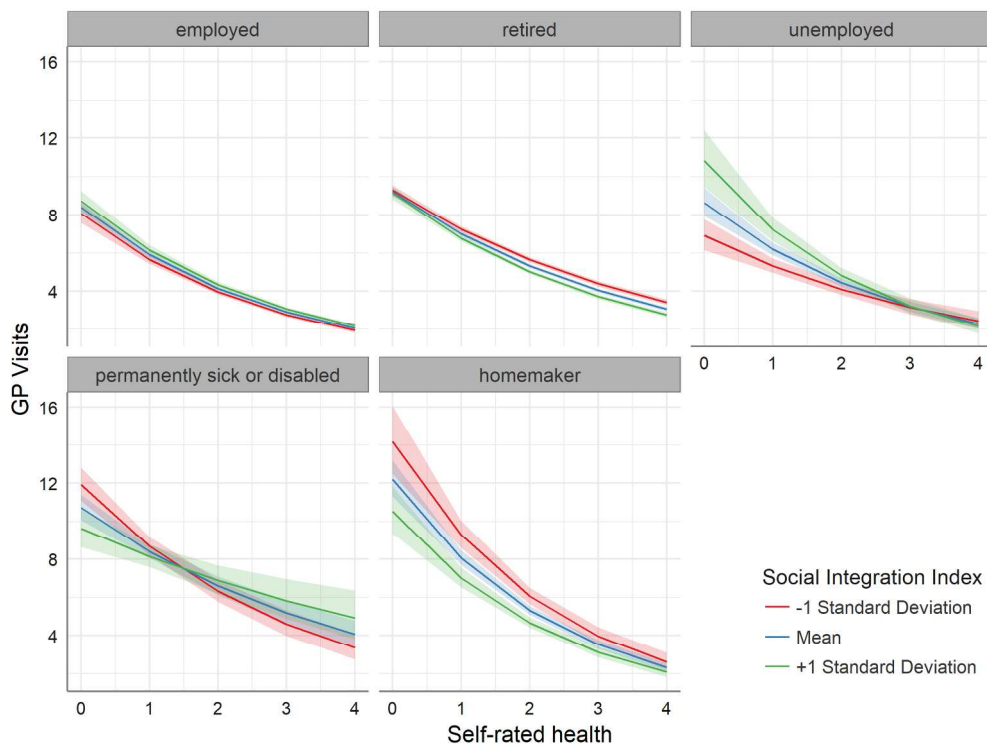


Figure 5 Number of GP visits on health, social integration & employment status

203x152mm (300 x 300 DPI)

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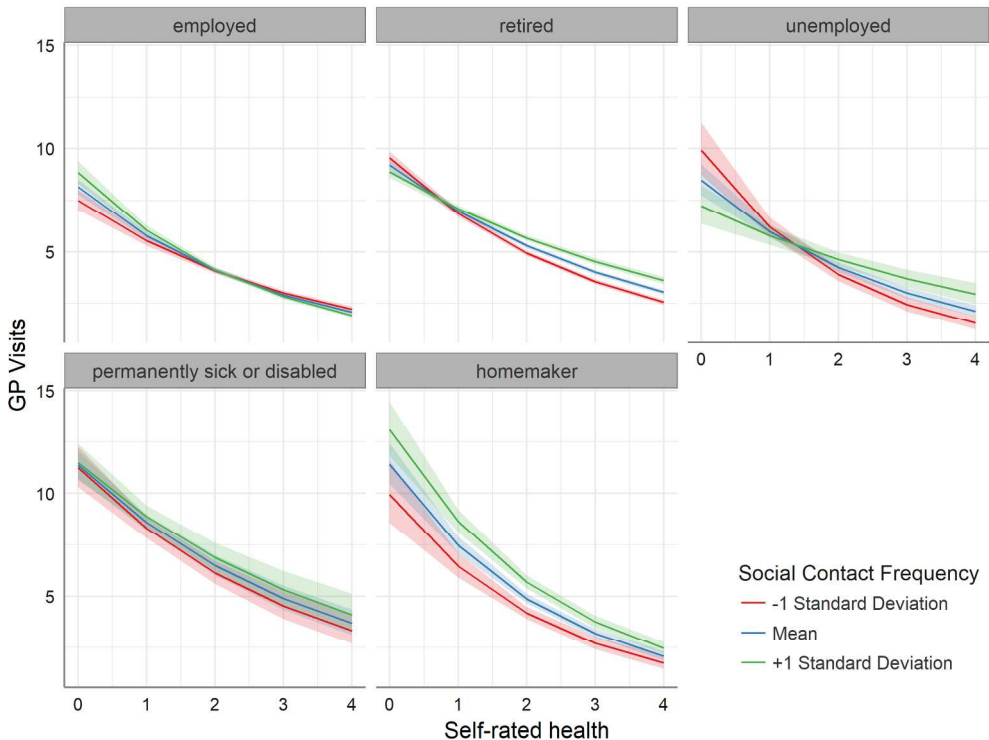


Figure 6 Number of GP visits on health, social contact frequency & employment status

203x152mm (300 x 300 DPI)

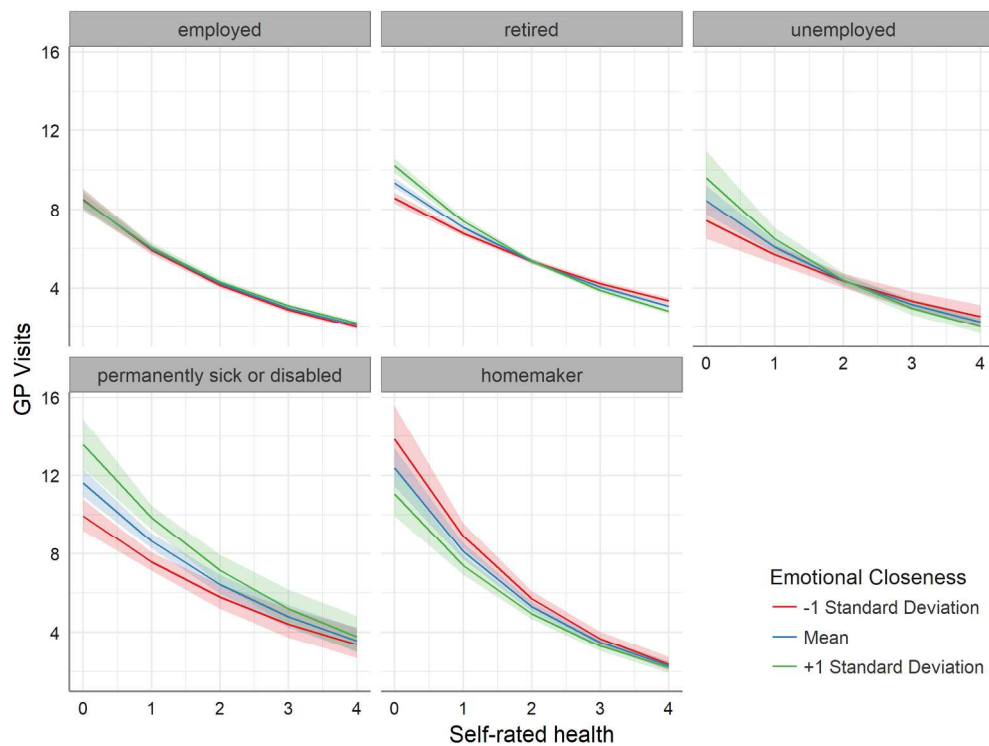


Figure 7 Number of GP visits on health, closeness & employment status

203x152mm (300 x 300 DPI)

Supplement Table 1 pairwise correlations

	GP visits	gender	age	education	make ends meet	employment status	health	social integration	contact frequency
gender	0.0200								
age	0.1192	0.0089							
education	-0.1297	-0.0809	-0.2345						
make ends meet	-0.1231	-0.0414	0.0339	0.2156					
employment status	0.1044	0.1287	0.0709	-0.1895	-0.1304				
health	-0.2585	-0.0460	-0.2478	0.2496	0.2650	-0.1756			
social integration	-0.0984	-0.0917	-0.2636	0.2637	0.2119	-0.0692	0.2574		
contact frequency	0.0446	-0.0650	-0.0522	-0.1362	-0.1141	0.0216	-0.0594	-0.0631	
emotional closeness	-0.0098	0.1232	-0.0793	0.0962	0.0755	0.0008	0.1032	0.3924	-0.1698

SUPPLEMENT Table 2

Model 1 - Negative binomial regression models based on full sample (social integration index)

<i>Variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0362	0.0298	0.9773	1.0986	0.2338
Age	1.0064	0.0028	1.001	1.0119	0.0205
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9439	0.0132	0.9197	0.9687	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8499	0.0305	0.8006	0.9024	0.000
Employment status (employed = Ref.)					
<i>retired</i>	1.2417	0.0567	1.111	1.3877	1e-04
<i>unemployed</i>	1.054	0.0622	0.933	1.1907	0.3982
<i>permanently sick or disabled</i>	1.4841	0.0938	1.2349	1.7836	0.000
<i>homemaker</i>	1.291	0.0623	1.1427	1.4586	0.000
Self-perceived health (0=poor – 4=excellent)	0.7405	0.0272	0.7021	0.781	0.000
Social integration index (0=low – 6=high)	0.9876	0.0118	0.965	1.0106	0.288
Intercept	8.9883	0.0626	7.9503	10.1618	0.000
Alpha	0.6091	0.0251	0.5618	0.6604	
n – unweighted			47,066		
N – weighted			119,390,189		
Number of strata (countries)			16		
Number of primary sampling units (households)			34,623		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

Model 2 - Negative binomial regression models based on full sample (contact frequency)

<i>variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0548	0.0341	0.9867	1.1276	0.1174
Age	1.0059	0.0029	1.0002	1.0116	0.041
Education (ISCED-1997 Coding: 0=low – 6=high)	0.945	0.013	0.9212	0.9694	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8487	0.0333	0.7951	0.9058	0.000
Employment status (employed = Ref.)					
<i>retired</i>	1.2792	0.0588	1.1401	1.4353	0.000
<i>unemployed</i>	1.0731	0.0656	0.9436	1.2204	0.2821
<i>permanently sick or disabled</i>	1.5336	0.0984	1.2646	1.8599	0.000
<i>homemaker</i>	1.271	0.0657	1.1174	1.4457	3e-04
Self-perceived health (0=poor – 4=excellent)	0.7391	0.0286	0.6989	0.7817	0.000
Average of contact frequency in social network (0=less than once per month or never – 5=daily)	1.0351	0.0182	0.9988	1.0726	0.058
Intercept	8.7504	0.0655	7.696	9.9492	0.000
alpha	0.6055	0.0266	0.5556	0.6600	
n – unweighted			43,962		
N – weighted			110,219,002		
Number of strata (countries)			16		
Number of primary sampling units (households)			32,616		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

Model 3 - Negative binomial regression models based on full sample (emotional closeness)

<i>variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0432	0.0344	0.9752	1.1158	0.219
Age	1.0064	0.0028	1.0009	1.012	0.0228
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9434	0.0136	0.9187	0.9689	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8354	0.0335	0.7823	0.8921	0.000
Employment status (employed = Ref.)					
<i>retired</i>	1.2502	0.0587	1.1143	1.4028	1e-04
<i>unemployed</i>	1.0476	0.0648	0.9226	1.1896	0.4729
<i>permanently sick or disabled</i>	1.5124	0.0962	1.2524	1.8262	0.000
<i>homemaker</i>	1.2873	0.0649	1.1334	1.462	1e-04
Self-perceived health (0=poor – 4=excellent)	0.7381	0.0292	0.697	0.7817	0.000
Number of very to extremely close people in social network (0-7)	1.0151	0.0115	0.9925	1.0381	0.193
Intercept	9.0879	0.0635	8.0245	10.2921	0.000
alpha	0.6112	0.0270	0.5605	0.6666	
n – unweighted			44,840		
N – weighted			112,626,161		
Number of strata (countries)			16		
Number of primary sampling units (households)			33,160		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

SUPPLEMENT Table 3

Model 4 - Negative binomial regression models based on full sample - 2-way interaction

(social integration index)

<i>Variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0378	0.0301	0.9784	1.1008	0.2175
Age	1.0065	0.0028	1.001	1.0121	0.0208
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9441	0.0132	0.92	0.9688	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8492	0.0303	0.8002	0.9012	0.000
Employment status (employed = Ref.)					
<i>retired</i>	1.2398	0.0572	1.1082	1.3869	2e-04
<i>unemployed</i>	1.0508	0.0616	0.9312	1.1856	0.4216
<i>permanently sick or disabled</i>	1.4829	0.094	1.2332	1.783	0.000
<i>homemaker</i>	1.2876	0.0626	1.139	1.4556	1e-04
Self-perceived health (0=poor – 4=excellent)	0.7391	0.0262	0.7022	0.778	0.000
Social integration index (0=low – 6=high)	1.0032	0.0215	0.9617	1.0464	0.8831
Self-perceived health * Social integration index	0.9902	0.0096	0.9716	1.0091	0.3059
Intercept	9.0466	0.0621	8.0092	10.2184	0.000
Alpha	0.6090	0.0250	0.5618	0.6601	
n – unweighted			47,066		
N – weighted			119,390,189		
Number of strata (countries)			16		
Number of primary sampling units (households)			34,623		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

Model 5 - Negative binomial regression models based on full sample - 2-way interaction
(contact frequency)

<i>variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0568	0.0336	0.9895	1.1287	0.0997
Age	1.0062	0.0028	1.0007	1.0117	0.0268
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9458	0.0124	0.9231	0.969	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8498	0.0331	0.7965	0.9068	0.000
Employment status (employed = Ref.)					
<i>retired</i>	1.2739	0.056	1.1416	1.4216	0.000
<i>unemployed</i>	1.068	0.0645	0.9411	1.2119	0.3082
<i>permanently sick or disabled</i>	1.5354	0.0977	1.2678	1.8596	0.000
<i>homemaker</i>	1.2687	0.0657	1.1154	1.4431	3e-04
Self-perceived health (0=poor – 4=excellent)	0.738	0.027	0.6999	0.7781	0.000
Average of contact frequency in social network (0=less than once per month or never – 5=daily)	0.9941	0.0441	0.9118	1.0839	0.8938
Self-perceived health * contact frequency	1.026	0.0248	0.9773	1.0771	0.3007
Intercept	8.7676	0.0642	7.7315	9.9425	0.000
alpha	0.6049	0.0259	0.5562	0.6579	
n – unweighted			43,962		
N – weighted			110,219,002		
Number of strata (countries)			16		
Number of primary sampling units (households)			32,616		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

Model 6 - Negative binomial regression models based on full sample - 2-way interaction

<i>variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0444	0.0346	0.9761	1.1176	0.2083
Age	1.0063	0.0028	1.0008	1.0119	0.0253
Education (ISCED-1997 Coding: 0=low – 6=high)	0.944	0.0133	0.9198	0.9688	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8345	0.0332	0.782	0.8906	0.000
Employment status (employed = Ref.)					
<i>retired</i>	1.2499	0.0595	1.1123	1.4045	2e-04
<i>unemployed</i>	1.0445	0.0642	0.9209	1.1847	0.4979
<i>permanently sick or disabled</i>	1.5056	0.0938	1.2528	1.8094	0.000
<i>homemaker</i>	1.2846	0.0658	1.1291	1.4615	1e-04
Self-perceived health (0=poor – 4=excellent)	0.7371	0.0279	0.6979	0.7785	0.000
Number of very to extremely close people in social network (0-7)	1.0486	0.0233	1.0017	1.0977	0.042
Self-perceived health * emotional closeness	0.9804	0.0137	0.9544	1.0072	0.1506
Intercept	9.118	0.0624	8.0685	10.3041	0.000
alpha	0.6105	0.0265	0.5607	0.6648	
n – unweighted			44,840		
N – weighted			112,626,161		
Number of strata (countries)			16		
Number of primary sampling units (households)			33,160		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

SUPPLEMENT Table 4

Model 7 - Negative binomial regression models based on full sample – 3-way interaction
(social integration index)

<i>Variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.033	0.029	0.9759	1.0935	0.263
Age	1.0061	0.0029	1.0003	1.0119	0.0377
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9441	0.0127	0.9209	0.9678	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.851	0.0293	0.8035	0.9014	0.000
Employment status (employed = Ref.)					
<i>retired</i>	0.7027	0.0285	0.6645	0.7432	0.000
<i>unemployed</i>	1.0258	0.0564	0.9185	1.1456	0.6519
<i>permanently sick or disabled</i>	1.0986	0.1099	0.8857	1.3625	0.3923
<i>homemaker</i>	1.0305	0.1441	0.7769	1.3668	0.8349
Self-perceived health (0=poor – 4=excellent)	1.2763	0.1287	0.9917	1.6426	0.058
Social integration index (0=low – 6=high)	1.4546	0.1577	1.068	1.9813	0.0175
Self-perceived health * Social integration index	1.0028	0.0229	0.9587	1.0489	0.9033
Self-perceived health * employment status					
<i>Self-perceived health * retired</i>	1.0807	0.0447	0.9901	1.1797	0.0823
<i>Self-perceived health * unemployed</i>	1.0201	0.0683	0.8922	1.1663	0.7708
<i>Self-perceived health * permanently sick or disabled</i>	1.1167	0.0874	0.9408	1.3254	0.207
<i>Self-perceived health * homemaker</i>	0.9394	0.0692	0.8202	1.0758	0.366
Social integration index * employment status					
<i>Social integration index * retired</i>	0.9694	0.061	0.8602	1.0925	0.6107
<i>Social integration index * unemployed</i>	1.1323	0.0829	0.9626	1.3321	0.1337
<i>Social integration index * permanently sick or disabled</i>	0.908	0.1141	0.7261	1.1355	0.3977

	<i>Social integration index * homemaker</i>	0.8828	0.1035	0.7206	1.0814	0.2284
Self-perceived health * social integration index * employment status						
	<i>Self-perceived health * social integration index * retired</i>	0.9805	0.0251	0.9334	1.0299	0.4327
	<i>Self-perceived health * social integration index * unemployed</i>	0.9504	0.041	0.877	1.0299	0.2147
	<i>Self-perceived health * social integration index * permanently sick or disabled</i>	1.0483	0.0796	0.8969	1.2253	0.5532
	<i>Self-perceived health * social integration index * homemaker</i>	1.0033	0.0466	0.9157	1.0993	0.9438
<hr/>						
	Intercept	9.8174	0.0854	8.3046	11.6058	0.000
	alpha	0.6045	0.0240	0.5596	0.6539	
	n – unweighted			47,066		
	N – weighted			119,390,189		
	Number of strata (countries)			16		
	Number of primary sampling units (households)			34,623		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

Model 8 - Negative binomial regression models based on full sample – 3-way interaction
(social contact frequency)

<i>Variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0574	0.0326	0.992	1.1271	0.0867
Age	1.0066	0.0028	1.0011	1.0121	0.018
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9464	0.0117	0.9249	0.9684	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.8477	0.0317	0.7966	0.9021	0.000
Employment status (employed = Ref.)					
<i>retired</i>	0.7102	0.0284	0.6718	0.7509	0.000
<i>unemployed</i>	1.0848	0.0757	0.9352	1.2584	0.2823
<i>permanently sick or disabled</i>	1.1295	0.1135	0.9042	1.4108	0.2834
<i>homemaker</i>	1.0391	0.1435	0.7845	1.3765	0.7889
Self-perceived health (0=poor – 4=excellent)	1.3951	0.1594	1.0207	1.9067	0.0367
Average of contact frequency in social network (0=less than once per month or never – 5=daily)	1.4007	0.191	0.9633	2.0367	0.0777
Self-perceived health * Contact frequency	0.9626	0.0284	0.9104	1.0177	0.1796
Self-perceived health * employment status					
<i>Self-perceived health * retired</i>	1.0681	0.0455	0.977	1.1676	0.1475
<i>Self-perceived health * unemployed</i>	0.9969	0.0685	0.8716	1.1402	0.9635
<i>Self-perceived health * permanently sick or disabled</i>	1.0637	0.1135	0.8516	1.3287	0.586
<i>Self-perceived health * homemaker</i>	0.9208	0.0822	0.7838	1.0817	0.3153
Contact frequency * employment status					
<i>Contact frequency * retired</i>	0.8891	0.0948	0.7384	1.0706	0.2149
<i>Contact frequency * unemployed</i>	0.7879	0.1516	0.5853	1.0605	0.1158
<i>Contact frequency * permanently sick or disabled</i>	0.9316	0.1271	0.7262	1.1952	0.5774
<i>Contact frequency * homemaker</i>	1.0568	0.1504	0.787	1.419	0.7134

**Self-perceived health * Contact frequency *
employment status**

<i>Self-perceived health * Contact frequency * retired</i>	1.0949	0.0464	0.9998	1.1992	0.0506
<i>Self-perceived health * Contact frequency * unemployed</i>	1.1731	0.0742	1.0144	1.3567	0.0314
<i>Self-perceived health * Contact frequency * permanently sick or disabled</i>	1.0632	0.0622	0.9412	1.2011	0.3242
<i>Self-perceived health * Contact frequency * homemaker</i>	1.0475	0.0663	0.9199	1.1928	0.4838
Intercept	9.4885	0.0848	8.0361	11.2034	0.000
Alpha	0.6009	0.0245	0.5547	0.6509	
n – unweighted			43,962		
N – weighted			110,219,002		
Number of strata (countries)			16		
Number of primary sampling units (households)			32,616		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

Model 9 - Negative binomial regression models based on full sample – 3-way interaction
(emotional closeness)

<i>Variable</i>	<i>irr</i>	<i>std.error</i>	<i>conf.low</i>	<i>conf.high</i>	<i>p.value</i>
Gender: female (male = Ref.)	1.0428	0.0338	0.9759	1.1143	0.2152
Age	1.0066	0.0029	1.0008	1.0124	0.0258
Education (ISCED-1997 Coding: 0=low – 6=high)	0.9437	0.0126	0.9206	0.9673	0.000
Income: make ends meet: fairly easy or easy (with great or some difficulty = Ref.)	0.834	0.032	0.7833	0.888	0.000
Employment status (employed = Ref.)					
<i>retired</i>	0.7057	0.0287	0.6671	0.7465	0.000
<i>unemployed</i>	0.997	0.0447	0.9133	1.0884	0.9462
<i>permanently sick or disabled</i>	1.1027	0.1153	0.8797	1.3823	0.3964
<i>homemaker</i>	0.9959	0.1493	0.7433	1.3345	0.9781
Self-perceived health (0=poor – 4=excellent)	1.3689	0.1537	1.0128	1.8503	0.0411
Number of very to extremely close people in social network (0-7)	1.4595	0.1588	1.0691	1.9926	0.0173
Self-perceived health * Contact frequency	1.0089	0.016	0.9778	1.041	0.5778
Self-perceived health * employment status					
<i>Self-perceived health * retired</i>	1.0726	0.0458	0.9804	1.1734	0.1264
<i>Self-perceived health * unemployed</i>	1.0202	0.0701	0.8891	1.1705	0.7758
<i>Self-perceived health * permanently sick or disabled</i>	1.0548	0.1132	0.845	1.3167	0.6374
<i>Self-perceived health * homemaker</i>	0.9282	0.0666	0.8145	1.0576	0.2632
Emotional closeness * employment status					
<i>Emotional closeness * retired</i>	1.0632	0.0543	0.9558	1.1827	0.2594
<i>Emotional closeness * unemployed</i>	1.0921	0.1072	0.8851	1.3476	0.4111
<i>Emotional closeness * permanently sick or disabled</i>	1.1124	0.1122	0.8927	1.3861	0.3427
<i>Emotional closeness * homemaker</i>	0.931	0.0929	0.776	1.1168	0.4412
Self-perceived health * Emotional closeness *					

employment status

<i>Self-perceived health * Emotional closeness * retired</i>	0.963	0.0261	0.9151	1.0135	0.1483
<i>Self-perceived health * Emotional closeness * unemployed</i>	0.9513	0.05	0.8625	1.0493	0.3181
<i>Self-perceived health * Emotional closeness * permanently sick or disabled</i>	0.9751	0.0761	0.84	1.1318	0.7401
<i>Self-perceived health * Emotional closeness * homemaker</i>	1.0038	0.0401	0.9279	1.086	0.9247
Intercept	9.9586	0.0854	8.4236	11.7733	0.000
alpha	0.6074	0.0255	0.5594	0.6595	
n – unweighted			44,840		
N – weighted			112,626,161		
Number of strata (countries)			16		
Number of primary sampling units (households)			33,160		

IRR = incidence rate ratio

95%-confidence interval

alpha = estimate of dispersion parameters

Age, social integration, contact frequency and closeness are centered at the mean

n = number of observations; N = population size based on survey design

Observations with missing values were dropped (listwise deletion).

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6-7, 9-10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-9
Bias	9	Describe any efforts to address potential sources of bias	6-7, 9-10
Study size	10	Explain how the study size was arrived at	6-7, 9-10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-9, 10-11, Table 1, Supplement Table 2-4
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9-10
		(b) Describe any methods used to examine subgroups and interactions	9-10
		(c) Explain how missing data were addressed	7, 9-10, Supplement Table 2-4
		(d) If applicable, describe analytical methods taking account of sampling strategy	9-10

		(e) Describe any sensitivity analyses	Supplement Table 1; Appendix 1
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-7, 10-11, Table 1
		(b) Give reasons for non-participation at each stage	6, 10-11, Table 1
		(c) Consider use of a flow diagram	Table 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-11, Table 1
		(b) Indicate number of participants with missing data for each variable of interest	10-11, Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	10-11, Table 1
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Figures 1-8, Supplement Tables 2-4
		(b) Report category boundaries when continuous variables were categorized	10-11, Table 1
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Appendix 1-3
Discussion			
Key results	18	Summarise key results with reference to study objectives	15-17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18-20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	20-21
Generalisability	21	Discuss the generalisability (external validity) of the study results	21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.