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Original Article

The Work Productivity of Cancer-survivor and Non-cancer-survivor Workers

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We investigated the work productivity levels of employed cancer survivors and non-cancer-survivor workers by conducting a cross-sectional study in Japan between February and March 2019, using an online survey. A total of 561 employed individuals aged 20-64 years were analyzed. Work productivity was assessed using the Work Productivity and Activity Impairment-General Health questionnaire which evaluates absenteeism, presenteeism, and overall work productivity loss. The questionnaire responses demonstrated that the cancer survivors within 1 year of diagnosis had significantly higher absenteeism compared to the non-cancer workers ($p = 0.048$). Although presenteeism and overall work productivity loss were also higher in the non-cancer-survivor group, the differences were not significant. Cancer survivors within 1 year of diagnosis exhibited higher absenteeism, but their work productivity appeared to recover to levels comparable to those of the non-cancer workers over time. These findings may contribute to workplace policies supporting cancer survivors' return to work.

Key words: cancer survivor, work productivity, absenteeism, presenteeism

Cancer remains a major public health concern globally, with a substantial number of individuals receiving diagnoses and undergoing treatment. Advances in medical technology have significantly improved the survival rates of individuals with cancer, leading to a growing population of cancer survivors, particularly in high-income countries [1-3]. The process of returning to work (RTW) is increasingly recognized as a critical aspect of cancer survivors' reintegration into society [4,5]. Given the rising retirement age associated with aging populations in many countries, the role of older workers has become increasingly vital [6,7], and consequently, cancer survivors' RTW has emerged as a pressing societal issue, necessitating concerted efforts to facilitate their workforce reintegration. This challenge is underscored in Japan's Basic Plan to Promote Cancer Control, which emphasizes the importance of balancing cancer treatment with continued employment [8].

Even after completing treatment, cancer survivors frequently encounter physical, psychological, and social challenges that can impair work productivity, manifesting as absenteeism and presenteeism [9]. Cancer survivors often experience diminished workplace performance [10-12] that is influenced by multiple factors, including the adverse effects of chemotherapy [4,13-15], surgical interventions [16], cancer-related fatigue [17], their cancer type [18], and the stage of their cancer at the initial diagnosis [19,20]. A cohort study conducted in Northern Europe comparing the employment status of survivors of multiple cancer types

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with that of individuals without cancer found that absenteeism rates were significantly higher among the cancer survivors within the first 5 years after their diagnoses [21, 22]. Cohort studies focusing exclusively on breast cancer survivors [15, 23] and those with various cancer types including breast cancer [11] reported increased absenteeism and presenteeism within the first year post-diagnosis. Cross-sectional studies examining work productivity among cancer survivors and non-cancer survivors have similarly demonstrated survivors' elevated absenteeism [10], increased cognitive limitations at work in breast cancer survivors [24], and reduced work ability [12, 25, 26]. However, these studies did not assess the impact of the length of time since diagnosis on cancer survivors' work productivity. There is thus a lack of comprehensive evidence regarding the long-term effects of cancer survivorship on labor productivity and how these effects compare with those of non-cancer workers. We speculated that a deeper understanding of the relationship between the work productivity of cancer survivors and that of non-cancer workers across different time points after diagnosis could inform strategies to facilitate cancer survivors' return to work and improve their employment conditions. We conducted the present study to (*i*) compare the work productivity of cancer-survivor workers and non-cancer workers and (*ii*) clarify the impact of the length of time since the cancer diagnosis on the worker's productivity.

Materials and Methods

Data source and study population. We applied a cross-sectional design and distributed a survey in Japan between February and March 2019. Data were collected through an online survey using the Internet panel provided by Macromill, Inc. (Tokyo), Japan's largest online survey provider, with participants randomly selected from the panel. Eligibility criteria required the participants to be ≥20 years old. Individuals who were undergoing treatment for multiple cancers or other serious medical conditions were excluded. A total of 1,500 individuals participated in the survey, comprising 300 individuals diagnosed with stomach cancer, colorectal cancer, lung cancer, and breast cancer, respectively, along with 300 participants with no history of cancer.

After the exclusion of participants with missing data, the final study population included 561 individuals aged 20-64 years, consisting of both cancer survivors and cancer-free individuals who were engaged in paid employment at the time of the survey (Fig. 1). The analysis was restricted to participants <65 years old, considering that the standard retirement age in Japan ranges from 60 to 65 years.

Work productivity indicators. The primary outcome measures in this study were work productivity loss, assessed using the Work Productivity and Activity Impairment-General Health questionnaire (WPAI-GH) [27]. This instrument evaluates absenteeism (the percentage of work time missed due to health problems over the past 7 days), presenteeism (the percentage of productivity loss while at work due to health problems over the past 7 days), and overall work productivity loss (a composite measure incorporating both absenteeism and presenteeism). For absenteeism, the participants reported the amount of work time missed due to health-related issues in the past 7 days. For presenteeism, the participants rated the extent to which health problems

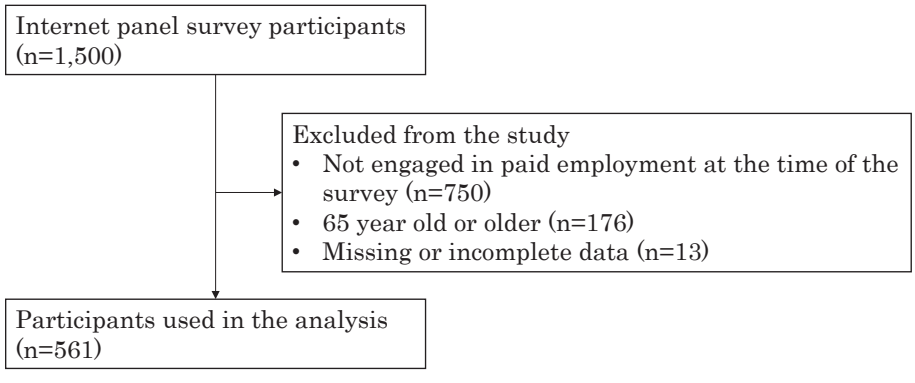

Fig. 1 Flow chart of the participant enrollment.

affected their work productivity on a 0- to 10-point scale, with higher scores indicating greater impairment. The WPAI-GH has demonstrated validity in cancer populations, including studies investigating its association with quality of life in patients with advanced breast cancer [28]. The WPAI-GH has also been widely utilized to assess work productivity among cancer patients [10, 11, 23, 29].

Variables. The work productivity of the non-cancer-survivor workers was compared with that of the cancer-survivor workers, stratified into four groups based on the the length of time since the cancer survivors' diagnoses: < 1 year, from > 1 year to 3 years, from > 3 years to < 5 years, and ≥ 5 years. The analysis covariates included sex (male, female), age at the time of the survey (20-39, 40-49, 50-59, 60-64), marital status (married, unmarried), and cancer type (stomach, colorectal, lung, breast). Employment status was categorized as full-time, part-time, or self-employed. the presence of comorbidities (including heart, cerebrovascular, gastrointestinal, hepatic, respiratory, orthopedic, connective tissue diseases, diabetes, hypertension, mental disorders, and other cancers) was considered. The number of comorbidities was classified as none, one, or two or more. The cancers examined in this study represent the four most prevalent cancer types in Japan [30].

Statistical analyses. The primary outcomes of this study were the work productivity indicators: absenteeism, presenteeism, and overall productivity loss. To examine the associations between these outcomes and various factors, we performed bivariate analyses using either an analysis of variance (ANOVA) or nonparametric tests, depending on the data distribution. Multiple regression models were used for the multivariate analysis, with absenteeism, presenteeism, and overall productivity loss as the dependent variables. The explanatory variables included the number of years since cancer diagnosis (non-cancer, < 1 year, from > 1 year to 3 years, from > 3 years to < 5 years, and ≥ 5 years), sex, age group (20-39, 40-49, 50-59, 60-64 years), marital status (married, never married), employment status (full-time, part-time, self-employed), and the number of comorbidities (none, one, two or more). The adjusted values for absenteeism, presenteeism, and overall productivity loss were estimated. As a sub-analysis, we compared the non-cancer and cancer groups for each of the four cancer types examined in this study (stomach, colorectal, lung, breast).

Statistical significance was set at $p < 0.05$. All analyses were conducted using JMP® Pro 16.1.0 (SAS, Cary, NC, USA). The sample size was estimated using the software program G*Power [31]. The parameters for the one-way ANOVA were set as: effect size f = 0.25, α = 0.05, power = 0.8, and number of groups = 5, resulting in a calculated sample size of 255. Given that the study targeted four cancer types and non-cancer controls, we planned a total sample size of 1,500 ($\fallingdotseq 5 \times 255$).

Ethical considerations. This study was reviewed and approved by the Ethics Committee of Kagawa University School of Medicine (approval no. Heisei 30-169). Only participants who provided informed consent were included. All analytical procedures were conducted in accord with the principles of the Declaration of Helsinki, and this report complies with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.

Results

Participant characteristics. Of the 561 participants, 383 (68.3%) were cancer survivors and 178 (31.7%) were non-cancer individuals; 57% were male and 43% were female. In terms of age, 47% of the participants were in their 50s, 25% were in their 40s, and 21% were aged 60-64, with the cancer survivors being older. Among all of the participants, 67% were married, 73% worked full-time, 16% worked part-time, and 11% were self-employed. The most common type of cancer was breast cancer (35%), followed by colorectal (24%), lung (22%), and stomach (19%) cancer. The most common comorbidities were hypertension (13%), psychiatric disorders (7%), diabetes (6%), gastrointestinal disorders (3%), and orthopedic disorders (3%). Seventy percent of the participants had no comorbidities, 22% had one comorbidity, and 8% had two or more comorbidities. With regard to the number of years since the diagnosis for the cancer survivors, 8 participants (2%) had been diagnosed < 1 year before completing the questionnaire, 102 (27%) had been diagnosed from > 1 year to 3 years, 68 (18%) from > 3 years to < 5 years, and 205 (54%) ≥ 5 years (Table 1).

Work productivity.

1. Bivariate analysis.

The absenteeism value among all 561 participants was 4.9%, while presenteeism and overall work pro-

Table 1 Participant characteristics

Level	Prticipants, No.(%)			*P*-value	Years since diagnosis of cancer survivors			
	Total (n = 561)	No history of cancer (n = 178)	Cancer survivor workers (n = 383)		< 1 year (n = 8)	< 3 years (n = 102)	< 5 years (n = 68)	≥ 5 years (n = 205)
Sex								
Men	318 (57)	118 (66)	200 (52)	0.001	6 (75)	59 (58)	42 (62)	93 (45)
Women	243 (43)	60 (34)	183 (48)		2 (25)	43 (42)	26 (38)	112 (55)
Age in years at time of the survey								
20–39	41 (7)	29 (16)	12 (3)	< .0001	1 (13)	4 (4)	3 (4)	4 (2)
40–49	141 (25)	63 (35)	78 (20)		2 (25)	28 (27)	15 (22)	33 (16)
50–59	261 (47)	69 (39)	192 (50)		3 (38)	46 (45)	33 (49)	110 (54)
60–64	118 (21)	17 (10)	101 (26)		2 (25)	24 (24)	17 (25)	58 (28)
Marital status								
Married	376 (67)	116 (65)	260 (68)	0.524	6 (75)	72 (71)	46 (68)	136 (66)
Unmarried	185 (33)	62 (35)	123 (32)		2 (25)	30 (29)	22 (32)	69 (34)
Employment status								
Full-time	410 (73)	143 (80)	267 (70)	0.027	6 (75)	72 (71)	48 (71)	141 (69)
Part-time	88 (16)	19 (11)	69 (18)		1 (13)	14 (14)	15 (22)	39 (19)
Self- employed	63 (11)	16 (9)	47 (12)		1 (13)	16 (16)	5 (7)	25 (12)
Type of Cancer								
Stomach	71 (19)	–	71 (19)		1 (13)	17 (17)	13 (19)	40 (20)
Colorectal	92 (24)	–	92 (24)		2 (25)	26 (25)	18 (26)	46 (22)
Lung	85 (22)	–	85 (22)		3 (38)	25 (25)	20 (29)	37 (18)
Breast	135 (35)	–	135 (35)		2 (25)	34 (33)	17 (25)	82 (40)
Comorbid conditions								
Heart diseases	12 (2)	3 (2)	9 (2)	0.761	0 (0)	5 (5)	0 (0)	4 (2)
Cerebrovascular diseases	3 (1)	2 (1)	1 (0)	0.238	0 (0)	1 (1)	0 (0)	0 (0)
Gastrointestinal diseases	19 (3)	5 (3)	14 (4)	0.803	0 (0)	2 (2)	6 (9)	6 (3)
Liver diseases	8 (1)	2 (1)	6 (2)	1.000	0 (0)	3 (1)	0 (0)	3 (1)
Respiratory diseases	10 (2)	4 (2)	6 (2)	0.571	0 (0)	2 (2)	1 (1)	3 (1)
Orthopedic diseases	17 (3)	4 (2)	13 (3)	0.601	0 (0)	5 (5)	2 (3)	6 (3)
Mental disorders	38 (7)	10 (6)	28 (7)	0.589	1 (13)	3 (3)	8 (12)	16 (8)
Connective tissue diseases	7 (1)	0 (0)	7 (2)	0.104	0 (0)	4 (4)	1 (1)	2 (1)
Diabetes	31 (6)	3 (2)	28 (7)	0.001	0 (0)	11 (11)	4 (6)	13 (16)
Hypertension	75 (13)	22 (12)	53 (14)	0.691	1 (13)	15 (15)	10 (15)	27 (13)
Other cancers	10 (2)	0 (0)	10 (3)	0.035	0 (0)	3 (3)	3 (4)	4 (2)
Number of comorbid conditions								
None	395 (70)	136 (76)	259 (68)	0.103	6 (75)	70 (69)	46 (68)	137 (67)
One	124 (22)	32 (18)	92 (24)		2 (25)	22 (22)	13 (19)	55 (27)
≥ Two	42 (8)	10 (6)	32 (8)		0 (0)	10 (10)	9 (13)	13 (6)

The analyses were performed using chi-square test or Fischer's exact test.

ductivity loss were 20.4% and 22.9%, respectively. When stratified by the length of time since their cancer diagnoses, the cancer survivors within 1 year of their diagnoses exhibited the highest absenteeism (19.1%), presenteeism (30.0%), and overall work productivity loss (35.9%), although these differences were not significant compared to those of the non-cancer workers. No significant differences were observed between sexes.

Presenteeism was notably higher among the younger age groups, at 24.6% in the 20- to 39-year-old group

and 24.5% in the 40- to 49-year-olds. The married individuals exhibited higher absenteeism than their unmarried counterparts. Regarding employment status, the self-employed individuals reported the highest rates across all measures, with absenteeism at 11.0%, presenteeism at 33.0%, and overall work productivity loss at 37.3%. The participants with any comorbidities had higher absenteeism, presenteeism, and lesser overall work productivity values compared to those without comorbidities (Table 2).

2. Multivariate analysis.

The comparison of the cancer survivors and non-cancer workers by length of time since the cancer diagnosis revealed that absenteeism was significantly higher among the individuals diagnosed with cancer within the past year ($p=0.048$). Although the presenteeism rate and overall productivity loss were also elevated in this group, the differences from the noncancer group were not significant. The married individuals exhibited significantly higher absenteeism than the unmarried individuals in this multivariate analysis ($p=0.040$).

Regarding employment status, the self-employed individuals showed the highest levels of absenteeism, presenteeism, and overall productivity loss. The participants with comorbidities demonstrated significantly higher presenteeism and overall productivity loss compared to those without comorbidities (Table 3).

3. Analysis by cancer type.

Subgroup analyses were performed for each cancer type. After the adjustment for sex, age, marital status, employment status, and the number of comorbidities,

Table 2 Summary of work productivity: A bivariate analysis

			Absenteeism			Presenteeism			Overall		
		n (%)	mean	SD	*P*-value	mean	SD	*P*-value	mean	SD	*P*-value
Total		561 (100)	4.9	15.4		20.4	27.2		22.9	29.6	
No history of cancer		178 (32)	4.6	12.9	0.508	22.5	28.1	0.308	25.0	29.9	0.309
Cancer survivor workers	< 1 year	8 (1)	19.1	37.5		30.0	37.4		35.9	37.5	
Years since diagnosis	< 3 years	102 (18)	6.7	19.6		22.4	28.2		25.6	32.0	
	< 5 years	68 (12)	2.2	7.5		19.0	24.9		19.8	25.9	
	≥ 5 years	205 (37)	4.6	15.5		17.7	26.2		20.3	28.7	
Sex											
Men		318 (57)	5.0	15.5	0.935	20.0	26.7	0.661	22.7	29.3	0.811
Women		243 (43)	4.8	15.4		21.0	28.0		23.3	29.9	
Age in years at time of the survey											
20-39		41 (7)	6.2	13.4	0.385	24.6	26.0	0.043	27.8	29.0	0.099
40-49		141 (25)	6.0	17.3		24.5	30.2		27.0	32.6	
50-59		261 (47)	3.7	12.8		19.7	27.1		21.7	28.8	
60-64		118 (21)	5.8	18.7		15.6	23.2		19.0	27.3	
Marital status											
Married		376 (67)	5.8	17.0	0.043	19.7	26.5	0.402	23.0	29.5	0.962
Unmarried		185 (33)	3.0	11.4		21.8	28.7		22.8	29.9	
Employment status											
Full-time		410 (73)	3.6	12.5	0.001	18.9	25.5	0.000	20.8	27.3	0.000
Part-time		88 (16)	6.8	19.2		18.3	27.8		22.4	31.9	
Self- employed		63 (11)	11.0	23.3		33.0	34.0		37.3	36.1	
Number of comorbid conditions											
None		395 (77)	3.9	14.0	0.003	17.7	25.7	0.001	19.8	27.8	0.0004
One		124 (22)	7.6	19.4		25.7	29.7		29.4	32.9	
≥ Two		42 (7)	6.3	13.8		29.8	29.8		32.9	30.8	

The analyses were performed using ANOVA, Wilcoxon or Kruskal-Wallis test.
SD, standard deviation.

Table 3 Summary of work productivity: A multivariate analysis

			Absenteeism		Presenteeism		Overall	
		n (%)	estimate (95%CI)	*P*-value	estimate (95%CI)	*P*-value	estimate (95%CI)	*P*-value
Total		561 (100)						
No history of cancer		178 (32)	6.0 (3.2–8.9)	0.048	22.5 (17.5–27.5)	0.567	25.6 (20.2–31.1)	0.402
Cancer survivor workers	<1 year	8 (1)	20.0 (9.4–30.6)		31.2 (12.6–49.9)		37.4 (17.1–57.6)	
Years since diagnosis	<3 years	102 (18)	7.6 (4.2–11.1)		22.4 (16.3–28.5)		26.0 (19.4–32.6)	
	<5 years	68 (12)	3.6 (−0.5–7.7)		20.4 (13.2–27.5)		21.5 (13.7–29.3)	
	≥5 years	205 (37)	5.8 (2.9–8.7)		18.9 (13.9–24.0)		21.9 (16.4–27.3)	
Sex								
Men		318 (57)	8.5 (5.2–11.8)	0.882	22.5 (16.7–28.3)	0.644	26.0 (19.6–32.3)	0.719
Women		243 (43)	8.7 (5.5–12.0)		23.7 (18.0–29.4)		27.0 (20.8–33.1)	
Age in years at time of the survey								
20–39		41 (7)	10.2 (4.8–15.6)	0.393	27.5 (18.1–37.0)	0.048	31.6 (21.4–41.8)	0.084
40–49		141 (25)	9.2 (5.7–12.7)		26.4 (20.3–32.6)		29.5 (22.9–36.2)	
50–59		261 (47)	6.8 (3.6–10.1)		21.6 (15.9–27.3)		24.3 (18.1–30.4)	
60–64		118 (21)	8.2 (4.2–12.1)		16.8 (9.8–23.7)		20.4 (12.9–28.0)	
Marital status								
Married		376 (67)	10.0 (7.0–13.1)	0.040	22.7 (17.4–28.1)	0.780	27.2 (21.4–33.0)	0.593
Unmarried		185 (33)	7.2 (3.7–10.6)		23.4 (17.4–29.5)		25.8 (19.2–32.3)	
Employment status								
Full-time		410 (73)	5.3 (2.5–8.1)	0.002	19.4 (14.4–24.3)	0.001	21.2 (15.9–26.5)	0.001
Part-time		88 (16)	8.4 (4.4–12.4)		17.6 (10.6–24.6)		21.8 (14.2–29.4)	
Self- employed		63 (11)	12.1 (7.6–16.6)		32.3 (24.4–40.3)		36.3 (27.7–45.0)	
Number of comorbid conditions								
None		410 (73)	8.6 (5.7–11.6)	0.059	23.1 (17.9–28.3)	0.000	26.5 (20.8–32.1)	0.000
One		88 (16)	12.3 (8.6–16.0)		32.3 (25.8–38.8)		37.1 (30.0–44.2)	
≥ Two		63 (11)	11.0 (5.8–16.2)		35.4 (26.2–44.5)		39.8 (29.9–49.7)	

the number of years since diagnosis for the cancer survivors and non-cancer workers was compared, and in the cases of stomach cancer and colorectal cancer, the rate of absenteeism was significantly higher for the cancer survivors who were within 1 year of diagnosis (Table 4). The comparison of the cancer survivors and non-cancer workers by length of time since diagnosis demonstrated that the absenteeism rates were significantly higher among the individuals diagnosed with stomach cancer or colorectal cancer within 1 year before completing the questionnaire (Table 4).

Discussion

The results of our analyses revealed two important findings (1) Cancer survivors within 1 year of their diagnosis of cancer had higher absenteeism than the non-cancer workers. (2) Presenteeism was slightly higher among the cancer survivors within 1 year of diagnosis compared to the non-cancer workers, although the difference was not significant. This finding regarding absenteeism was consistent with the results of previous studies [11, 15, 21, 22, 25]. Regarding presenteeism, cancer survivors within 1 year of diagnosis showed higher levels than non-cancer workers, but the difference between cancer survivors more than 1 year after diagnosis and non-cancer workers was smaller. None of these differences were statistically significant, suggesting that there are no significant differences in workplace productivity between cancer survivors and non-cancer workers. However, the small sample size (n = 561) necessitates caution in interpreting our findings.

Notably, as only eight participants had been diagnosed within the past year, this study may have lacked sufficient statistical power to detect potential differences in presenteeism and overall work productivity. A larger sample size might have revealed significant differences in these outcomes among participants diagnosed within the past year. Nevertheless, the results suggest that

Table 4 Esimates of work productivity in stomach, colorectal, lung and breast cancer

			Absenteeism		Presenteeism		Overall	
		n	estimate (95%CI)	*P*-value	estimate (95%CI)	*P*-value	estimate (95%CI)	*P*-value
Stomach cancer								
No history of cancer		178	4.1 (0.6–7.5)	0.009	19.2 (12.7–25.6)	0.523	22.0 (15.1–28.9)	0.139
Cancer survivor workers	<1 year	1	54.8 (26.3–83.3)		20.5 (−33.0–74.0)		67.5 (10.0–125)	
(Years since diagnosis)	<3 years	17	2.3 (−5.1–9.7)		10.5 (−3.5–24.4)		11.4 (−3.5–26.4)	
	<5 years	13	4.0 (−4.5–12.5)		17.3 (1.4–33.2)		18.3 (1.2–35.4)	
	≥5 years	40	7.3 (2.1–12.5)		24.4 (14.6–34.2)		28.9 (18.4–39.4)	
Colorectal cancer								
No history of cancer		178	6.2 (3.0–9.4)	0.005	20.5 (14.3–26.7)	0.296	23.5 (16.9–30.1)	0.479
Cancer survivor workers	<1 year	2	45.0 (25.2–64.9)		59.8 (21.0–98.6)		57.1 (16.2–98.1)	
(Years since diagnosis)	<3 years	26	7.5 (1.5–13.5)		16.4 (4.6–28.2)		20.4 (7.9–32.8)	
	<5 years	18	5.4 (−1.4–12.2)		17.2 (3.9–30.5)		19.4 (5.4–33.5)	
	≥5 years	46	5.7 (0.8–10.6)		18.4 (8.8–27.9)		20.5 (10.4–30.7)	
Lung cancer								
No history of cancer		178	5.8 (2.5–9.1)	0.528	18.5 (12.4–24.6)	0.351	22.6 (15.9–29.3)	0.429
Cancer survivor workers	<1 year	3	3.7 (−12.8–20.2)		6.2 (−24.4–36.8)		9.2 (−24.3–42.7)	
(Years since diagnosis)	<3 years	25	9.4 (3.2–15.5)		20.1 (8.7–31.6)		25.8 (13.3–38.3)	
	<5 years	20	2.0 (−5.1–9.1)		22.8 (9.7–36.0)		24.2 (9.8–38.7)	
	≥5 years	37	4.9 (−0.7–10.4)		10.3 (0.0–20.6)		14.0 (2.7–25.3)	
Breast cancer								
No history of cancer		178	5.1 (2.2–8.0)	0.791	19.8 (13.9–25.7)	0.199	23.1 (16.8–29.4)	0.207
Cancer survivor workers	<1 year	2	0.4 (−18–18.8)		31.0 (−6.8–68.7)		31.5 (−8.8–71.7)	
(Years since diagnosis)	<3 years	34	7.1 (1.6–12.6)		26.4 (15.2–37.7)		29.2 (17.2–41.2)	
	<5 years	17	3.0 (−4.0–10.0)		15.1 (0.7–29.5)		16.6 (1.3–32.0)	
	≥5 years	82	4.3 (0.0–8.6)		13.6 (4.8–22.4)		15.7 (6.4–25.1)	

The analysis was performed using multivariate analysis adjusting for sex, age, marital status, employment status and number of comorbid conditions.

beyond 1 year post-diagnosis, and particularly after 3 years, the work productivity among cancer survivors is comparable to that of non-cancer workers. This appears to be a novel finding, since our review of the relevant literature identified no studies that directly compared work productivity between cancer survivors and non-cancer workers over time. Although this study has certain limitations that warrant a careful interpretation our findings as discussed later, the results provide encouraging insights for both cancer survivors seeking employment and employers considering the inclusion of cancer survivors in their workforce. These findings may help inform future workplace policies and initiatives to support RTW efforts.

In our sub-analysis by cancer type, the absenteeism rates were notably high within the first year after the diagnosis of stomach cancer or colorectal cancer, whereas no significant difference was observed for lung or breast cancer. Given the extremely small number of cases that were within 1 year of diagnosis in this study (n=8), these findings should be interpreted with caution. However, the results suggest that, for at least these four cancer types, there is no significant difference in labor productivity between cancer survivors diagnosed 1-3 years ago and non-cancer individuals. Further cancer-type-specific analyses are warranted to validate these findings.

Study limitations. There are several study limitations to consider. It was a cross-sectional investigation and did not follow the same participants over time, and it was thus not possible to assess temporal changes in the participants' work productivity. Instead, we compared the work productivity of cancer survivors to that of non-cancer workers based on the number of years that had passed since the cancer diagnoses at the time of the survey. In addition, the work productivity survey

included only employed individuals, resulting in a selection bias known as 'the healthy worker effect'. Our findings are thus limited to cancer survivors who are currently employed. However, given that some cancer survivors want to work but are not employed, the results of this study are expected to help promote RTW from both the perspective of employers and society.

It is also possible that the risk adjustment applied in this study was not fully appropriate. Although adjustments were made for sex, age, and the number of comorbidities, no adjustment was used for the cancer group's cancer stage, treatment details, or performance status. In addition, factors that may promote RTW, such as educational level, financial situation, and use of RTW support programs were not included in the study analyses. Further research incorporating these variables is necessary to conduct a more robust and detailed analysis.

Our use of an Internet panel may have introduced a selection bias, thus adding to the need for caution in interpreting our results. This is a particular concern for older adults who may not use the Internet as frequently as younger individuals. In this survey, the sample of respondents in their 60s was small (n = 118, 21% of the 561), but this is a group that can be expected to have a high incidence of cancer. However, as this study focused on participants aged 20-64, which is the demographic comprising a large proportion of the workforce, the potential impact of this sampling bias is likely mitigated. Nonetheless, given the increasing proportion of elderly individuals in Japan and the rising number of older adults remaining in the workforce, further research focusing specifically on individuals aged ≥ 60 years is necessary.

An advantage of our use of the Internet panel meant that samples were obtained from all over Japan, reducing the chance of regional bias. In addition, 13 individuals were excluded from the study due to missing or incomplete data, but all were cases in which the participant had not worked during the 7-day survey period, making it impossible to calculate absenteeism or presenteeism. Compared to the 561 participants included in the analysis, the excluded individuals had a slightly higher proportion of part-time and self-employed workers, as well as those with a > 3-year cancer history. Nevertheless, as these 13 individuals represent only 2% of the total sample, their exclusion is unlikely to have had a substantial impact on the overall results.

Conclusions. The responses by 561 workers to the WPAI-GH questionnaire distributed in Japan revealed that compared to workers who had not had cancer, the cancer survivors within 1 year of their diagnosis had a higher rate of absenteeism. Presenteeism of cancer survivors within 1 year of diagnosis was also higher than that of the non-cancer workers, although the difference was not significant. These findings should be interpreted with caution, but they may help promote cancer survivors' return to work.

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