# RESEARCH





Association between fragmented care and incident mood disorder in elderly patients with colorectal cancer: a retrospective cohort study in South Korea

Woo-Ri Lee<sup>1</sup>, Kyu-Tae Han<sup>2\*</sup> and Woorim Kim<sup>2,3\*</sup>

# Abstract

**Background** This study investigated the relationship between fragmented care (patient care provided at multiple hospitals) and incident mood disorders in elderly colorectal cancer patients. Fragmented care was defined as a change in the medical institution providing first cancer treatment within 180 days of cancer diagnosis. The aim of this study was to investigate the impact of fragmented care on the incidence of mood disorder after cancer diagnosis in elderly colorectal cancer patients.

**Methods** This study used NHIS Senior cohort data between 2002 and 2019 in South Korea. The participants included individuals aged 60 to 80 years who were diagnosed with colorectal cancer between 2008 and 2014. The primary outcome measure was the incidence of mood disorders within five years after cancer diagnosis. The independent variable was fragmented care. Regression analysis was conducted using the Cox proportional hazard model, and a sensitivity analysis was performed to enhance the robustness of the study findings.

**Results** Of the total 3,726 participants, 878 (23.6%) were diagnosed with mood disorders, and 328 (8.8%) experienced fragmented care. The mood disorder incidence rate per 100,000 person-days was higher among those who experienced fragmented care (18.9 cases) compared to those who did not (14.6 cases). Participants who received fragmented care had a significantly higher risk of incident mood disorders (hazard ratio 1.39, 95% confidence interval 1.10–1.77). The results of the sensitivity analysis, which extended the fragmented care observation period, remained consistent with the original findings. Additionally, subgroup analysis revealed that the effect of fragmented care on incident mood disorders was significantly associated with female sex, chronic diseases, lower economic status, and type of colon cancer (C18).

**Conclusions** Fragmented care increased the risk of incident mood disorders within the first five years of diagnosis in elderly patients with colorectal cancer. The findings highlight the potentially important role of a cohesive health

\*Correspondence: Kyu-Tae Han kthan.phd@gmail.com Woorim Kim wklaura@gmail.com

Full list of author information is available at the end of the article



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system in managing the mental health of patients with colorectal cancer, which is important considering that depression is relatively commonly found in these patients.

**Keywords** Fragmented care, Hospital switching, Mood disorder, Colorectal cancer, Elderly

# Introduction

Colorectal cancer is a common type of cancer in South Korea as it ranks second in incidence (age standardized incidence, 61.9 per 100,000 in 2021) excluding thyroid cancer (age standardized incidence, 68.8 per 100,000 in 2021) [1]. The incidence of colorectal cancer is likely to continuously increase in Korea which has a rapidly aging population as old age is reported as a major risk factor for colorectal cancer [2]. At the same time, old age has also been linked to a higher likelihood of depression, with studies revealing that more than a third of older populations reported depression [3]. Considering such increases in the number of affected individuals, a need exists to explore the potential deterioration of mental health, in particular depression, in patients with colorectal cancer. Specifically, depressive symptoms have been commonly found among patients with colorectal cancer, with rates of depression ranging between approximately 1.6-57.0% in previous studies [4]. Previous literature has also reported that rates of depressive symptoms are roughly around 10% higher in such patients [5].

Several factors apart from older age have been associated with depression in patients with cancer, including economic or educational status [6]. However, studies investigating the impact of cancer treatment patterns on depression in patients with colorectal cancer are lacking. The selection of medical institutions for treatment and patterns of healthcare utilization are important factors in the management of cancer symptoms. As Korea lacks a strong referral system, patients are able to easily visit any institution for diagnosis and treatment. Hence, despite the availability of university-based or large, tertiary hospitals nationwide, many patients visit many patients with cancer prefer to visit large tertiary hospitals located in the capital area in the belief that such hospitals provide superior treatment [7]. As many patients make such decisions regardless of their residing region and environment, individuals face the possibility of fragmented care as, in most cases, one-time treatment is insufficient for cancer. For instance, individuals may receive health examinations and receive diagnosis at a healthcare institution nearby their residing area, then select to receive treatment at a large, tertiary hospital located in the capital area. As such, patients may then face the possibility of fragmented care at follow-up as they return to their residing areas, which may be a loss of care in the cancer continuum. Such loss in the care continuum can lead to lower quality of care, delayed treatment, an increase in unnecessary examinations, and an escalation in healthcare costs [8-10]. From the perspective of the mental health of patients with cancer, receiving care at several different hospitals has been associated with a reduced level of trust between physicians and patients [11, 12]. Several studies have reported that maintaining continuity of care can exert a positive effect on the quality of life of patients with cancer [13–15].

The aim of this study was to investigate the impact of fragmented care on the incidence of mood disorders after cancer diagnosis in elderly patients with colorectal cancer. Fragmented care refers to a situation in which care for a patient is provided at multiple hospitals, which has been associated with a decrease in continuity of care [16]. Colorectal cancer was selected because it ranks second in cancer incidence in Korea, following thyroid cancer. Previous studies have reported that colorectal cancer patients have a high prevalence of depression, and it were selected to provide a basis for cancer control according to the study considering the future aging and increasing number of colorectal cancer patients [17]. We hypothesized that patients who received treatment for cancer from multiple providers would have a higher risk of being diagnosed with a mood disorder. Additional subgroup analysis was performed according to sex, chronic disease, economic status, and type of cancer.

# Methods

#### Data and study population

This study used NHIS Senior cohort data between 2002 and 2019 in South Korea. NHIS provides coverage for nearly 97% of the population, while the remaining 3% are supported through the Medical Aid Program [18]. Under this single-payer system, the NHIS collects insurance premiums from citizens based on their income and property [19]. When individuals utilize medical services, they bear part of the cost out-of-pocket, while the rest is subsidized by the NHIS [19]. Therefore, This system enables the NHIS to gather extensive, anonymized data on healthcare usage nationwide. The NHIS Senior Cohort dataset includes approximately 8% of South Koreans aged 60-80 years in 2008, selected through stratified random sampling based on sex (male, female), age (60 to 80 years, in one-year increments), residential area (metropolitan,

urban, rural), and insurance premium (10–100%, in 10% increments) [20, 21].

This study included individuals diagnosed with colorectal cancer (International Classification of Diseases, Tenth Revision [ICD-10]: C18-C20) between 2008 and 2014. Of a total of 11,006 patients aged between 60 and 80 years diagnosed with colorectal cancer and covered by the NHI, those who died within 180 days of colorectal cancer diagnosis, those who diagnosed any cancer within five years before colorectal cancer diagnosis, did not receive surgery for colorectal cancer within 180 days after colorectal cancer diagnosis, and received other types of treatment were excluded to enhance the homogeneity of the study population, as surgery may not be performed solely for treatment purposes in cases of metastasis to distant organs or tissues, especially because the data used lacked information on cancer severity. Surgery is considered standard in treating colorectal cancer of lower severity. Participants diagnosed with mood disorders within one year before colorectal cancer diagnosis or within 180 days after colorectal cancer diagnosis, those with recurrent depression, and those who died but were not diagnosed with mood disorders were also excluded, as this study aimed to investigate the effect of fragmented care on the risk of incident mood disorders in patients with colorectal cancer. This led to a final study population of 3,726 participants. Details on the selection process for the study population can be found in Fig. 1.

#### **Outcome measure**

The outcome measure of this study was a mood disorder. Mood disorder was identified using the ICD-10 codes F32 and F34–F39. Incident cases that occurred within five years of colorectal cancer diagnosis were included in the analysis.

#### Independent variables

The main independent variable in this study was fragmented care. Fragmented care refers to circumstances in which patients receive care from multiple healthcare providers and has been associated with lower healthcare quality, higher medical costs, and poorer outcomes in patients with cancer [9, 22]. A previous study has shown that patients with colorectal cancer are at a high risk of developing a short-term outcome within six months of cancer diagnosis [23]. According to this reason, in this study, fragmented care was defined as a change in the medical institution that provided care for the first treatment of colorectal cancer within 180 days of colorectal cancer diagnosis.

This study included various demographic, healthrelated, medical institution-related, and cancer-related factors as covariates. Demographic factors included sex (male or female), age (60 to 64, 65 to 69, 70 to 74, or 75 to 79 years, 80 years), economic status (quintiles), type of healthcare insurance (NHI self-employed or NHI employee-covered), and region (capital area, metropolitan cities, or rural area). Health-related factors included disability status at baseline (no or yes), chronic diseases diagnosed before cancer diagnosis (no or 1+), and the Charlson Comorbidity Index, calculated using claims data from the 12 months preceding the cancer diagnosis as recommended by the National Cancer Institute [24], categorized as 0, 1, or  $\geq 2$ . Hospital-related factors included hospital type (tertiary, general, or other hospital) and location (capital area, metropolitan cities, or rural area). Hospital-related factors were constructed based on the characteristics of the hospital where the patient first received surgical treatment. Cancer-related factors included type of surgery (colorectomy and total colopropectomy; rectal, sigmoid resection, and resection of rectal tumor; enterostomy and intestinal anastomosis; and



colonoscopic operation) and type of cancer (colon or rectosigmoid junction).

#### Statistical analysis

In this study, the index date was defined as the date of colorectal cancer diagnosis, and the incidence of mood disorders was followed up for five years from the date of diagnosis. The statistical analyses in this study were conducted in four stages. First, a Chi-squared test was performed to explore the general characteristics of the study participants and their relationship with mood disorders. Statistical significance for the Chi-squared test was determined at a *p*-value of less than 0.05. Second, the incidence rate of mood disorders during the total follow-up period was calculated for each general characteristic of the study participants. The incidence rate was presented as the number of cases per 100,000 person-days. Additionally, to compare survival times, t-tests and analysis of variance (ANOVA) were conducted. Statistical significance for the t-tests and ANOVA was also determined at a *p*-value of less than 0.05. Third, survival analyses were performed to explore the association between fragmented care and the incidence of mood disorders. The proportional hazards assumption was examined using the Kaplan-Meier survival curve, and the statistical significance of the survival curves was evaluated using the log-rank test, with a p-value of less than 0.05 considered significant. Regression analysis was conducted using the Cox proportional hazard model, and statistical significance in Cox regression was defined as when the 95% confidence interval (CI) of the hazard ratio (HR) did not include 1. Fourth, to enhance the robustness of the findings, sensitivity analyses were performed using two approaches, and Cox regression was conducted for both: (a) Extending the observation period for fragmented care to one year, and (b) Conducting subgroup analyses based on sex, chronic diseases, socioeconomic status, and cancer type. All Cox regression models were adjusted for all independent variables included in the study. The interesting variable in this study, fragmented care, is a time-dependent variable that can occur repeatedly over time. To effectively control for the immortal time bias that may arise from this time dependency, we employed the landmark method for analysis. Accordingly, we defined the landmark period as 180 days, which corresponds to the observation period for fragmented care, and conducted the analysis based on this period [25, 26]. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA) and R software (version 3.6.3; R Foundation for Statistical Computing, Vienna, Austria).

# **Ethical declarations**

This study used secondary data in which all personal information was anonymized and de-identified. The requirement for ethical approval was waived by the Institutional Review Board of the National Cancer Center of Korea (NCC2022-0298).

### Results

The general characteristics of the study population are shown in Table 1. Of a total of 3,726 study participants, 878 (23.6%) were diagnosed with mood disorders within five years of their initial colorectal cancer diagnosis. A total of 328 (8.8%) individuals experienced fragmented care. Incident mood disorder was more common in those who experienced fragmented care (28.4%) than in those who did not (23.1%) (p = 0.03). Additionally, the number of mood disorder rates was significantly higher among those of older age (p < 0.0001), those residing in rural areas (p = 0.0005), individuals with a disability (p < 0.0001), those with a CCI score of 1 or higher (p < 0.0001), and patients treated in hospitals located in rural areas (p = 0.03).

The results of the comparison of mood disorder incidence rates and survival times by the general characteristics of the study population are presented in Table 2. The average survival time for all participants was 1,572 days, and the overall mood disorder incidence rate was 15.5 cases per 100,000 person-days. Participants who did not experience fragmented care had an average survival time of 1,579 days, while those who experienced fragmented care had a shorter survival time of 1,498 days (p = 0.01). Moreover, the mood disorder incidence rate was 14.6 cases per 100,000 person-days for participants without fragmented care, compared to 18.9 cases per 100,000 person-days for those who experienced fragmented care, indicating a higher incidence in the experienced fragmented care group.

The results of the survival analysis on the association between fragmented care and incident mood disorders can be found in Table 3; Fig. 2. The Kaplan– Meier survival curves reveal that the proportional hazard assumption was not violated. The log-rank test showed that there was a difference in the incidence of mood disorders based on care fragmentation over time (p = 0.02). Participants who received fragmented care showed a higher risk of incident mood disorders within five years (HR 1.39, 95% CI 1.10–1.77).

The results of the sensitivity analysis are presented in Table 4. When the observation period for fragmented care was extended to one year, the group that experienced fragmented care exhibited a higher risk of developing mood disorders within five years (HR 1.34, 95% CI 1.03–1.75). Subgroup analysis revealed

# Table 1 General characteristics of the study population

Variable	Total	Five-year mood disorder incidence				
		No		Yes		<i>p</i> -value
		N	%	N	%	
Total	3,726	2,848	(76.4)	878	(23.6)	
Fragmented Care						
No	3,398	2,613	(76.9)	785	(23.1)	0.03
Yes	328	235	(71.6)	93	(28.4)	
Sex						
Male	2,421	1,894	(78.2)	527	(21.8)	< 0.001
Female	1,305	954	(73.1)	351	(26.9)	
Age						
60 to 64 years	1,058	857	(81.0)	201	(19.0)	< 0.001
65 to 69 years	981	764	(77.9)	217	(22.1)	
70 to 74 years	1,006	746	(74.2)	260	(25.8)	
75 to 79 years	606	428	(70.6)	178	(29.4)	
80 vears	75	53	(70.7)	22	(29.3)	
Economic status						
Low	558	441	(79.0)	117	(21.0)	0.13
Low-middle	446	342	(76.7)	104	(23.3)	
Middle	559	437	(78.2)	122	(21.8)	
Middle-high	852	656	(77.0)	196	(23.0)	
High	1,311	972	(74.1)	339	(25.9)	
Type of healthcare insurance						
NHI Self-employed	1,159	876	(75.6)	283	(24.4)	0.41
NHI Employee	2.567	1,972	(76.8)	595	(23.2)	
Region	,	,				
Capital	1,550	1,210	(78.1)	340	(21.9)	0.005
Metropolitan	945	737	(78.0)	208	(22.0)	
Rural	1,231	901	(73.2)	330	(26.8)	
Disability						
Non-disabled	3,205	2,472	(77.1)	733	(22.9)	0.01
Disabled	521	376	(72.2)	145	(27.8)	
Chronic disease						
None	2,366	1,875	(79.2)	491	(20.8)	< 0.001
≥1	1,360	973	(71.5)	387	(28.5)	
CCI						
0	1,601	1,285	(80.3)	316	(19.7)	< 0.001
1	696	511	(73.4)	185	(26.6)	
≥2	1,429	1,052	(73.6)	377	(26.4)	
Type of hospital						
Tertiary hospital	2,184	1,688	(77.3)	496	(22.7)	0.13
General hospital	1,121	833	(74.3)	288	(25.7)	
Other hospital	421	327	(77.7)	94	(22.3)	
Hospital region						
Capital	2,208	1,713	(77.6)	495	(22.4)	0.03
Metropolitan	990	754	(76.2)	236	(23.8)	
Rural	528	381	(72.2)	147	(27.8)	
Type of surgery			- *			
Colorectomy and total colopropectomy	831	619	(74.5)	212	(25.5)	0.34
Rectal & Sigmoid resection & Resection of	1,510	1,153	(76.4)	357	(23.6)	
Rectal tumor		, -	. /		. /	
Enterostomy and Intestinal Anastomosis	77	62	(80.5)	15	(19.5)	
Colonoscopic operation	1,308	1,014	(77.5)	294	(22.5)	
Type of cancer						

Variable	Total	Five-year mood disorder incidence				
		No		Yes		<i>p</i> -value
		N	%	N	%	
Colon	2,365	1,804	(76.3)	561	(23.7)	0.36
Rectosigmoid junction	319	254	(79.6)	65	(20.4)	
Rectum	1,042	790	(75.8)	252	(24.2)	

## Table 1 (continued)

\*NHI: National Health Insurance; CCI: Charlson Comorbidity Index

that participants who were female (HR 1.57, 95% CI 1.07–2.29), had chronic diseases (HR 2.10, 95% CI 1.47–3.01), belonged to the below-median income group (HR 1.50, 95% CI 1.04–2.17), or were diagnosed with colon cancer (HR 1.51, 95% CI 1.12–2.03) had a significantly higher risk of developing mood disorders compared to their counterparts who did not experience fragmented care.

# Discussion

This study investigated the impact of fragmented care on the risk of incident mood disorders in elderly patients with colorectal cancer. The findings revealed that patients who received fragmented care had a higher risk of mood disorders within five years of cancer diagnosis. Such increases were particularly significant in females, patients with at least one chronic disease, those of lower economic status, and those diagnosed with colon cancer. The results reveal the impact of healthcare utilization patterns on the mental health of individuals diagnosed with cancer.

Investigating factors associated with the risk of depression in patients with cancer is important because cancer is becoming a chronic disease for many patients, in which major depression is reported to affect approximately 10% of such patients [27]. Disorders of the depressive spectrum manifest due to a variety of factors in patients with cancer, such as the loss of one's health or social roles and sadness; moreover, these factors are prevalent throughout the disease course [28]. Managing major depression is essential, as it is linked to increased anxiety, pain, fatigue, and functioning and poor adherence to cancer treatment [29-33]. Major depression is also associated with a poor quality of life and increased healthcare costs when comorbid with a chronic disease [34, 35]. Furthermore, patients with depression have a higher risk of suicide, which shows the importance of preventing mood disorders in individuals with cancer diagnosis [36]. Recent literature has stressed the importance of integrating the management of comorbid depression into cancer patients' care regimens [37]. Studies have shown that receipt of depression care in patients with cancer is associated with various symptoms such as anxiety, pain, fatigue, functional ability, and quality of care [37].

Many previous studies examining the factors associated with mood disorders in individuals diagnosed with cancer have focused largely on individual patient characteristics and comorbidities [38]. The findings of this study show that in addition to patient characteristics, patterns of healthcare utilization, such as care fragmentation, may impact the risk of incident mood disorders in patients with cancer. These findings support previous study findings that high continuity of care is associated with improved health-related quality of life in patients with cancer [13]. Ensuring continuity of care with the provision of psychological interventions was also found to be effective in mitigating negative emotions and enhancing the quality of life of patients with cancer [39]. The study results additionally imply that the impact of fragmented care on incident mood disorders is particularly pronounced in females, individuals with one or more chronic diseases, and those of comparatively lower economic status. This has important implications for identifying vulnerable populations. It is necessary to secure guidance and support programs for the vulnerable to maintain continuity of cancer diagnosis-treatment-management and improve access to treatment. In addition, national support for the vulnerable is needed to lead daily life in the cancer treatment process, and physical/psychological/socioeconomic accessibility of cancer patients is needed by fostering and distributing regional base cancer medical institutions. Taken together, our findings suggest the potential importance of reducing fragmented care to address mood disorders in patients with cancer, which is noteworthy considering the escalation in the number of cancer survivors and the negative impact of comorbid depressive symptoms. This may also be further significant for patients with cancer because the benefits of continuity of care are known to vary according to medical complexity, and cancer is a complex disease characterized by diverse clinical features and treatment modalities [40, 41]. In fact, studies show that cancer care has moved towards fitting psychological care into cancer treatment services [42]. Psychological intervention, along with ensuring care continuity, have increased [40].

Variable	Incidence rate (per 100,000 person-days)	Five-year mood disorder incidence		
		Survival time		<i>p</i> -value
		Mean	±Std	
Total	15.5	1,572	493	
Fragmented Care				
No	14.6	1,579	486	0.01
Yes	18.9	1,498	559	
Sex				
Male	13.7	1,592	477	0.001
Female	17.5	1,536	419	
Age				
60 to 64 years	11.6	1,631	436	< 0.001
65 to 69 years	13.9	1,595	473	
70 to 74 years	16.8	1,535	526	
75 to 79 years	19.5	1,505	536	
80 vears	19.9	1.476	572	
Economic status		<b>y</b>		
	13.0	1.610	448	0.02
l ow-middle	14.9	1.568	495	
Middle	13.7	1 589	482	
Middle-high	14 5	1 591	479	
High	16.8	1 538	522	
Type of healthcare insurance		1,000	522	
NHI Self-employed	15.6	1 566	494	0.59
NHI Employee	14.7	1,500	/03	0.59
Pagion	1.7	0,07	775	
Capital	12 7	1.605	163	0.001
Metropolitan	14.1	1,005	509	0.001
Bural	17.5	1,500	514	
Disability	17.5	1,550	514	
Non-disabled	14.5	1 5 8 7	183	0.005
Disabled	19.4	1,502	-10J	0.005
Chronic discoso	10.4	1,510	545	
None	12.0	1 605	167	< 0.001
	12.9	1,005	407	< 0.001
21	10.0	1,510	221	
	10.1	1.000	445	< 0.001
0	12.1	1,020	445	< 0.001
	17.3	1,539	511	
≥∠ Tomo of homestal	17.3	1,528	528	
	14.2	1 500	477	0.01
Concerning hospital	14.3	1,588	477	0.01
General nospital	16./	1,535	523	
Other hospital	14.1	1,589	491	
Hospital region	14.0	1.506	474	0.000
Capital	14.0	1,596	4/1	0.002
Metropolitan	15.5	1,542	526	
Kurai	18.2	1,530	515	
lype of surgery	44.5			
Colorectomy and total colopropectomy	16.3	1,564	495	0.32
Rectal & Sigmoid resection & Resection of Rectal tumor	15.0	1,572	490	
Enterostomy and Intestinal Anastomosis	13.2	1,481	583	
Colonoscopic operation	14.2	1,583	489	
Type of cancer				

Table 2 Comparison of mood disorder incidence rates and survival times by general characteristics of the study population

Variable	Incidence rate (per 100,000 person-days)	Five-year mood disorder incidence		
		Survival time		<i>p</i> -value
		Mean	±Std	
Colon	15.1	1,573	493	0.63
Rectosigmoid junction	12.8	1,594	479	
Rectum	15.5	1,564	497	

# Table 2 (continued)

\*NHI: National Health Insurance; CCI: Charlson Comorbidity Index

This study has some limitations. First, the severity of colorectal cancer, such as cancer stage at diagnosis, could not be accounted for due to claim data limitations. To partially overcome this limitation, this study only included patients who received surgical treatment. Surgical treatment is the most common method of treatment for colorectal cancer and is reported to be more frequently conducted in patients with lower cancer severity. By limiting the study population to only patients with surgical treatment, this study could secure the homogeneity of the participants and external validity of the study results. However, in this study, we focused only on colorectal cancer to analyze its association with fragmented care, which requires careful interpretation from the perspective of generalizing to other types of cancer. Second, manic episodes and bipolar affective disorder (ICD-10: F30, F31) could not be considered in the analysis because these diseases were masked for privacy protection in the data used. Third, although various covariates were accounted for, the possibility of residual confounding cannot be completely ruled out as information on certain variables, such as education level, was not available in the data used. Fourth, the pattern of treatment between the first and subsequent hospitals visited for colorectal cancer could not be confirmed. Nevertheless, this study did consider the type of surgery as a covariate. Fifth, because this study used claims data, economic status could only be measured using the level of NHI premiums as a proxy for income. Finally, future studies investigating which mood disorder entails the highest risk, the mode of institutional change, and comorbid chronic diseases are needed to gain a more detailed insight into the topic investigated. Despite the limitations detailed above, this study is novel in that it is the first to examine the impact of fragmented care on the incidence of mood disorders in elderly patients with colorectal cancer using nationwide data. The findings also revealed that the impact of fragmented care on incident mood disorders tends to be stronger in the comparatively vulnerable population, including those with lower socioeconomic status. This is noteworthy considering that the healthcare system of Korea functions to cover all individuals either by NHI or Medical Aid while lacking a strong referral system, which allows individuals to easily visit any level of healthcare institution of their choice. This feature provides patients with cancer with a wide range of options in selecting a medical institution to receive treatment, and socially vulnerable groups may select less optimal institutions due to a variety of reasons, such as a gap in accessing health information or high costs. As a result, the risk of developing mood disorders due to fragmented and delayed treatment may exist, as reflected in this study. Despite the increase in cancer survival rates, these occurrences represent a new phase and challenge in national cancer control. It is necessary to consider the introduction of a national support program to ensure continuity of diagnosis-treatmentmanagement for cancer patients, especially the vulnerable and review the foster local hub cancer medical institutions, to prevent adverse effects from the concentration of cancer in the Seoul metropolitan area.

# Conclusions

This study investigated the impact of fragmented care on incident mood disorders in elderly patients with colorectal cancer. Patients who received fragmented care for cancer treatment had a higher risk of incident mood disorder within five years of their initial cancer diagnosis. The findings suggest that fragmented care may have a negative impact on the mental health of elderly patients with colorectal cancer. The results highlight the potentially important role of a cohesive health system in managing the mental health of patients with colorectal cancer, which is important considering that depression is relatively commonly found in these patients. Table 3 Results of the multivariable Cox regression analysis of the association between fragmented care and incident mood disorder

Variable	Five-year mood disorder incidence		
	HR	95% CI	
Fragmented Care			
No	1.00		
Yes	1.39	(1.10–1.77)	
Sex			
Male	1.00		
Female	1.22	(1.06–1.39)	
Age			
60 to 64 years	1.00		
65 to 69 years	1.14	(0.94–1.38)	
70 to 74 years	1.32	(1.10–1.60)	
75 to 79 years	1.45	(1.17–1.78)	
80 years			
Economic status			
Low	1.00		
Low-middle	1.13	(0.87–1.48)	
Middle	1.03	(0.80–1.33)	
Middle-high	1.06	(0.85–1.34)	
High	1.22	(0.98–1.50)	
Type of healthcare insurance		(	
NHI Self-employed	1.00		
NHI Employee	0.94	(0.82-1.09)	
Region	0.51	(0.02 1.03)	
Capital	1.00		
Metropolitan	0.94	(0.74_1.20)	
Rural	1 16	(0.95-1.41)	
Disability	1.10	(0.55 1.11)	
Non-disabled	1.00		
Disabled	1.00	(0.00, 1.43)	
Chronic dicesce	1.12	(0.57 1.+5)	
None	1.00		
	1.00	(1 17 1 55)	
21 CCI	1.55	(1.17-1.55)	
	1.00		
1	1.25	(1 12 1 62)	
	1.55	(1.15-1.05)	
22 Turno of hospital	1.50	(1.1–1.51)	
Tertiany bochital	1.00		
Conoral hospital	1.11	(0.06, 1.20)	
	1.11	(0.90-1.50)	
	1.03	(0.81-1.31)	
Hospital region	1.00		
Capital	1.00	(0.00, 1.20)	
Metropolitan	1.12	(0.90–1.39)	
	1.16	(0.92–1.45)	
lype of surgery	4.00		
Colorectomy and total colopropectomy	1.00	(0.04	
Rectal & Sigmoid resection & Resection of	0.98	(0.81–1.18)	
Rectal turnor	0.02	(0.40, 1.20)	
Enterostomy and intestinal Anastomosis	0.82	(U.48-1.39)	
	0.87	(0./2-1.06)	
iype of cancer	1.00		
Colon	1.00		

# Table 3 (continued)

Variable	Five-year mood disorder i	ncidence
	HR	95% CI
Rectosigmoid junction	0.85	(0.65–1.11)
Rectum	1.05	(0.89–1.23)

\*HR: Hazard Ratio; CI: Confidence Interval; NHI: National Health Insurance; CCI: Charlson Comorbidity Index

\*\*Cox regression was adjusted for all independent variables



Fig. 2 Kaplan-Meier survival curves constructed according to patients' experience of fragmented care

# Table 4 Results of the sensitivity analysis

Sensitivity analysis		Variable	Five-year mood disorder incidence		
			HR	95% CI	
Observation period for		Fragmented Care			
fragmented	d care extend	No	1.00		
to one-year		Yes	1.34	(1.03–1.75)	
Subgroup	Sex	Fragmented Care			
analysis	Male	No	1.00		
		Yes	1.35	(0.99–1.83)	
	Female	No	1.00		
		Yes	1.57	(1.07–2.29)	
	Chronic disease	Fragmented Care			
	None	No	1.00		
		Yes	1.07	(0.77–1.48)	
	≥1	No	1.00		
		Yes	2.10	(1.47–3.01)	
	Income	Fragmented Care			
	Below median	No	1.00		
		Yes	1.50	(1.04–2.17)	
	Above median	No	1.00		
		Yes	1.31	(0.96–1.80)	
	Type of cancer	Fragmented Care			
	Colon	No	1.00		
		Yes	1.51	(1.12–2.03)	
	Recto- sigmoid junction	No	1.00		
	,	Yes	1.28	(0.47-3.47)	
	Rectum	No	1.00	, /	
		Yes	1.27	(0.81-1.98)	

\*HR: Hazard Ratio; CI: Confidence Interval

\*\*All sensitivity analysis was adjusted for all independent variables

#### Abbreviations

CCI Charlson Comorbidity In	dex
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- CI Confidence interval
- HR Hazard ratio

 ICD-10
 International Classification of Diseases, Tenth Revision

 NHI
 National Health Insurance

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# Author contributions

Conceptualization: Lee W-R, Han K-T, Kim W. Data curation: Lee W-R, Han K-T. Methodology: Lee W-R, Han K-T, Kim W. Formal analysis: Lee-WR, Han K-T. Writing—original draft: Han K-T, Kim W. Writing—review & editing: Lee W-R, Han K-T, Kim W. Kyu-Tae Han and Woorim Kim contributed equally to this work.

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## Data availability

No datasets were generated or analysed during the current study.

#### Declarations

#### Ethics approval and consent to participate

Informed consent was not required from the study participants as we used secondary data from National Health Insurance Services (NHIS) and the data were analyzed anonymously and the requirement for ethical approval was waived by the Institutional Review Board of the National Cancer Center of Korea (NCC2022-0298).

#### **Consent for publication**

## Not applicable

Competing interests

The authors declare no competing interests.

#### Author details

<sup>1</sup>Department of Research and Analysis, National Health Insurance Service IIsan Hospital, Goyang, South Korea <sup>2</sup>Division of Cancer Control & Policy, National Cancer Control Institute, National Cancer Center, Goyang, South Korea <sup>3</sup>National Hospice Center, National Cancer Control Institute, National Cancer Center, Goyang, South Korea

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