



Original Research

Impact of continuity of care on older adults diagnosed with mental and behavioural disorders at risk of death due to intentional self-harm: a retrospective Korean cohort study

I. Yun ^{a, b}, H. Kim ^{b, c, d}, E.-C. Park ^{b, c, *}^a Department of Public Health, Graduate School, Yonsei University, Seoul, Republic of Korea^b Institute of Health Services Research, Yonsei University, Seoul, Republic of Korea^c Department of Preventive Medicine, Yonsei University College of Medicine, Seoul, Republic of Korea^d Department of Psychiatry, Yonsei University College of Medicine, Seoul, Republic of Korea

ARTICLE INFO

Article history:

Received 23 July 2023

Received in revised form

17 January 2024

Accepted 25 January 2024

Available online 19 February 2024

Keywords:

Elderly suicide rate

Death due to intentional self-harm

Mental health

Continuity of care

CoC index

UPC index

ABSTRACT

Objectives: The aim of this study was to evaluate the impact of continuity of care on older adults diagnosed with mental and behavioural disorders who are at risk of death due to intentional self-harm.

Study design: This was a retrospective cohort study.

Methods: Data from the Korean National Health Insurance Service-Elderly Cohort Database (2002–2013) were used. A total of 53,980 patients who had visited the outpatient clinic three or more times within the year following the initial diagnosis of mental and behavioural disorders were included. A generalised estimating equation model was generated to examine the impact of continuity of care (CoC) on the risk of death due to intentional self-harm among older adults with mental illnesses.

Results: The risk of death due to intentional self-harm was significantly higher in those with poor CoC for mental and behavioural disorders than in those with good CoC. The risk ratio, adjusting for all covariates, was larger for the Usual Provider of Care index (adjusted risk ratio [aRR]: 1.63, 95% confidence interval [CI]: 1.25–2.12) than for the CoC index (aRR: 1.50, 95% CI: 1.18–1.90), indicating a stronger association with the concentration of contact with the most frequently visited provider.

Conclusions: Poor CoC among Korean older adults diagnosed with mental and behavioural disorders was identified as a significant risk factor for death due to intentional self-harm. The results of this study highlight the need for interventions that can prevent suicidal behaviour in older adults, such as institutionalising the usual providers of mental health care for older adults.

© 2024 The Authors. Published by Elsevier Ltd on behalf of The Royal Society for Public Health. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

Introduction

With a rapidly ageing global population, several issues have emerged as a result of the social isolation experienced by older adults. Among the various issues linked to social isolation, the late-in-life attempt of self-harm or suicide stands out as a major problem faced by older adults. In particular, South Korea, renowned for being the world's fastest-ageing country, has the highest suicide rate of adults aged ≥ 60 years compared with other Organisation for Economic Co-operation and Development (OECD) countries, with a

rate of 46.6 deaths per 100,000 persons as of 2022.¹ This is approximately 2.7 times higher than the OECD average of 17.2 deaths per 100,000 persons.²

Suicide and self-harm are not solely attributable to a single cause; rather, they arise from the intricate interplay of multiple factors that occur over a person's lifetime. These factors differ according to sex, age, ethnicity and geographical location.³ Numerous studies have identified risk factors for suicide attempts following intentional self-harm among older adults. According to their findings, poor physical health conditions, such as chronic illness, severe pain and physical disabilities, can increase the risk of suicidal behaviours.^{4,5} Several studies have confirmed the significant effects of social isolation and loneliness on suicidal ideation and attempts in older adults.^{6–8} Loss of social connections, such as the death of a spouse or friends, retirement or reduced mobility, can exacerbate these feelings. In

* Corresponding author. Department of Preventive Medicine & Institute of Health Services Research, Yonsei University College of Medicine 50-1 Yonsei-to, Seodaemun-gu, Seoul 03722, Republic of Korea. Tel.: +82 2228 1862.

E-mail address: ecpark@yuhs.ac (E.-C. Park).

addition, mental health disorders, including depression, are known to be one of the major determinants of suicide and self-harm in older adults.^{9,10} These conditions may go undiagnosed or remain untreated, leading to increased vulnerability.

Among the numerous prominent intricate factors that impact self-harm and suicide attempts in older adults, this study specifically focused on the management of mental and behavioural disorders in late life. This focus was chosen because a considerable number of older adults do not visit the hospital despite experiencing poor mental health. Moreover, Korea does not have an established primary care physician system that can provide personal care for the mental health of the elderly. Therefore, even if a person is diagnosed with mental illness, the lack of consistent treatment may escalate the risk of intentional self-harm leading to death. Furthermore, a few nationwide studies have demonstrated the importance of continuous treatment by the usual mental health providers among older adults, serving as a preventive measure against self-harm and suicide.

This retrospective cohort study aimed to explore the association between the continuity of care (CoC) for mental and behavioural disorders and mortality due to intentional self-harm. Through the analysis of large-scale elderly cohort data in South Korea, this study attempted to establish a basis for public health policy for mental health care that could prevent suicide in older people.

Methods

Data and study population

This retrospective cohort study used data from the Korean National Health Insurance Service-Elderly Cohort Database (NHIS-ECD) between 2002 and 2013. The Korean NHIS provides researchers access to comprehensive medical claims data for academic research and policy development.¹¹ The NHIS-ECD consists of the medical claims records of 558,147 people aged ≥ 60 years in South Korea, randomly selected to represent 10% of the total eligible population in 2002.¹² This database includes information on socio-economic characteristics and medical use history based on the clinically determined *International Classification of Diseases, 10th revision* (ICD-10) diagnosis codes and deaths of older adults in Korea. Because the NHIS-ECD data did not contain any identifying information, the need for informed consent was waived by the Institutional Review Board of Yonsei University's Health System (IRB No. 4-2021-0833).

The study population was selected based on the following criteria: first, only patients who were newly diagnosed with mental and behavioural disorders (ICD codes: F00–F99) between 2004 and 2012 were included. The first 2 years of cohort data were designated as the washout period (2002 and 2003) because treatment received during this time might be a result of pre-existing conditions.¹³ In addition, to secure a time interval of at least 1 year to measure the CoC, individuals who were diagnosed with mental and behavioural disorders for the first time after January 2013 were excluded from the analysis. Second, patients who died within 1 year of the first diagnosis of mental and behavioural disorders were excluded because the CoC could not be measured. Third, only patients who had three or more outpatient visits during the first year following initial diagnosis were included. After excluding all missing values, a total of 53,980 patients were eligible for the analysis.

Variables

The outcome variable was death due to intentional self-harm, defined as the cause of death, coded with ICD-10 codes X60–X84. Because of concerns about personal identification, information on the detailed causes of intentional self-harm was not provided by

the Korean NHIS. Intentional self-harm refers to causes of death that include purposely self-inflicted poisoning or injury and suicide (attempted).¹⁴

The main variable of interest was the CoC for mental and behavioural disorders, which was measured by considering the characteristics of the Korean medical delivery system, in which patients can freely choose their preferred primary care provider without restriction.¹⁵ This study defined CoC in two ways: first, using the CoC index score, proposed by Bice et al.,¹⁶ which stands for the concentration of patient visits to individual physicians and has been extensively applied in studies using claims data sets.^{17–19} The second is the Usual Provider of Care (UPC) index, which indicates the concentration of a patient's total visits to the most common provider of care.²⁰ The formulas used to calculate the CoC and UPC indices were as follows:

$$\text{CoC Index} = \frac{\sum_{i=1}^k n_i - N}{N(N-1)}$$

$$\text{UPC Index} = \frac{\max(n_i)}{N}$$

where n_i = the number of visits to the i th provider, k = number of medical providers, N = total number of visits and $\max(n_i)$ = the number of visits the patient has with their most frequently visited provider.^{16,21} Both indices range from 0 to 1, with a value close to 1 indicating a higher degree of care. This study determined an exposure period of 1 year to ensure continuity over time and reflected the CoC and UPC indices of patients with three or more visits. This time frame was chosen because it was assumed that treatment during the first year after the onset of mental and behavioural disorders was imperative. The minimum number of visits was specified for calculating the indices because reaching the maximum value of 1 or the minimum value of 0 is relatively easy with a small number of visits.²² This study defined a cutoff point of 0.75 for both the CoC and UPC indices, which has been extensively validated in previous studies.^{23,24} Thus, patients were categorised as having good or poor CoC depending on whether more or less than 75% of their outpatient visits were with the same physician during the year following their initial diagnosis of mental and behavioural disorders.

As covariates, this study included socio-economic factors, such as sex (men and women), age (range: 60–69, 70–79, and ≥ 80 years), region (metropolitan and urban area, and rural area), income (divided into tertiles: low, middle, and high), type of medical insurance (workplace insured, regionally insured, and medical aid) and Charlson Comorbidity Index scores (range: 0, 1–2, and ≥ 3) reflecting health status, and type of medical facility where care was received (clinic, hospital, general hospital and public health centre).

Statistical analyses

First, the frequencies and percentages of each categorical variable for the study population at baseline were examined. Then, the Chi-squared tests were performed to examine the distribution of the outcome variable according to each covariate. The impact of CoC for mental and behavioural disorders on the risk of death due to intentional self-harm was evaluated using generalised estimating equation (GEE) models. The GEE model considers time variation and addresses the correlation among repeated measurement in a longitudinal study. As key results, the adjusted risk ratios (aRRs) and 95% confidence intervals (CIs) were calculated and presented.^{25,26} For all statistical analyses, SAS software (version 9.4; SAS Institute Inc., Cary, NC, USA) was used; a P -value < 0.05 was considered statistically significant.

Results

Fig. 1 shows a flowchart of the study sample selection. The stratified random sample enrolled in the NHIS-ECD in 2022 included 558,147 individuals, of which 316,858 had claims records for mental and behavioural disorders between 2002 and 2013. Among them, those who were diagnosed with mental and behavioural disorders during the washout period from 2002 to 2003 ($n = 88,732$) and those who visited the outpatient clinic less than three times within the year following the first diagnosis ($n = 134,863$) were excluded. Among the 93,263 initially selected patients, those who were first diagnosed with mental and behavioural disorders after 2013 ($n = 14,729$), those who died within 1 year of the initial diagnosis ($n = 22,301$) and those with missing covariate data ($n = 2,253$) were excluded. In total, 53,980 new-onset patients were included in the study population.

Table 1 presents the general characteristics of the study population. Of the 53,980 individuals eligible for analysis, 293 (0.54%) died due to intentional self-harm. According to the CoC index, 26.6% of patients had poor continuity of care for mental and behavioural disorders. However, based on the UPC index, 17.3% of the patients had poor CoC.

Table 2 presents the results for the factors associated with the outcome variable. The risk of death due to intentional self-harm was significantly higher in older adults with poor CoC for mental and behavioural disorders than in older adults with good CoC (CoC index: aRR 1.50, 95% CI 1.18–1.90; UPC index: aRR 1.63, 95% CI 1.25–2.12). The possibility of death due to intentional self-harm was lower in women than in men and in those aged ≥ 70 years. On the other hand, the highest risk of outcome occurrence was observed when the type of health insurance subscription was medical aid and the type of medical facility used was a clinic.

Sensitivity analyses were also performed by applying different criteria to define the CoC and UPC indices; the results are presented in Table 3. In the main analysis, which explored the association of CoC for mental and behavioural disorders with death due to intentional self-harm, the cutoff of CoC was set at 0.75 to define good and poor. However, in these sensitivity analyses, the criteria for the CoC and UPC indices were set to 0.33 units and 0.5 units, respectively, and reclassified. Regardless of which criterion unit was applied, the risk of an outcome increased linearly as the CoC approached 0 compared with 1, which is a perfect scale. In particular, the statistically highest risk was observed in the range of CoC index between 0 and 0.32 (aRR: 2.56, 95% CI: 1.68–3.90).

Discussion

Among the various intricate factors that affect death by intentional self-harm in older adults, this retrospective cohort study investigated this association by focusing on the CoC for mental and behavioural disorders. The present study results suggest that the risk of death due to intentional self-harm was significantly higher in older adults with poor CoC for mental and behavioural disorders than in those with good CoC. In particular, the risk ratio calculated by adjusting for all covariates was larger based on the UPC index, which indicated the concentration of contact with the most frequently visited provider. These findings suggest that having a dedicated provider for mental health care is crucial for mitigating the risk of death due to intentional self-harm among the elderly. In addition, it may be implied that the UPC index, which takes into account the presence of the usual sources of care and providers, is more useful in measuring CoC for the mental health of the elderly. However, the implementation of this initiative may face challenges in Korea owing to the absence of a well-established healthcare

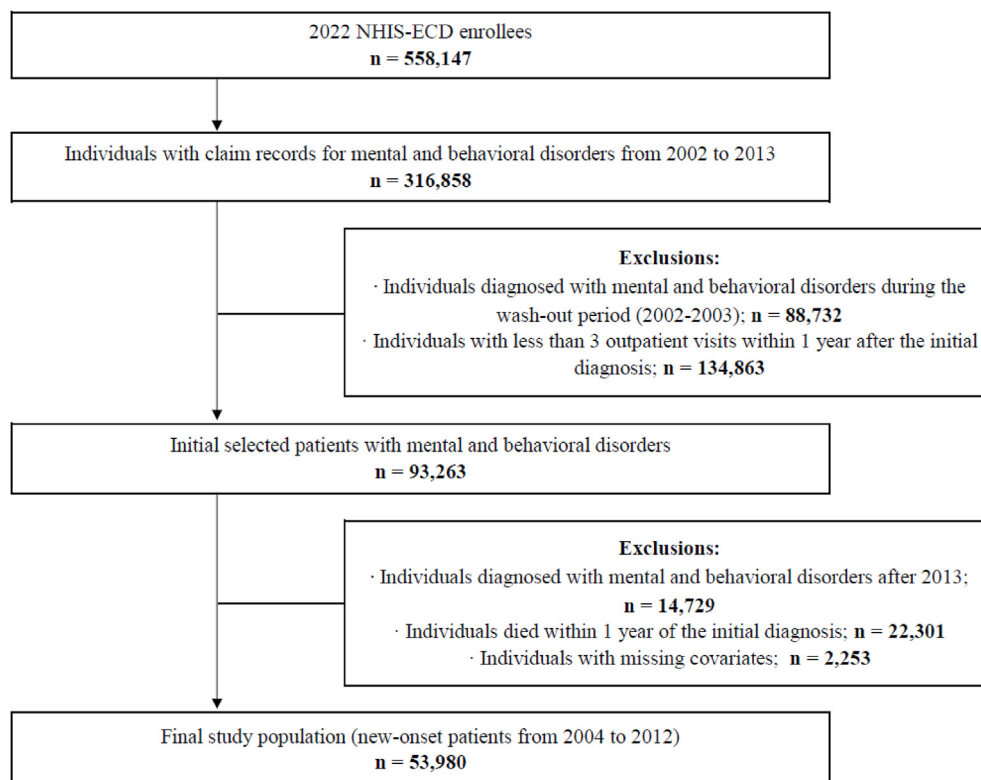


Fig. 1. Flowchart of study sample selection.

Table 1
General characteristics of the study population.

Characteristics	Death due to intentional self-harm						P-value
	Total		Yes (n = 293)		No (n = 53,687)		
	n	%	n	%	n	%	
CoC index							0.002
≥0.75	40,270	74.6	196	0.5	40,074	99.5	
<0.75	13,710	25.4	97	0.7	13,613	99.3	
UPC index							0.001
≥0.75	45,071	83.5	223	0.5	44,848	99.5	
<0.75	8909	16.5	70	0.8	8839	99.2	
Sex							<0.0001
Men	19,728	36.5	168	0.9	19,560	99.1	
Women	34,252	63.5	125	0.4	34,127	99.6	
Age in years							<0.0001
60–69	506	0.9	41	8.1	465	91.9	
70–79	31,512	58.4	161	0.5	31,351	99.5	
≥80	21,962	40.7	91	0.4	21,871	99.6	
Region							0.371
Metropolitan and urban area	30,848	57.1	175	0.6	30,673	99.4	
Rural area	23,132	42.9	118	0.5	23,014	99.5	
Income							0.580
Low	16,684	30.9	94	0.6	16,590	99.4	
Middle	12,309	22.8	72	0.6	12,237	99.4	
High	24,987	46.3	127	0.5	24,860	99.5	
Type of medical insurance							0.298
Workplace insured	32,999	61.1	169	0.5	32,830	99.5	
Regionally insured	14,350	26.6	80	0.6	14,270	99.4	
Medical aid	6631	12.3	44	0.7	6587	99.3	
Charlson Comorbidity Index							0.620
0	11,697	21.7	70	0.6	11,627	99.4	
1–2	38,813	71.9	206	0.5	38,607	99.5	
≥3	3470	6.4	17	0.5	3453	99.5	
Type of medical facility							0.032
Clinic	32,705	60.6	200	0.6	32,505	99.4	
Hospital	5537	10.3	24	0.4	5513	99.6	
General hospital	14,220	26.3	59	0.4	14,161	99.6	
Public health centre	1518	2.8	10	0.7	1508	99.3	

CoC, Continuity of Care; UPC, Usual Provider Continuity.

system provided by regular primary care physicians.³¹ As a result of the usual sources of care and providers not being officially institutionalised, some individuals overuse medical care, whereas others experience unmet medical care needs. Even if it is premature to assign a primary care physician to all health insurance subscribers, a continuous care system by a usual provider should be introduced, especially for older adult patients whose needs result in increased social burden.³¹

Previous studies have identified physical illness and functional limitations,⁴ social isolation and loneliness^{6,8} and poor mental health^{10,27} as major risk factors affecting self-harm and suicide among older adults. In addition to investigating the determinants of suicide among older adults, the present study extended its scope to assess how CoC impacts the occurrence of death due to intentional self-harm in older adults diagnosed with mental and behavioural disorders. As expected, older adults with poor mental health who did not receive continuous mental health care showed marked vulnerability to the occurrence of outcomes. Given that the suicide rate among older adults in Korea is the highest among all the OECD countries, the findings of the present study, which were analysed using large-scale and representative nationwide claims data, serve as a crucial basis for developing public health policies aimed at preventing self-harm and suicide among the elderly. Furthermore, the results of this study provide implications in controlling the social burden caused by rapid ageing and increased life expectancy around the world. As poor mental health is an important factor that determines the quality of life at the end of life,

it is expected that if it is continuously and well managed by a personal doctor, much of the burden in terms of support and medical care can be reduced.

This study had certain limitations. First, there is a concern regarding the accuracy of the ICD-10 diagnostic codes recorded in the claims data.^{28–30} These codes primarily serve administrative purposes and may not provide a comprehensive overview of the patients' clinical information. To mitigate these limitations in the claims data, this study only included patients who died from intentional self-harm who had visited the outpatient clinic three or more times within the year after the initial diagnosis.¹⁵ Second, because information on the individual causes of death is very sensitive, the type of self-harm leading to death was not analysed as a subgroup. Third, due to the sensitive nature of mental and behavioural disorders and the fact that they encompass diverse types of disorders, we were unable to identify the detailed diagnoses. This is because the Korean NHIS measures consider that mental illnesses are sensitive diseases and individuals with rare diseases may potentially be identifiable. For similar reasons, the severity of the mental and behavioural disorders could not be determined. Fourth, although this study tried to adjust for possible confounders that might impact the likelihood of the occurrence of an outcome, it is important to note that the study was unable to completely eliminate the possibility of residual confounding effects from unmeasured variables. For instance, the occurrence of death due to intentional self-harm may be impacted by factors such as history of diseases, one's living conditions, employment status and

Table 2
Results of factors associated with death due to intentional self-harm.

Variables	Death due to intentional self-harm			
	aRR ^a	95% CI	aRR ^a	95% CI
CoC index				
≥0.75	1.00			
<0.75	1.50	(1.18–1.90)		
UPC index				
≥0.75			1.00	
<0.75			1.63	(1.25–2.12)
Sex				
Men	1.00			
Women	0.46	(0.36–0.59)	0.46	(0.36–0.59)
Age in years				
60–69	1.00		1.00	
70–79	0.07	(0.05–0.10)	0.07	(0.05–0.10)
≥80	0.06	(0.04–0.09)	0.06	(0.04–0.09)
Region				
Metropolitan and urban area	1.00		1.00	
Rural area	0.88	(0.69–1.11)	0.88	(0.69–1.11)
Income				
Low	1.01	(0.72–1.41)	1.00	(0.81–1.45)
Middle	1.09	(0.81–1.46)	1.08	(0.81–1.45)
High	1.00		1.00	
Type of medical insurance				
Workplace insured	1.00		1.00	
Regionally insured	1.09	(0.83–1.43)	1.09	(0.83–1.44)
Medical aid	1.57	(1.03–2.40)	1.57	(1.03–2.41)
Charlson Comorbidity Index				
0	1.00		1.00	
1–2	0.90	(0.68–1.18)	0.90	(0.68–1.19)
≥3	0.60	(0.35–1.04)	0.60	(0.35–1.04)
Type of medical facility				
Clinic	1.51	(1.12–2.03)	1.50	(1.12–2.02)
Hospital	1.09	(0.68–1.76)	1.09	(0.67–1.75)
General hospital	1.00		1.00	
Public health centre	1.60	(0.82–3.14)	1.61	(0.82–3.16)

aRR, adjusted risk ratio; CI, confidence interval; CoC, Continuity of Care; UPC, Usual Provider Continuity.

^a aRRs were adjusted for other covariates.

Table 3
Results of sensitivity analyses by different criteria for defining CoC and UPC indices.

Index	Criteria	Range	Death due to intentional self-harm	
			aRR ^a	95% CI
CoC index	0.33 units	1	1.00	
		0.66–0.99	1.08	(0.69–1.69)
		0.33–0.65	1.29	(0.97–1.72)
	0.5 units	0–0.32	2.56	(1.68–3.90)
		1	1.00	
		0.5–0.99	1.15	(0.83–1.59)
UPC index	0.33 units	0–0.49	1.65	(1.24–2.19)
		1	1.00	
		0.66–0.99	1.05	(0.78–1.41)
	0.5 units	0.33–0.65	2.15	(1.58–2.94)
		0–0.32	3.29	(0.89–12.14)
		1	1.00	
	0.5–0.99	1.35	(1.06–1.72)	
	0–0.49	1.90	(1.04–3.47)	

aRR, adjusted risk ratios; CI, confidence interval; CoC, Continuity of Care; UPC, Usual Provider Continuity.

^a aRRs were adjusted for other covariates.

physical activity levels. Finally, the varied factors and trends influencing CoC in older adults with mental and behavioural disorders may limit the generalisability of the findings to other countries.

Conclusions

The findings of the present study demonstrate that the risk of death due to intentional self-harm increases when the CoC is poor

in older adults diagnosed with mental and behavioural disorders. This finding highlights the need for public health interventions that can prevent suicidal behaviours in older adults, such as institutionalising the usual providers of mental health care for older adults.

Author statements

Acknowledgements

The authors would like to thank the members of the Institute of Health Services Research at Yonsei University for their advice for the further development of this study.

Ethical approval

The study protocol was approved by the Institutional Review Board of Yonsei University's Health System (IRB No. 4-2021-0833). Since NHIS-ECD did not contain any identifiable information, the requirement for informed consent was waived.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interests

None declared.

Author contributions

I.Y. made a substantial contribution to the concept or design of the work; the acquisition, analysis, or interpretation of data; and drafted the article; H.K. and E.C.P. revised it critically for important intellectual content. All authors approved the version to be published and participated sufficiently in the work to take public responsibility for the appropriate portions of the content.

Data sharing statement

No data are available because the National Health Information Database can only be accessed by researchers authorised by the Korean National Health Insurance Service.

References

- Jeong KH, Yoon JY, Lee S, Cho S, Woo H-J, Kim S. Changes in the suicide rate of older adults according to gender, age, and region in South Korea from 2010 to 2017. *Healthcare* 2022;**10**:2333. <https://doi.org/10.3390/healthcare10112333>.
- Ministry of health and welfare (South Korea). *White Paper on Suicide Prevention*. 2021.
- Knipe D, Padmanathan P, Newton-Howes G, Chan LF, Kapur N. Suicide and self-harm. *Lancet* 2022;**399**:1903–16. [https://doi.org/10.1016/S0140-6736\(22\)00173-8](https://doi.org/10.1016/S0140-6736(22)00173-8).
- Kaplan MS, McFarland BH, Huguet N, Newsom JT. Physical illness, functional limitations, and suicide risk: a population-based study. *Am J Orthopsychiatry* 2007;**77**:56–60. <https://doi.org/10.1037/0002-9432.77.1.56>.
- O'Connell H, Chin A-V, Cunningham C, Lawlor BA. Recent developments: suicide in older people. *BMJ* 2004;**329**:895–9. <https://doi.org/10.1136/bmj.329.7471.895>.
- Ryan MC, Patterson J. Loneliness in the elderly. *J Gerontol Nurs* 1987;**13**:6–9. <https://doi.org/10.3928/0098-9134-19870501-04>.
- Conwell Y, Duberstein PR. Suicide in elders. *Ann N Y Acad Sci* 2001;**932**:132–50. <https://doi.org/10.1111/j.1749-6632.2001.tb05802.x>.
- Heuser C, Howe J. The relation between social isolation and increasing suicide rates in the elderly. *Qual Ageing* 2019;**20**:2–9. <https://doi.org/10.1108/QAOA-06-2018-0026>.

9. Barnow S, Linden M, Freyberger H-J. The relation between suicidal feelings and mental disorders in the elderly: results from the Berlin Aging Study (BASE). *Psychol Med* 2004;**34**:741–6. <https://doi.org/10.1017/S0033291703008912>.
10. Waern M, Runeson BS, Allebeck P, Beskow J, Rubenowitz E, Skoog I, et al. Mental disorder in elderly suicides: a case-control study. *Am J Psychiatr* 2002;**159**:450–5. <https://doi.org/10.1176/appi.ajp.159.3.450>.
11. Shin DW, Cho B, Guallar E. Korean national health insurance database. *JAMA Intern Med* 2016;**176**:138. <https://doi:10.1001/jamainternmed.2015.7110>.
12. Kim YI, Kim YY, Yoon JL, Won CW, Ha S, Cho KD, et al. Cohort Profile: national health insurance service-senior (NHIS-senior) cohort in Korea. *BMJ Open* 2019;**9**:e024344. <https://doi:10.1136/bmjopen-2018-024344>.
13. Kim H, Jeong W, Kwon J, Kim Y, Park EC, Jang SI. Association between depression and the risk of Alzheimer's disease using the Korean national health insurance service-elderly cohort. *Sci Rep* 2021;**11**:22591. <https://doi.org/10.1038/s41598-021-02201-6>.
14. Thomas KH, Davies N, Metcalfe C, Windmeijer F, Martin RM, Gunnell D. Validation of suicide and self-harm records in the clinical practice research data-link. *Br J Clin Pharmacol* 2013;**76**:145–57. <https://doi.org/10.1111/bcp.12059>.
15. Kim SH, Kim H, Jeong SH, Jang SY, Park EC. Impact of continuity of care on risk for major osteoporotic fracture in patients with new onset rheumatoid arthritis. *Sci Rep* 2022;**12**:10189. <https://doi.org/10.1038/s41598-022-14368-7>.
16. Bice TW, Boxerman SB. A quantitative measure of continuity of care. *Med Care* 1977;**15**:347–9. <https://www.jstor.org/stable/3763789>.
17. Sveréus S, Larsson K, Rehnberg C. Clinic continuity of care, clinical outcomes and direct costs for COPD in Sweden: a population based cohort study. *Eur Clin Respir J* 2017;**4**:1290193. <https://doi.org/10.1080/20018525.2017.1290193>.
18. Kao YH, Wu SC. Effect of continuity of care on emergency department visits in elderly patients with asthma in Taiwan. *J Am Board Fam Med* 2017;**30**:384–95. <https://doi.org/10.3122/jabfm.2017.03.160285>.
19. Hong JS, Kang HC, Kim J. Continuity of care for elderly patients with diabetes mellitus, hypertension, asthma, and chronic obstructive pulmonary disease in Korea. *J Kor Med Sci* 2010;**25**:1259–71. <https://doi.org/10.3346/jkms.2010.25.9.1259>.
20. Cohen-Mekelburg S, Waljee AK, Kenney BC, Tapper EB. Coordination of care is associated with survival and health care utilization in a population-based study of patients with cirrhosis. *Clin Gastroenterol Hepatol* 2020;**18**:2340–8. <https://doi.org/10.1016/j.cgh.2019.12.035>.
21. Knight JC, Dowden JJ, Worrall GJ, Gadag VG, Murphy MM. Does higher continuity of family physician care reduce hospitalizations in elderly people with diabetes? *Popul Health Manag* 2009;**12**:81–6. <https://doi.org/10.1089/pop.2008.0020>.
22. Nyweide DJ, Anthony DL, Bynum JP, Strawderman RL, Weeks WB, Casalino LP, et al. Continuity of care and the risk of preventable hospitalization in older adults. *JAMA Intern Med* 2013;**173**:1879–985. <https://doi:10.1001/jamainternmed.2013.10059>.
23. Cho KH, Lee SG, Jun B, Jung BY, Kim JH, Park EC. Effects of continuity of care on hospital admission in patients with type 2 diabetes: analysis of nationwide insurance data. *BMC Health Serv Res* 2015;**15**:1–10. <https://doi.org/10.1186/s12913-015-0745-z>.
24. Menec VH, Sirski M, Attawar D, Katz A. Does continuity of care with a family physician reduce hospitalizations among older adults? *J Health Serv Res Policy* 2006;**11**:196–201. <https://doi.org/10.1258/1355819067784765>.
25. Knol MJ, Le Cessie S, Algra A, Vandenbroucke JP, Groenwold RH. Over-estimation of risk ratios by odds ratios in trials and cohort studies: alternatives to logistic regression. *CMAJ (Can Med Assoc J)* 2012;**184**:895–9. <https://doi.org/10.1503/cmaj.101715>.
26. Huang FL. Alternatives to logistic regression models in experimental studies. *J Exp Educ* 2022;**90**:213–28. <https://doi.org/10.1080/00220973.2019.1699769>.
27. Henriksson MM, Marttunen MJ, Isometsä ET, Heikkinen ME, Aro HM, Kuoppasalmi KI, et al. Mental disorders in elderly suicide. *Int Psychogeriatr* 1995;**7**:275–86. <https://doi:10.1017/S1041610295002031>.
28. Surján G. Questions on validity of international classification of diseases-coded diagnoses. *Int J Med Inf* 1999;**54**:77–95. [https://doi.org/10.1016/S1386-5056\(98\)00171-3](https://doi.org/10.1016/S1386-5056(98)00171-3).
29. Stausberg J, Lehmann N, Kaczmarek D, Stein M. Reliability of diagnoses coding with ICD-10. *Int J Med Inf* 2008;**77**:50–7. <https://doi.org/10.1016/j.ijmedinf.2006.11.005>.
30. Quan H, Li B, Duncan Saunders L, Parsons GA, Nilsson CI, Alibhai A, et al. Assessing validity of ICD-9-CM and ICD-10 administrative data in recording clinical conditions in a unique dually coded database. *Health Serv Res* 2008;**43**:1424–41. <https://doi.org/10.1111/j.1475-6773.2007.00822.x>.
31. Heo YC, Kahng SK, Kim S. Mental health system at the community level in Korea: development, recent reforms and challenges. *Int J Ment Health Syst* 2019;**13**:1–5. <https://doi.org/10.1186/s13033-019-0266-y>.