ORIGINAL RESEARCH

Long-Term Conditions in Older People are Linked with Loneliness, but a Sense of Coherence Buffers the Adverse Effects on Quality of Life: A Cross-Sectional Study

Hugo C van Woerden [1,2]
Neil Angus[2]
Vasiliki Kiparoglou[3]
Iain Atherton[4]
Janni Leung[5]

[1]University of the Highlands and Islands, Centre for Health Science, Inverness, IV2 3JH, UK; [2]Ulster University, Coleraine, County Londonderry, BT52 1SA, Northern Ireland, UK; [3]National Institute of Health Research Oxford Biomedical Research Centre, Unipart House Business Centre, Oxford, OX4 2PG, UK; [4]Edinburgh Napier University, Edinburgh, EH11 4BN, UK; [5]University of Queensland, St Lucia, QLD, 4067, Australia

Background: The impact of disability, long-term conditions, rurality, living alone, and being a carer on health has some evidence base, but the extent to which a strong sense of coherence (SoC), a factor hypothesised to promote wellbeing, may moderate these associations is unknown. A model of physical, environmental and social factors on quality of life was tested, with particular emphasis on whether a strong SoC buffered (mitigated) these determinants of quality of life.

Material and Methods: A cross-sectional postal survey was undertaken of a random sample of 1471 respondents aged over 65 years, across a population of rural individuals. Physical, environmental, and psychological variables were assessed against quality of life using ANOVA and a generalised linear model including the interaction effects of SoC.

Results: ANOVA demonstrated that age, gender, long-term conditions or disability (LTC-D), living alone, >20 hours unpaid care for others per week, SoC, and loneliness, were associated with lower quality of life ($p<0.01$). There were strong correlations ($p>0.01$), between age and LTC-D, living alone, and poor SoC. Living alone was correlated with emotional and social loneliness; but those with higher SoC were less likely to experience loneliness. In an adjusted generalised linear model, significant associations with a lower quality of life were observed from: LTC-D, emotional loneliness and social loneliness (B= −0.44, −0.30, and −0.39, respectively, all $p<0.001$). The only interaction with SoC that was statistically significant (at $p<0.05$) was LTC-D. A stronger sense of coherence buffered the negative effects of long-term condition/disability on quality of life.

Discussion: The physical, environmental and social factors examined, identified LTC-D and loneliness to be the strongest factors associated with poor quality of life.

Conclusion: SoC somewhat buffered the adverse effect of LTC-D on quality of life, but did not do so for loneliness.

Keywords: loneliness, social loneliness, disability, rurality, quality of life

Introduction

A significant proportion of older people are affected by a long-term condition/ disability. This issue is of significant policy interest, as there is increasing recognition that there is a need to understand the different factors that contribute to quality of life in this population. Loneliness is an important potential factor in this context,[1] but quality of life in older populations is affect by a wide range of other factors

Correspondence: Hugo C van Woerden
Email Hugo.VanWoerden@uhi.ac.uk

including social isolation,[2] disability,[3] long-term conditions,[4] living alone, or being a carer.[5] Rurality is another factor that may be associated with poorer health outcomes,[6] but the picture is complicated, as there is also evidence that rural communities can provide each other with greater support.[7] Relatively little research has been undertaken to understand the interactions between these factors, and they have therefore been incorporated in this study.

Measuring "quality of life" as an outcome is complex, and it should be acknowledged that simplistic assumptions that a long-term condition/disability inevitably leads to a poor quality of life is incorrect.[8] Although quality of life is sometimes restricted to health-related quality of life,[9] we have used the term in a much wider sense based on a single validated question.[10,11] This may be because the components that constitute quality of life reflect changing life goals, and an inherent capacity to adjust to loss during the life course. Quality of life in the presence of a long-term condition/disability may also be influenced by factors such as a sense of meaning, purpose, and a sense of being valued, which are incorporated in the model underpinning salutogenesis.[12] Salutogenesis in effect refers to something that generates health and well-being. The term was developed to describe the capacity to cope in the face of adversity, which was studied by Antonovsky, who investigated holocaust survivors after the Second World War, and sought to understand the characteristics that had been most significant in those who survived.[13] He characterised these factors as "saluto-genic", and emphasised the importance of a personal sense of coherence.

A sense of coherence may be defined as,

> The extent to which one has a pervasive, enduring though dynamic, feeling of confidence that one's environment is predictable and that things will work out as well as can reasonably be expected.[14,15]

Antonovsky suggested that sense of coherence is composed of three factors: comprehensibility, manageability, and meaningfulness. Expressed in greater detail,

> comprehensibility is the extent to which events are perceived as making logical sense, that they are ordered, consistent, and structured. Manageability is the extent to which a person feels they can cope. Meaningfulness is how much one feels that life makes sense, and challenges are worthy of commitment.[16]

There are a wide range of concepts that overlap with sense of coherence including mastery, resilience and hardiness.[17] However, the concept of a sense of coherence has stood the test of time and has therefore been used in this paper.

Loneliness is most often assessed using the De Jong-Gierveld loneliness scale, which has six items and can be split into two three-item scales covering emotional loneliness and social loneliness.[21] The distinction is important in certain contexts, as someone can be socially lonely, with few friends or family but not feel emotionally lonely. The reverse is also possible.

The geographical context for this study, NHS Highland, is very rural. NHS has a low population density, covering 41% of the land mass of Scotland, but with only a population of 320,000. There is one small city, a number of market towns, many small towns and villages, and 26 inhabited islands. The effect of rurality on the interplay between different factors affecting quality of life was therefore of interest to this study.

The impact of disability, long-term conditions, rurality, living alone, and being a carer on health has some evidence base, however, the extent to which these factors might be buffered by a strong SoC is unknown. To explore this, we hypothesised a model of physical, environmental and social factors, and sought to examine whether SOC buffers any of these factors, in terms of their impact on quality of life, in the context of older people (65+) in a rural Scottish Health Board.

Methods
Study Design
A cross-sectional survey was undertaken of a random sample of 3000 households across a defined area of the north of Scotland (NHS Highland). The survey sample frame was drawn from the set of all patients registered with GP practices within the health board, where there was known to be at least one individual in the household over 65 years. The sample size was designed to be adequate to identify differences in characteristics in relevant subgroups, based on a power analysis undertaken by an epidemiologist, based on a minimum 25% response rate to achieve a minimum sample size of 750 respondents with consent and valid data. A questionnaire was drawn up which included the De Jong-Gierveld loneliness scale,[21] the three-item sense of coherence scale,[20,23] demographic data, and a single item quality of life question, "How is your quality of life?" with responses, excellent, good, fair,

poor, very poor.[24] The three items in the sense of coherence scale are: "Do you usually see a solution to problems and difficulties that other people find hopeless?"; "Do you usually feel that the things that happen to you in your daily life are hard to understand?"; and "Do you usually feel that your daily life is a source of personal satisfaction?" with response choices of "yes usually, yes sometimes, no".

Population surveys need to be kept short to improve completion rates. It is therefore welcome that the original 29-item sense of coherence scale was later reduced to 13 items and has more recently been reduced to a three item scale.[19,20] The three item sense of coherence scale has consequently been used in this study. Measuring rurality in Scotland is generally undertaken using an eight, six or three category index. For the purposes of this study, the index was collapsed into three categories, which is standard practice for this index.[22]

The survey was posted with a reply envelope. A single reminder was also sent. We asked that the questionnaire be completed by or on behalf of the oldest member of the household.

Participants

Participants had a mean age of 74.4 (SD=7.01). From the 3000 surveys issued, 1547 were returned, a response rate of 51.6%. Sixty-five responses were excluded due to consent for research purposes being withheld, and a further 11 were excluded due to missing data on the quality of life question (our key outcome measure). The final sample size for this study was N = 1471 (see flow chart in Figure 1).

Variables

Physical variables examined included age (10-year age intervals), gender, and long-term condition/disability (yes or no). Environmental variables examined included rurality ("other urban areas"; "small towns, accessible rural, or remote rural"; "very remote rural"), living alone, and being a carer for others ("no or <20 hours"; "yes 20 hours+"). The majority (96%) of participants in the "no or <20 hours" belonged in the "no care" category. Among those who provided some but <20 hours of care, the sample size was small, with the majority providing only a small number of hours of care, and their profile was more similar to those in the "no care" category, therefore they were combined into one group for analytical purposes. Psychological variables examined included sense of coherence (classed as "weak" (scores 6–9), "intermediate" (scores 4–5) and "strong" (score 3 or less), and three
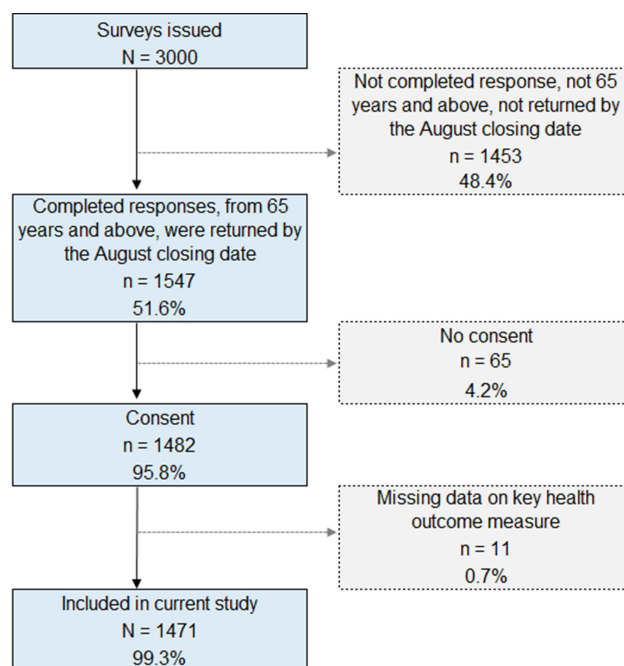
Figure 1 Flowchart of participants.

loneliness scales - "emotional loneliness", "social loneliness" and "overall loneliness" (in each loneliness scale scores >1 SD above the mean were categorised as "high"). Quality of life (scored 1–5, from very poor to excellent) was used as the outcome variable.

A range of studies have demonstrated that sense of coherence can have main, moderating, and mediating effects on health and quality of life,[18] and this project therefore sought to assess any buffering effect that a sense of coherence might have on associations with quality of life, in the context of a population survey.

Statistical Analysis

Descriptive statistics analysis was undertaken and the pattern of missing data in participants was examined. Missing data were below 5% for the physical and environmental factors, and sense of coherence (Table S1 in the supplementary file). However, there was a moderately high level of missing data for the loneliness scales, ranging from 22.9% - 29.8%, due to the absence of at least one answer to the six relevant answers making up the three scales for "social loneliness" (3 questions), "emotional loneliness" (3 questions) and "overall loneliness" (combined 6 questions).

To address potential bias from missing data across the loneliness scales, missing data analyses were conducted. Missing data in the loneliness scales were associated with

older age (p<0.001), female gender (p=0.012), disability (p<0.001), living alone (p=0.001), and lower quality of life (p=0.006). Multiple imputations to handle missing data was the best option because we did not have very high levels of missing data (<40%) and we had identified correlates of the missing data. We also compared levels of loneliness in the baseline data set, against the data set including imputed values, where multiple imputation was used to impute missing values drawing on all the variables of interest in our a priori defined model. In confirmation of our assumption, levels of loneliness were lower in the baseline data set than in the imputed data set. Based on this finding, multiple imputation was used for the analysis presented in this paper.

Bivariate associations between "quality of life" and physical, environmental, and psychological variables were examined by conducting ANOVAs for categorical variables. A correlation matrix was used to examine collinearity among physical, environmental, and psychological variables.

Our level of missing data for the loneliness scale was higher than that of our other measures but were lower than the upper threshold of >40% where multiple imputation would be inappropriate. In our case where we had 22.9–29.8% of missing data on loneliness, <5% of missing data on other variables, and that we were able to identify correlates of our missing data, we conclude that multiple imputation was the best option.[25]

The main analysis for this paper was a generalised linear model with the physical, environmental, and psychological variables as the exposure variables, and "quality of life" as the outcome. The model included testing for interaction effects between physical, environmental, and psychological exposure variables and "sense of coherence" in relation to the outcome of "quality of life". The analysis was undertaken in SPSS 25.

Results
Descriptive Statistics and Characteristics of Sample
There was a spread of age across participants, with about half in the 70–79 age group, and the sex distribution was fairly equal (Males 48.4%) (see Table 1. Over half had a long-term condition/disability. Proportions of participants by rurality of residence were: 21.5% living in "other urban areas"; 42.4% in "small towns,

Table 1 Descriptive Statistics of Participants' Physical, Environmental, and Psychological Characteristics

Physical	%
Age groups	
60–69	29.7
70–79	47.3
80+	23.0
Male	48.4
Long-term condition or disability	61.4
Environmental	
Rurality	
Other urban areas	21.5
Small towns, accessible rural, and remote rural	42.4
Very remote rural	36.0
Living alone	30.1
Unpaid care for others 20+ hrs per week	6.6
Psychological	
Sense of coherence	
Weak	20.5
Intermediate	46.8
Strong	32.7
High levels of loneliness (1 SD or more above the mean)	
Overall	21.8
Emotional	17.2
Social	20.9
Quality of life; Mean [SD]	3.97 [0.77]

accessible rural, and remote rural"; and 36% in "very remote rural areas". Seventy percent of the participants were not living alone, and 6.6% of participants provided 20 hours or more per week of unpaid care for others. Overall, participants reported moderate levels of sense of coherence, and moderately high levels of quality of life. Approximately 20% reported high levels of loneliness.

Bivariate Associations with Quality of Life
Lower levels of quality of life were significantly associated with older age, female gender, having a long-term condition/disability, living alone, providing unpaid care for others for 20 hours or more per week, low sense of coherence, and high levels of loneliness (Table 2). Quality of life did not differ by level of rurality.

Table 2 Bivariate Associations of Physical, Environmental, and Psychological Variables with Quality of Life

Characteristics	Quality of Life		Anova	
	Mean	SD	F	p
Age group				
60–69	4.12	0.72	22.67	<0.001
70–79	3.98	0.74		
80+	3.75	0.83		
Gender				
Female	3.90	0.77	8.58	<0.001
Male	4.05	0.75		
Long-term condition/disability				
No	4.26	0.74	143.35	<0.001
Yes	3.79	0.70		
Rurality				
Other urban areas	3.98	0.79	0.44	0.668
Small towns, accessible rural, and remote rural	3.98	0.76		
Very remote rural	3.95	0.76		
Living alone				
Yes	3.78	0.77	37.56	<0.001
No	4.05	0.78		
Unpaid care for others per week				
0–<20 hrs	3.99	0.76	16.79	<0.001
20 hrs+	3.66	0.77		
Sense of coherence				
Weak	3.31	0.79	246.41	<0.001
Intermediate	3.96	0.65		
Strong	4.40	0.59		
Overall loneliness				
Low	4.08	0.75	175.11	<0.001
High (1 SD or more above the mean)	3.48	0.74		
Emotional loneliness				
Low	4.09	0.75	212.97	<0.001
High (1 SD or more above the mean)	3.36	0.73		
Social loneliness				
Low	4.10	0.76	195.60	<0.001
High (1 SD or more above the mean)	3.46	0.74		

Inter-Correlation Between Exposure Variables

Inter-correlation between exposures were moderate for the loneliness scales, and very low to moderately low for all other variables (see Table 3). Sense of coherence was negatively associated with age, long-term condition/disability, unpaid care for others of 20+ hours per week, and loneliness, but positively associated with male gender and not living alone. Overall loneliness was more strongly associated with emotional loneliness subscale than social loneliness subscale of the De Jong-Gierveld loneliness scale, while the correlation between emotional and social loneliness was weak and not statistically significant, allowing both types of loneliness to be entered into a generalised linear model as separate constructs.

Main and Interaction Effects on Quality of Life

In the fully adjusted model, significant main effects indicated that those who were female, had a long-term condition/disability, and had higher emotional or social loneliness, were associated with a lower quality of life (see Table 4).

Discussion

Some aspects of our a priori model were confirmed by our statistical analysis, whilst others were not. Model variables including age, gender, long-term condition/disability, living alone, providing more than 20 hours unpaid care for others per week, sense of coherence, overall loneliness, social loneliness and emotional loneliness, were strongly associated with quality of life, but perhaps surprisingly level of rurality was not. There are challenges in measuring rurality, as any approach inevitably averages households over a given geographical area and there may be subtle effects that have been overlooked by our current categorization into three levels of rurality.[26]

An interesting cluster of relationships identified in this study was the relationship between "long-term condition/disability" with: age; living alone; overall loneliness; emotional loneliness; social loneliness; and a low sense of coherence. This is an extensive list of negative attributes,

Table 3 Correlation Matrix of Physical, Environmental, and Psychological Exposure Variables (P<0.05 in Blue and P<0.01 in Red)

	Age	Male Gender	Long-Term Condition/ Disability	Rurality	Not Living Alone	Unpaid Care for Others 20+ hrs per Week	Overall Loneliness	Emotional Loneliness	Social Loneliness	Sense of Coherence
Age	1.00									
Male gender	−0.04	1.00								
Long-term condition/ disability	0.16	0.06	1.00							
Rurality	−0.01	−0.02	−0.02	1.00						
Not living alone	−0.16	0.21	−0.08	0.10	1.00					
Unpaid care for others 20 + hrs per week	−0.01	−0.04	−0.01	0.02	0.14	1.00				
Overall loneliness	0.04	−0.10	0.12	−0.01	−0.17	0.06	1.00			
Emotional loneliness	0.07	−0.12	0.13	−0.03	−0.21	0.02	0.67	1.00		
Social loneliness	−0.01	0.00	0.08	0.01	−0.12	0.09	0.48	0.24	1.00	
Sense of coherence	−0.11	0.09	−0.15	−0.01	0.12	−0.07	−0.25	−0.34	−0.28	1.00

describing the huge challenges faced by an aging population who have a long-term condition/disability. Similarly, in our generalized linear model, a contributor to lower quality of life was long-term condition/disability.

Those with a high sense of coherence were less likely to have emotional or social loneliness. This is perhaps unsurprising, as salutogenesis proposes that "general resistance resources" underpin a sense of coherence. Resistance resources include interpersonal-relational skills, which would be expected to lead to more extensive social networks and hence lower levels of loneliness.[27]

The response rate, at 51.6%, was reasonable for a survey of this nature, but still leaves the possibility of bias in relation to those who did not respond. A comparison of the characteristics of the survey population, the responding population, and the underlying sample frame, is provided in the Supplementary Material (Table S2 in the supplementary file), and provides some evidence that the respondents were representative of the population.

We note as a limitation that the six questions on loneliness were variably completed, perhaps because some participants appear to have thought that only some of the set of six loneliness questions needed to be answered. This misunderstanding may have arisen because each of the six loneliness questions did not have a specific question number assigned within the questionnaire, they were all clustered under one question number. There is potential learning for the way in which questions in a questionnaire are numbered that could be drawn from

Table 4 Generalized Linear Model on Quality of Life Testing the Main Effects of Physical, Environmental, and Psychological Variables, and Their Interaction with Sense of Coherence

	B	**SE**	**Lower**	**Upper**	**p**
Main effects					
Age	−0.08	0.05	−0.17	0.01	0.075
Male gender (a)	0.14	0.06	0.01	0.27	0.030
Long-term condition/disability (b)	−0.44	0.07	−0.57	−0.31	<0.001
Rurality	0.02	0.04	−0.07	0.10	0.705
Not living alone	0.01	0.07	−0.13	0.14	0.890
Unpaid care for others 20+ hrs per week	−0.14	0.11	−0.36	0.08	0.218
Emotional loneliness (b)	−0.30	0.08	−0.45	−0.14	<0.001
Social loneliness (b)	−0.39	0.07	−0.52	−0.25	<0.001
Sense of coherence	0.40	0.27	−0.12	0.92	0.134
Interaction with sense of coherence					
Age	−0.01	0.03	−0.08	0.06	0.775
Male gender	−0.05	0.05	−0.15	0.04	0.279
Long-term condition/disability (a)	0.10	0.05	0.01	0.20	0.037
Rurality	−0.04	0.03	−0.11	0.03	0.268
Not living alone	0.04	0.05	−0.07	0.15	0.468
Unpaid care for others 20+ hrs per week	−0.08	0.09	−0.27	0.11	0.396
Emotional loneliness	0.02	0.08	−0.13	0.18	0.754
Social loneliness	0.04	0.06	−0.08	0.16	0.523

Note: (a) refers to p<0.05; (b) refers to p<0.01. A significant interaction was observed between "long-term condition/disability" and "sense of coherence" in relation to the outcome of "quality of life".

this study. As a result of missing data, some interpolation was undertaken, which should be noted as having some risk of bias associated with it, although our investigation of the issue indicates that it would have diluted any findings, and the risk of a Type 1 error, identifying an association that is not present, therefore appears to be relatively low. It can be argued that failure to address missing data would provide a greater risk of bias than the use of multiple interpolation. We asked that the questionnaire be completed by or on behalf of the oldest member of the household, but do not know what percentage were filled in by proxies, which may have affected the results.

This study is novel in examining the relationship between the presence of a long-term condition/disability and loneliness in an older rural population. A comparably study was identified, which examined the relationship between loneliness and depressive symptoms in nursing homes, and demonstrated a relationship with resilience and social support, which is broadly consistent with the findings in this study.[28] Another study found the moderating effects of the "subjective perception of how long an

individual expects to live", which is a concept that overlaps with salutogenesis.[29]

A key question is what interventions can be put in place to address the needs of those with long-term conditions/disability in older populations, particularly where this is associated with living alone, and the associated risk of loneliness. Several reviews have identified a range of health promotion activities that can make a difference.[30,31] One study identified public sector savings of up to £300 per year for individuals receiving befriending support. Similarly, in selected groups, arts-based community activities have been shown to significantly reduce the need for acute hospital care.[32]

Health and social care systems have a growing challenge in supporting an elderly and lonely population who have long-term conditions or disability, who have high care needs. Population projections indicate that the numbers in this sector of the population will grow rapidly in developed countries over the next two decades.[33] From a policy perspective, there is a growing need to understand interactions between different factors that affect the rising

numbers of older people in the population who have a long-term condition/disability. This study has sought to explore some of these factors in a rural context, and identified some important associations and explain the complex interaction between different factors, which in part explains why some very elderly and disabled individuals thrive while others do not.

Data Sharing Statement

The data set is available from the corresponding author.

Ethics Approval and Informed Consent

Ethical approval was obtained from South Central - Oxford B Research Ethics Committee, reference 16/SC/0356. Consent was obtained as part of the survey form. Participants were informed about the purpose of the study. The study was undertaken in accordance with the Declaration of Helsinki.

Disclosure

The authors have no competing interests to declare.

References

1. Piccirillo JF, Vlahiotis A, Barrett LB, Flood KL, Spitznagel EL, Steyerberg EW. The changing prevalence of comorbidity across the age spectrum. *Crit Rev Oncol Hematol*. 2008;67(2):124–132. doi:10.1016/j.critrevonc.2008.01.013
2. Breheny M, Stephens C. Social policy and social identities for older people. In: *The SAGE Handbook of Applied Social Psychology*. London: Sage. 2019 Jan 14:347–65.
3. Motl RW, McAuley E. Physical activity, disability, and quality of life in older adults. *Phy Med Rehabil Clin*. 2010;21(2):299–308.
4. Heyworth IT, Hazell ML, Linehan MF, Frank TL. How do common chronic conditions affect health-related quality of life? *Br J Gen Pract*. 2009;59(568):e353–e358. doi:10.3399/bjgp09X453990

5. Rees J, O'Boyle C, MacDonagh R. Quality of life: impact of chronic illness on the partner. *J R Soc Med*. 2001;94(11):563–566. doi:10.1177/014107680109401103
6. Garcia MC, Faul M, Massetti G, et al. Reducing potentially excess deaths from the five leading causes of death in the rural United States. *MMWR Surveill Summ*. 2017;66(2):1. doi:10.15585/mmwr.ss6602a1
7. Henning-Smith C, Moscovice I, Kozhimannil K. Differences in social isolation and its relationship to health by rurality. *J Rural Health*. 2019;35(4):540–549. doi:10.1111/jrh.12344
8. Albrecht GL, Devlieger PJ. The disability paradox: high quality of life against all odds. *Soc Sci Med*. 1999;48(8):977–988. doi:10.1016/S0277-9536(98)00411-0
9. Ferrans CE, Zerwic JJ, Wilbur JE, Larson JL. Conceptual model of health-related quality of life. *J Nurs Scholarsh*. 2005;37(4):336–342. doi:10.1111/j.1547-5069.2005.00058.x
10. Khanna D, Tsevat J. Health-related quality of life-an introduction. *Am J Manag Care*. 2007;13(9):S218.
11. Balestroni G, Bertolotti G. EuroQol-5D (EQ-5D): an instrument for measuring quality of life. *Monaldi Arch Chest Dis*. 2012;78(3).
12. Sarvimäki A, Stenbock-Hult B. Quality of life in old age described as a sense of well-being, meaning and value. *J Adv Nurs*. 2000;32(4):1025–1033. doi:10.1046/j.1365-2648.2000.01568.x
13. Lindström B, Eriksson M. Salutogenesis. *J Epidemiol Community Health*. 2005;59(6):440–442. doi:10.1136/jech.2005.034777
14. Antonovsky A. *Unraveling the Mystery of Health: How People Manage Stress and Stay Well*. Jossey-bass; 1987.
15. Antonovsky A. The structure and properties of the sense of coherence scale. *Soc Sci Med*. 1993;36(6):725–733. doi:10.1016/0277-9536(93)90033-Z
16. Collingwood J. Your sense of coherence. Can your 'sense of coherence' influence your health? Psych Central. Available from: https://psychcentral.com/lib/your-sense-of-coherence/. Accessed February 20, 2019.
17. Almedom AM. Resilience, hardiness, sense of coherence, and post-traumatic growth: all paths leading to "light at the end of the tunnel"? *J Loss Trauma*. 2005;10(3):253–265. doi:10.1080/15325020590928216
18. Eriksson M, Lindström B. Antonovsky's sense of coherence scale and the relation with health: a systematic review. *J Epidemiol Community Health*. 2006;60(5):376–381. doi:10.1136/jech.2005.041616
19. Hittner JB. Factorial invariance of the 13-item sense of coherence scale across gender. *J Health Psychol*. 2007;12(2):273–280. doi:10.1177/1359105307074256
20. Schumann A, Hapke U, Meyer C, Rumpf HJ, John U. Measuring sense of coherence with only three items: a useful tool for population surveys. *Br J Health Psychol*. 2003;8(4):409–421. doi:10.1348/135910703770238275
21. Gierveld JDJ, Tilburg TV. A 6-item scale for overall, emotional, and social loneliness: confirmatory tests on survey data. *Res Aging*. 2006;28(5):582–598. doi:10.1177/0164027506289723
22. Scottish Government. Defining Scotland by Rurality; September 30, 2019. Available from: https://www2.gov.scot/Topics/Statistics/About/Methodology/UrbanRuralClassification. Accessed August 17, 2021
23. Lundberg O, Peck MN. A simplified way of measuring sense of coherence: experiences from a population survey in Sweden. *Eur J Public Health*. 1995;5(1):56–59. doi:10.1093/eurpub/5.1.56
24. Guyatt GH, Feeny DH, Patrick DL. Measuring health-related quality of life. *Ann Intern Med*. 1993;118(8):622–629. doi:10.7326/0003-4819-118-8-199304150-00009
25. Jakobsen JC, Gluud C, Wetterslev J, Winkel P. When and how should multiple imputation be used for handling missing data in randomised clinical trials–a practical guide with flowcharts. *BMC Med Res Methodol*. 2017;17(1):1–10. doi:10.1186/s12874-017-0442-1
26. Mountrakis G, AvRuskin G, Beard K. Modeling rurality using spatial indicators; 2005.

27. Langeland E, Wahl AK, Kristoffersen K, Hanestad BR. Promoting coping: salutogenesis among people with mental health problems. *Issues Ment Health Nurs*. 2007;28(3):275–295. doi:10.1080/01612840601172627

28. Zhao X, Zhang D, Wu M, et al. Loneliness and depression symptoms among the elderly in nursing homes: a moderated mediation model of resilience and social support. *Psychiatry Res*. 2018;268:143–151. doi:10.1016/j.psychres.2018.07.011

29. Bodner E, Bergman YS. Loneliness and depressive symptoms among older adults: the moderating role of subjective life expectancy. *Psychiatry Res*. 2016;237:78–82. doi:10.1016/j.psychres.2016.01.074

30. Findlay RA. Interventions to reduce social isolation amongst older people: where is the evidence? *Ageing Soc*. 2003;23(5):647–658. doi:10.1017/S0144686X03001296

31. Cattan M, White M, Bond J, Learmouth A. Preventing social isolation and loneliness among older people: a systematic review of health promotion interventions. *Ageing Soc*. 2005;25(1):41–67. doi:10.1017/S0144686X04002594

32. Pitkala KH, Routasalo P, Kautiainen H, Tilvis RS. Effects of psychosocial group rehabilitation on health, use of health care services, and mortality of older persons suffering from loneliness: a randomized, controlled trial. *J Gerontol a Biol Sci Med Sci*. 2009;64(7):792–800. doi:10.1093/gerona/glp011

33. Lafortune G, Balestat G. *Trends in Severe Disability Among Elderly People: Assessing the Evidence in 12 OECD Countries and the Future Implications*. OECD Health Working Papers, OECD Publishing; Paris. 2007:1–80. doi:10.1787/217072070078