MEDDOCS Open Access Publisher

ISSN: 2640-8198

Annals of Breast Cancer

Open Access | Research Article

The Impact of Age and Patient-Related Factors on the Administration of Chemotherapy for Older Patients with Breast and Colorectal Cancer: A Prospective Cohort Study

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Received: Aug 24, 2024

Accepted: Sep 16, 2024

Published Online: Sep 23, 2024

Journal: Annals of Breast Cancer

Publisher: MedDocs Publishers LLC

Online edition: http://meddocsonline.org/

Abstract

Objectives: This study aims to investigate the relationship between age and chemotherapy use in patients with Breast Cancer (BC) and Colorectal Cancer (CRC) while considering other patient-related factors. By investigating patient-related factors and their independent predictive impact on chemotherapy utilization, this research endeavors to enhance the understanding of treatment decision-making and improve patient outcomes in this vulnerable population.

Methods: We selected patients with BC and CRC from the prospective KLIMOP (Cancer in Limburg Older Patients) study. All were 50 years or older. In the univariable and multivariable logistic regression analyses on ACT use, we included age, gender, functional status, comorbidity, depressive symptoms, malnutrition, living situation, tumor status, nodal status, and for BC also adjuvant endocrine therapy use.

Results: We included 514 BC and 206 CRC patients, of whom respectively 34.2% and 64.6% received (neo-) adjuvant chemotherapy. In BC, the adjusted Odds Ratio (aOR) of chemotherapy use was 0.88 (95%CI 0.87-0.91) for increasing age per year, 7.89 (95%CI 4.82-12.91) for node-positive disease, 3.03 (95%CI 1.86-4.92) for T2+ status, and 0.28 (95%CI 0.16-0.48) for use of endocrine therapy. In CRC patients, the aOR was 0.91 (95%CI 0.86-0.96) for increasing age per year, 15.72 (95%CI 6.33-39.07) for node-positive disease, 0.25 (95%CI 0.10-0.60) for females and 0.26 (95%CI 0.11-0.60) for those with comorbidities. Living-together was an inde-

Cite this article: Tjan-Heijnen V, Abbema D V, Den Akker M V, Den Berkmortel F V, Koopmans M, et al. The Impact of Age and Patient-Related Factors on the Administration of Chemotherapy for Older Patients with Breast and Colorectal Cancer: A Prospective Cohort Study. 2024; 7(2): 1030.

pendent factor of increased chemotherapy use in female (aOR 5.37 (95%CI 1.22 - 23.71), but not in male patients with CRC. Noteworthy, functional dependency, depressive symptoms and malnutrition were in none of the analyses independently associated with chemotherapy use.

Conclusions: This study confirmed that older patients with BC and CRC were less likely to receive chemotherapy compared to younger patients, Unexpectedly, patient-related factors such as functional status and malnutrition were not independently associated with chemotherapy use. In CRC, female gender and the presence of comorbidities were associated with a lower likelihood of receiving chemotherapy, whereas the living situation had only an impact on chemotherapy administration in female CRC patients.

Introduction

Cancer continues to be a major global health challenge, with a significant impact on individuals and societies worldwide [1]. Female Breast Cancer (BC) is the most common malignancy in Europe, with 522,500 new cases each year (equivalent to 100.9 per 100,000 females) [2], followed by Colorectal Cancer (CRC), with 499,700 new cases each year (equivalent to 55.9 per 100,000 males and 35.6 per 100,000 females) [2]. Despite the increasing representation of older patients in the population affected by BC and CRC, older patients remain underrepresented in clinical trials [3,4]. This underrepresentation limits our understanding of treatment outcomes and optimal therapeutic strategies specifically tailored to older patients.

The underuse of neoadjuvant and adjuvant chemotherapy has been highlighted as potential cause of the higher cancer mortality rates in older patients [5-8]. Chemotherapy can obviously be more challenging and complicated in older patients. Indeed, previous studies reported that older patients are more likely to have serious side effects from chemotherapy [9]. That is, the high prevalence of geriatric syndromes in older patients can interfere with chemotherapy and can affect patient outcomes [10,11]. Geriatric syndromes is a collection of common medical conditions in older adults, such as physical frailty, cognitive impairment, and functional dependency [12]. In addition, the benefit of neoadjuvant and adjuvant chemotherapy in older patients may also differ from younger adults. Yet, there are large prospective and retrospective studies that suggest comparable survival benefits of chemotherapy in well-selected older patients [13,14].

While registry-based studies have investigated the impact of demographic, tumor-related, and comorbidity-related factors on the administration of chemotherapy in older patients, these studies often lack comprehensive information on patient-related factors that influence treatment decisions [15,16]. Therefore, this study aims to investigate the relationship between age and chemotherapy administration in older patients with BC and CRC while considering other patient-related factors, like functional dependency. By examining these factors independently, we can determine whether age alone is an independent predictive factor for chemotherapy utilization and identify patient-related factors that impact treatment decisions.

Material and methods

Study design

The KLIMOP study (Cancer in Limburg Older Patients) is a prospective observational cohort study. The methodology of the KLIMOP study was published by Decks et al. [17]. Patients were recruited between June 2010 and August 2014 from nine academic and non-academic hospitals in Belgium and the Netherlands. Eligible patients were patients aged ≥50 years at diagnosis of a primary cancer, and with a life expectancy of more than six months. Patients too ill to participate, previously diagnosed with cancer except for non-melanoma skin cancer, inability to speak Dutch, or with a formal diagnosis of dementia, were not eligible for enrollment. Patients received an explanatory letter about the KLIMOP study from their oncologist and they replied with a written informed consent if they agreed to participate.

Sample selection

Among the patients included in the KLIMOP study, we restricted our study cohort to those with a primary diagnosed BC and CRC, and those without signs of distant metastases at cancer diagnosis.

Data collection

Patient-related factors were collected through a personal interview or self-administrated questionnaire within three months after the primary diagnosis and included: gender, activities of daily living (ADL using the Katz scale; cut-off for dependency ≥1) [18]; instrumental activities of daily living (IADL, using the Lawton scale; cut-off for dependency ≥1) [19]; depressive symptoms (using the geriatric depression scale-15 (GDS-15); cut-off for depressive symptoms ≥5) [20]; nutritional status (using the Mini Nutrition Assessment-short form (MNA-SF); cut-off for malnutrition ≤11) [21], living situation (living together, institutionalized, or alone), and educational level (age at leaving school; <15 years, 15-18 years, and >18 years)

Tumor and treatment factors and comorbidities were issued from the medical chart. Cancer stage was based on the pathological TNM classification at the time of diagnosis (TNM classification, 6th edition). Treatment factors included primary cancer treatment (surgery, radiotherapy, endocrine therapy, chemotherapy, and immunotherapy) and date of diagnosis. Comorbidities were coded by means of the diseases listed in the Charlson Comorbidity Index (CCI) as 0, 1, or ≥2 comorbidities [22].

Statistical analysis

Descriptive statistics were used to describe baseline characteristics on patients, tumor and treatment factors of BC and CRC patients. The chi-square test for categorical data was used to compare older and younger patients.

Univariable and multivariable logistic regression was used to determine the association between chemotherapy use and baseline patient and tumor factors. The multivariable logistic regression models included patient factors (age in years, ADL, and IADL, comorbidities) and tumor factors (T and N status),. Unadjusted and adjusted Odd Ratios (ORs) with 95% Confidence Intervals (CI) were calculated.

Subgroup analyses were carried out with comparable univariable and multivariable analyses to evaluate patient and tumor factors in the younger (50-69 years) and older (≥70 years) patients separately. For CRC, additional subgroup analyses were carried out for gender (in female and male patients, separately).

All analyses were performed with SPSS (Statistical Package for the Social Sciences) version 21.0.

Ethics

The medical research ethics committees of KU Leuven, UZ Leuven (S52097-ML6279) and the Maastricht University Medical Center (NL414.068.10) approved the KLIMOP study. Written informed consent was obtained from all patients before participation.

Results

We included 514 BC and 206 CRC patients in the present study; among these, 178 patients with BC (34.6%) and 133 with CRC (64.6%) received neoadjuvant or adjuvant chemotherapy. Chemotherapy was used in 44.2% of patients with BC aged 50-69 years and in 11.0% of those aged ≥70 years. Chemotherapy was used in 74.4% of CRC patients aged 50-69 years and in 49.4% of CRC patients aged ≥70 years. The BC patients had a mean age of 64.6 years (standard deviation (SD) 9.6), 176 (34.6%) were independent in their ADL and 153 (29.8%) in their IADL, and 103 (20.0%) had ≥1 comorbidities (Table 1). The included CRC patients had a mean age of 67.4 (SD 8.65), 31 (38.1%) were independent in their ADL, 26 (32.1%) in their IADL, and 33 (42%) had ≥1 comorbidities (Table 2).

In Table 3, results of the multivariable analysis of the effect of age (per year) on neoadjuvant or adjuvant chemotherapy use in patients with primary BC are presented. Older age was negatively associated with chemotherapy use (adjusted Odds Ratio (aOR) 0.88, 95%CI 0.87-0.91). Tumor factors associated with chemotherapy use included positive lymph nodes (aOR 7.89, 95%CI 4.82-12.91) and T2-4 compared to T1 status (aOR 3.03, 95%CI 1.86-4.92). Patients with BC receiving endocrine therapy were significantly less likely to receive chemotherapy (aOR 0.28, 95%CI 0.16-0.48). ADL, IADL, depressive symptoms, malnutrition, living situation, and age at leaving school were not associated with chemotherapy use in patients with BC. Subgroup analyses were carried out for patients aged 50-69 years and ≥70 years with BC. The multivariate results were similar to those of the total sample, except that a higher T stage and N stage in patients with BC aged ≥70 years was not significantly associated with a higher likelihood of chemotherapy use after adjusting for all other factors.

Likewise, age was an independent predictor for chemotherapy use in patients with primary CRC (aOR 0.91, 95% CI 0.86-0.96) (Table 4). Other patient factors independently associated with chemotherapy use were, however, also female gender vs. male gender (aOR 0.25, 95% CI 0.10-0.60) and having one or more comorbidities (aOR 0.26, 95%CI 0.11-0.60). Tumor factors included a positive lymph node status (aOR 15.73, 95%CI 6.33-39.07). Further, in the subgroup analyses, relatively younger CRC patients (50-69 years) with ≥1 comorbidities were significantly less likely to receive chemotherapy (aOR 0.16, 95%CI 0.05-0.54), whereas presence of comorbidities was not significantly associated with chemotherapy use (aOR 0.40, 95%CI 0.11-1.51) in CRC patients ≥70 years.

As gender was a significant predictor for chemotherapy use, we carried out subgroup analyses for female and male patients with CRC (Table 5). Similar predictors were found for chemotherapy use in female and male patients. However, female patients living together with a partner compared to female patients living alone were significantly more likely to receive chemotherapy (aOR 5.37, 95%CI 1.22-23.71).

Table 1: Patient, tumour and treatment characteristics of patients with breast cancer (n = 514).

	All cases (%) (n = 514)	50 - 69 years (%) (n = 360)	≥ 70 year (%) (n = 154)	p
Mean age at diagnosis (SD), years	64.6 (9.6)	59.4 (5.4)	76.2 (4.2)	
Gender				
Male				
Female	514 (100)	360 (100)	154 (100)	
ADL				
Independent	336 (65.4)	265 (73,6)	71 (46.1)	<0.001
Dependent	178 (34.6)	95 (26,4)	83 (53.9)	
IADL				
Independent	342 (66.5)	257 (71.4)	85 (55.2)	<0.001
Dependent	153 (29.8)	88 (24.4)	65 (42.2)	
Missing	19 (3.7)	14 (4.2)	4 (2.6)	
Comorbidity				
0	358 (69.6)	268 (74.4)	90 (58.4)	<0.001
1	103 (20.0)	64 (17.8)	39 (25.3)	
≥ 2	53 (10.3)	28 (7.8)	4 (16.2)	
Depressive symptoms				
None	422 (82.1)	292 (81.1)	130 (84.4)	0.15
Mild or severe	5 (10.9)	44 (12.2)	12 (7.8)	
Missing	36 (7.0)	24 (6.7)	12 (7.8)	
Malnutrition				
No	205 (39.9)	135 (37.5)	70 (45.5)	0.04
Yes	269 (52.3)	201 (55.8)	68 (44.2)	
Missing	40 (7.8)	24 (6.7)	16 (10.4)	
Living situation				
Alone	113 (22.0)	52 (14.4)	61 (39.6)	<0.001
Together, institutionalized	401 (80.0)	308 (85.5)	93 (60.4)	
Age at leaving school				
< 15 years	81 (15.8)	30 (8.3)	51 (33.1)	<0.001
15 - 18 years	239 (46.5)	173 (48.1)	66 (42.9)	
> 18 years	177 (34.4)	145 (40.3)	32 (20.9)	
Missing	17 (3.3)	12 (3.3)	5 (3.2)	

T stage				
T1, Tx	282 (54.9)	244 (62.2)	58 (37.7)	<0.001
T2 - 4	216 (42.0)	127 (35.2)	89 (57.8)	
Missing	16 (3.1)	9 (2.5)	7 (4.5)	
N stage				
N0, Nx	321 (62.5)	229 (63.6)	92 (59.7)	0.69
N1 - 2	178 (34.6)	124 (34.4)	54 (35.1)	
Missing	15 (2.9)	7 (1.9)	8 (5.2)	
Treatment				
Surgery	509 (99.0)	360 (100)	149 (96.8)	<0.001
Radiotherapy	381 (74.1)	281 (78.1)	100 (64.9)	<0.001
Chemotherapy	176 (34.2)	159 (44.2)	17 (11.0)	<0.001
Endocrine therapy	369 (71.8)	255 (70.8)	114 (74.0)	0.49
Immunotherapy	42 (8.2)	36 (10.0)	6 (3.9)	<0.05

Table 2: Patient, tumour and treatment factors of patients with colorectal cancer (n = 206).

	All cases (%) (n = 206)	50 - 69 years (%) (n = 125)	≥ 70 year (%) (n = 81)	P
Mean age at diagnosis (SD), years	67.4 (8.65)	61.7 (5.3)	76.3 (4.2)	
Gender				
Male	126 (61.2)	75 (60.0)	51 (63.0)	0.67
Female	80 (38.8)	50 (40.0)	30 (37.0)	
ADL				
Independent	135 (65.5)	85 (68.0)	50 (61.7)	0.36
Dependent	71 (34.5)	40 (32.0)	31 (38.3)	
IADL				
Independent	135 (65.5)	88 (70.4)	54 (66.7)	0.43
Dependent	71 (34.4)	33 (26.4)	26 (32.1)	
Missing		4 (3.2)	1 (1.2)	
Comorbidity				
0	134 (65.0)	87 (69.6)	47 (58.0)	0.09
1	39 (18.9)	23 (18.4)	16 (19.8)	
≥ 2	33 (16.0)	15 (12.0)	18 (22.2)	
Depressive symptoms				
None		105 (84.0)	64 (79.0)	0.72
Mild or severe	169 (82.0)	11 (8.8)	8 (9.9)	
Missing	19 (9.2)	9 (7.2)	9 (11.1)	
Malnutrition				
No	59 (28.6)	38 (30.4)	21 (25.9)	0.67
Yes	131 (63.6)	80 (64.0)	51 (63.0)	
Missing	16 (7.8)	7 (5.6)	9 (11.1)	
Living situation				
Alone	38 9 (18.4)	21 (16.8)	17 (21.0)	0.48
Together, institutionalized	168 (81.6)	104 (84.2)	64 (79.0)	
Age at leaving school				
< 15 years	37 (18.0)	15 (12.0)	22 (27.2)	<0.05
15 - 18 years	96 (46.6)	57 (45.6)	39 (48.1)	
> 18 years	68 (33.0)	51 (40.8)	17 (21.0)	
Missing	5 (2.4)	2 (1.6)	3 (3.7)	
T stage				
T1, Tx	18 (8.7)	7 (5.6)	11 (13.6)	<0.05
T2 - 4	87.9 (91.0)	116 (92.8)	65 (80.2)	
Missing	7 (3.4)	2 (1.6)	5 (6.2)	
N stage				
N0, Nx	91 (44.2)	51 (40.8)	40 (49.4)	0.12
N1 - 2	106 (51.5)	71 (56.8)	35 (43.2)	
Missing	9 (4.4)	3 (2.4)	6 (7.4)	
Treatment				
Surgery	188 (91.3)	115 (92.0)	73 (90.1)	0.64
Radiotherapy	64 (31.1)	48 (38.4)	40 (49.4)	<0.05
Chemotherapy	133 (64.6)	93 (74.4)	16 (19.8)	<0.001

Abbreviations: ADL: Activity of Daily Living; IADL: Instrumental Activity of Daily Living.

Table 3: Unadjusted and adjusted odds ratios for adjuvant chemotherapy use by comparing patients with breast cancer and age at diagnosis.

	All cases (n = 514)		50 - 69 years (n = 360)		≥ 70 year (n = 154)	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Age at diagnosis, per year	0.92 (0.89 - 0.94) *	0.88 (0.87 - 0.91) *	0.95 (0.91 - 0.99) *	0.93 (0.88 - 0.98) *	0.85 (0.74 - 0.98) *	0.82 (0.69 - 0.96) *
ADL						
Independent	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Dependent	0.63 (0.42 - 0.93) *	0.69 (0.42 - 1.15)	1.00 (0.63 - 1.61)	0.77 (0.42 - 1.40)	0.56 (0.20 - 1.56)	0.59 (0.19 - 1.79)
IADL						
Independent	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Dependent	0.78 (0.52 - 1.17)	0.95 (0.56 - 1.62)	1.05 (0.64 - 1.70)	0.94 (0.50 - 1.76)	0.91 (0.33 - 2.52)	1.32 (0.42 - 4.14)
Comorbidity						
0	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
≥ 1	0.67 (0.44 - 1.01)	0.97 (0.58 - 1.63)	0.88 (0.55 - 1.43)	0.78 (0.60 - 1.98)	0.57 (0.19 - 1.71)	0.64 (0.20 - 2.09)
Depressive symptoms						
None	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Mild or severe	1.54 (0.88 - 2.72)	(1.19 (0.60 - 2.38)	1.37 (0.71 - 2.52)	1.17 (0.55 - 2.51)	1.80 (0.36 - 9.12)	2.17 (0.37 - 12.75)
Malnutrition						
No	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Yes	1.28 (0.87 - 1.89)	1.33 (0.82 - 2.14)	1.00 (0.65 - 1.56)	1.23 (0.71 - 2.14)	2.51 (0.82 - 7.65)	3.01 (0.91 - 9.94)
Living situation						
Alone	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Together, institutionalized	1.79 (1.11 - 2.87) *	1.19 (0.66 - 2.16)	0.92 (0.51 - 1.66)	0.84 (0.40 - 1.76)	2.32 (0.72 - 7.47)	2.01 (0.85 - 6.98)
Age at leaving school						
< 15 years	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
15 - 18 years	1.28(0.73 - 2.23)	1.05 (0.49 - 2.19)	0.59 (0.27 - 1.30)	0.97 (0.35 - 2.77)	0.89 (0.28 - 2.83)	1.02 (0.30 - 3.53)
> 18 years	1.80 (1.01 - 3.19) *	1.31 (0.60 - 2.89)	0.78 (0.35 - 1.70)	1.49 (0.51 - 4.38)	0.78 (0.18 - 3.35)	0.71 (0.15 - 3.34)
T stage						
T1, Tx	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
T 2 - 4	2.13 (1.47 - 3.10) *	3.03 (1.86 - 4.92) *	3.96 (2.50 - 6.28) *	3.42 (1.98 - 5.89) *	2.31 (0.71 - 7.47)	3.04 (0.86 - 10.74)
N stage						
N0, Nx	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
N1 - 2	6.33 (4.22 - 9.15) *	7.89 (4.82 - 12.91) *	12.28 (7.19 - 20.99) *	11.45 (6.49 - 20.22) *	2.1 (0.76 - 5.82)	1.99 (0.66 - 6.03)
Endocrine therapy						
No	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Yes	0.72 (0.48 - 1.07)	0.28 (0.16 - 0.48) *	1.10 (0.70 - 1.75)	0.44 (0.24 - 0.81) *	0.08 (0.02 - 0.25) *	0.17 (0.01 - 0.11) *

Abbreviations: ADL: activity of daily living; IADL: instrumental activity of daily living; OR: odds ratio; CI: confidence interval), * = p <0.05. Multivariable logistic regression models included tumor characteristics, ADL, IADL, comorbidities, and age.

Table 4: Unadjusted and adjusted odds ratios for adjuvant chemotherapy use by comparing patients with colorectal cancer and age at diagnosis.

	All cases (n = 206)		50 - 69 years (n = 125)		≥ 70 year (n = 81)	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Age at diagnosis, per year	0.92 (0.88 - 0.95) *	0.91 (0.86 - 0.96) *	0.93 (0.86 - 1.01)	0.94 (0.82 - 1.07)	0.82 (0.72 - 0.94) *	0.77 (0.65 - 0.92) *
Gender						
Male	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Female	0.47 (0.26 - 0.84) *	0.25 (0.10 - 0.60) *	0.34 (0.15 - 0.78) *	0.17 (0.05 - 0.54) *	0.55 (0.22 - 1.37)	0.64 (0.16 - 2.56)
ADL						
Independent	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Dependent	0.58 (0.32 - 1.06)	0.90 (0.39 - 2.20)	0.72 (0.31 - 1.67)	1.22 (0.37 - 4.06)	0.50 (0.20 - 1.24)	0.37 (0.09 - 1.54)
IADL						
Independent	(ref)	(ref)	(ref)	(ref)	(ref)	
Dependent	0.53 (0.29 - 0.99) *	0.80 (0.33 - 1.95)	0.40 (0.17 - 0.94) *	0.53 (0.16 - 1.78)	0.80 (0.31 - 2.03)	
Comorbidity						
0	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
≥ 1	0.29 (0.16 - 0.53) *	0.26 (0.11 - 0.60) *	0.26 (0.11 - 0.60) *	0.16 (0.05 - 0.54) *	0.37 (0.15 - 0.92)	0.40 (0.11 - 1.51)
Depressive symptoms						
None	(ref)	(ref)	(ref)	(ref)	-	-
Mild or severe	0.33 (0.13 - 0.88) *	0.36 (0.09 - 1.53)	0.92 (0.23 - 3.73)	1.20 (0.13 - 10.85)		

Malnutrition						
No	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Yes	0.46 (0.23 - 0.93) *	0.60 (0.23 - 1.56)	0.56 (0.22 - 1.45)	1.42 (0.39 - 5.19)	0.36 (0.12 - 1.06)	0.17 (0.03 - 1.05)
Living situation						
Alone	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Together, institutionalized	2.44 (1.19 - 4.99) *	2.23 (0.80 - 6.29)	1.63 (0.59 - 4.49)	1.85 (0.27 - 5.16)	4.18 (1.23 - 14.22) *	6.70 (1.09 - 41.14) *
Age at leaving school						
< 15 years	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
15 - 18 years	0.89 (0.41 - 1.94)	0.69 (0.22 - 2.18)	0.50 (0.13 - 1.99)	0.78 (0.11 - 5.61)	0.95 (0.33 - 2.70)	0.25 (0.04 - 1.60)
> 18 years	1.98 (0.83 - 4.72)	0.87 (0.24 - 3.13)	1.17 (0.27 - 5.00)	1.58 (0.19 - 13.02)	1.43 (0.40 - 5.12)	0.12 (0.01 - 1.04)
T stage						
T1, Tx	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
T 2 - 4	6.12 (2.08 - 18.00) *	3.98 (0.85 - 18.67)	4.62 (0.97 - 21.95)	3.17 (0.24 - 41.54)	5.95 (1.19 - 29.72)	9.03 (1.05 - 77.74) *
N stage						
N0, Nx	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
N1 - 2	10.93 (5.26 - 22.70) *	15.73 (6.33 - 39.07) *	16.11 (5.11 - 50.79) *	21.96 (5.83 - 82.69) *	7.88 (2.79 - 22.26)	11.23 (2.92 - 43.17) *

Abbreviations: ADL: activity of daily living; IADL: instrumental activity of daily living; OR: odds ratio; CI: confidence interval), * = p <0.05. Multivariable logistic regression models included tumor characteristics, ADL, IADL, comorbidities, and age.

Table 5: Unadjusted and adjusted odds ratios for adjuvant chemotherapy use by comparing patients with colorectal cancer and gender.

	Male (n = 126)		Female (n = 80)	
	Unadjusted OR (95% CI)	**Adjusted OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
Age at diagnosis	0.90 (0.85 - 0.95) *	0.92 (0.8 - 0.98) *	0.94 (0.89 - 0.99) *	0.89 (0.82 - 0.97) *
ADL				
Independent	(ref)	(ref)	(ref)	(ref)
Dependent	0.65 (0.28 - 1.50)	0.59 (0.19 - 1.86)	0.68 (028 - 1.65)	0.70 (0.41 - 2.77)
IADL				
Independent	(ref)	(ref)	(ref)	(ref)
Dependent	0.44 (0.18 - 1.08)	0.72 (0.21 - 2.47)	0.86 (0.25 - 2.09)	0.80 (0.21 - 3.05)
Comorbidity				
0	(ref)	(ref)	(ref)	(ref)
≥ 1	0.36 (0.16 - 0.81) *	0.40 (0.14 - 1.18)	0.10 (0.06 - 0.47)	0.13 (0.03 - 0.56) *
Depressive symptoms				
None	(ref)	(ref)	(ref)	(ref)
Mild or severe	0.23 (0.07 - 0.77) *	0.38 (0.07 - 2.14)	0.60 (0.12 - 2.89)	0.39 (0.03 - 5.23)
Malnutrition				
No	(ref)	(ref)	(ref)	(ref)
Yes	0.33 (0.12 - 0.88) *	0.36 (0.10 - 1.37)	0.80 (0.27 - 2.40)	1.08 (0.23 - 5.08)
Living situation				
Alone	(ref)	(ref)	(ref)	(ref)
Together, institutionalized	0.81 (0.24 - 2.71)	0.82 (0.16 - 4.24)	4.8 (1.62 - 14.22)	5.37 (1.22 - 23.71) *
Age at leaving school				
< 15 years	(ref)	(ref)	(ref)	(ref)
15 - 18 years	0.93 (0.32 - 2.67)	0.34 (0.07 - 1.77)	0.60 (0.29 - 3.19)	1.50 (0.22 - 10.38)
> 18 years	1.85 (0.59 - 5.82)	0.62 (0.11 - 3.35)	2.00 (0.50 - 8.00)	1.17 (0.13 - 10.56)
T stage				
T1, Tx	(ref)	(ref)	(ref)	(ref)
T 2 - 4	6.62 (1.55 - 28.31) *	10.39 (1.21 - 88.93) *	5.13 (0.99 - 26.51)	1.32 (0.12 - 14.06)
N stage				
N0, Nx	(ref)	(ref)	(ref)	(ref)
N1 -	13.28 (4.25 - 41.44) *	15.60 (4.12 - 59.07) *	14.22 (4.72 - 42.87)	23.41 (5.04 - 108.62) *

Abbreviations: ADL: activity of daily living; IADL: Instrumental Activity of daily living; OR: odds ratio; CI: confidence interval), * = p <0.05 Multivariable logistic regression models included tumor characteristics, ADL, IADL, comorbidities, and age.

Discussion

The objective of this study was to examine the relationship between age and chemotherapy utilization in older patients with BC and CRC while considering other patient-related factors. We found that age was a significant determining factor, with older patients less likely to receive chemotherapy compared to younger patients. This disparity remained even after considering tumor characteristics, functional status, and comorbidities. Interestingly, functional status, depression, malnutrition, living situation, and educational level did not show a significant association with chemotherapy administration in BC patients. In CRC patients, however, the presence of at least one comorbidity and female gender were associated with a lower likelihood of receiving chemotherapy. Additionally, in female CRC patients,

living situation (alone or together) had a significant impact on chemotherapy administration.

Our study contributes to the existing literature by examining the impact of age on chemotherapy administration in BC and CRC patients. Consistent with previous research [23-25], our findings indicate that older patients are less likely to receive chemotherapy compared to younger patients. However, the literature provides conflicting results regarding the influence of age on treatment decisions. Some studies suggest that age has less predictive power in chemotherapy utilization, while others suggest that older patients are less likely to receive chemotherapy even when considering tumor characteristics, comorbidities, and social factors [26]. The conflicting findings highlight the complexity of age as a factor in chemotherapy utilization. Therefore, it is important to consider other factors that could influence treatment decisions beyond age alone. Previous studies indicated that concerns regarding treatment toxicity, patient preferences, and oncologists' perceptions of chemotherapy tolerance in relation to age also play crucial roles [27]. Addressing age-related biases identified in our study is crucial to ensure equitable access and to improve treatment outcomes for this specific patient population.

Our study identified a notable disparity in chemotherapy administration for CRC patients, with lower rates observed among female patients compared to male patients. This finding is consistent with previous studies [16, 28]. Several studies indicated that patient preferences and social context play a significant role in these gender-related differences [29]. For instance, female patients might perceive the risk associated with chemotherapy differently than male patients, and female patients may prefer a more participatory role in treatment-decision making, potentially leading to different treatment choices [30, 31]. Interestingly, our analysis found that in female CRC patients, living situation (alone or together) had a significant impact on chemotherapy administration. Hamelinck et al. also suggested that the social situation is associated with patient preference for chemotherapy use in women with BC [29]. This highlights the need for further investigation into the broader social context in which women receive chemotherapy. By understanding the underlying mechanisms driving these gender-related disparities, we can strive for equitable healthcare outcomes for all patients, regardless of gender.

Guidelines have influenced the administration of chemotherapy among BC and CRC patients over time [32,33]. Interestingly, there are notable disparities in the level of clarity and specificity between guidelines for older BC patients compared to older CRC patients. For instance, Dutch BC guidelines suggest that for patients aged 70 years or older, strong chemotherapy recommendations are hindered due to insufficient data. However, chemotherapy may be considered for fit older patients with a high risk of BC recurrence [34]. On the other hand, CRC guidelines do not provide definitive conclusions regarding chemotherapy use in older patients. Instead, they emphasize that the potential benefits of chemotherapy should be carefully weighed against the treatment burden, with health status and comorbidities being more relevant factors than age [35]. This difference in guideline recommendations may contribute to the lower utilization of chemotherapy in older BC patients, highlighting the need for further refinement of guidelines to ensure equitable access and appropriate treatment decisions for all patient populations.

There are certain limitations to our study that should be considered. Firstly, the data collected from medical records had some limitations, including limited information on the patients' condition, such as the Eastern Cooperative Oncology Group (ECOG) performance status, elective or emergency surgeries, and surgical complications. These variables could have provided a more detailed understanding of the patient's condition at the time of treatment initiation. Additionally, our approach of combining data from both colon and rectal cancer patients may have limitations, as the treatment modalities for these two cancer types can significantly differ. Despite these limitations, our study has strengths. The prospective observational design allowed us to investigate the determinants of chemotherapy utilization. By investigating whether the administration of chemotherapy is influenced by patient-specific or clinical factors, our study adds valuable insights to the existing body of knowledge. The data collected allowed for an in-depth examination of patient-specific factors that may influence the utilization of chemotherapy in older patients.

In conclusion, our study found that age was the most significant factor influencing chemotherapy utilization in BC and CRC patients, even after controlling for confounding patient-related factors. This suggests that age plays a determinant role in treatment decision-making for this population. However, in CRC patients, patient-related factors such as comorbidities, gender, and living situation emerged as significant factors associated with chemotherapy administration. Our findings highlight the complexity of treatment decisions and the need for individualized, patient-centered care. While age is an important consideration, it is crucial to also take into account patient-specific factors that may impact treatment outcomes. Addressing age-related biases is essential to optimize treatment decisions and improve outcomes for older patients. Further research should focus on investigating the factors that influence treatment decisions and developing interventions to address disparities and improve care for older patients.

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