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Effects of multidisciplinary care on the survival of patients with oral cavity cancer in Taiwan

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SUMMARY

Objectives: The incidence of oral cavity cancer is high in Taiwan. To improve patient survival, multidisciplinary team (MDT) care was implemented. This research compared the survival of MDT care participants/non-participants and examined the effect of MDT care on patient characteristics.
Materials and Methods: In this study, 19,513 patients with newly diagnosed oral cavity cancer were recruited from 2004 to 2007 in Taiwan. Matching based on the propensity of receiving MDT care was used. In total, 9297 patients were observed until 2008. A Cox proportional hazards model was applied to elucidate the relative risks of death.
Results: The relative risk of death was lower for patients with MDT care than for those without such care (HR = 0.84; 95% CI = 0.78–0.90). Males had a higher risk of death than females (HR = 1.20; 95% CI = 1.04–1.38). Older age, lower income, and more severe comorbidity were associated with a higher risk of death. The effect of MDT care was stronger for older patients than for younger patients. Patients treated in public hospitals had a 1.24-fold (95% CI = 1.13–1.36) higher risk of death than patients treated in private hospitals. Patients treated in hospitals or by attending physicians with higher service volumes had a lower relative risk of death (HR = 0.89 and 0.78, respectively). The effect of MDT care was strong among patients with less severe comorbidities and patients without catastrophic illnesses.
Conclusion: The relative risk of death was lower for MDT care participants. The effect of MDT care was stronger among older patients and patients with fewer comorbidities.
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Introduction

Each year, 640,000 people are diagnosed with oral cavity cancer throughout the world, and only half of patients with newly diagnosed oral cavity cancer survive more than 5 years.[1] In Taiwan, the incidence and mortality rates of oral cavity cancer increased by 4- and 2.3-fold over 20 years, respectively.[2] Previous studies reported higher mortality rates for head and neck cancer among men than among women.[3,4] Another study indicated that the prognosis of oral cancer decreases with disease progression, low socioeconomic status (SES), advanced age, and the continuation of risky lifestyles.[5] In particular, the survival rates of younger and wealthier patients are higher than those of poorer or older patients.[6–8] Poor oral hygiene, including the use of tobacco and alcohol and the consumption of betel nut, increases the risk of developing oral cancer and influences patient survival.[9–11] Treatment methods and tumor type, size, and location are associated with cancer survival.[12] In addition, the relative risk factors of prognosis include the health care provider characteristics,[13] health services volume,[14] and the hospital characteristics.[13,15]

Multidisciplinary team (MDT) care goes beyond conventional treatments for oral cavity cancer, such as surgical excision, radiation therapy, and chemotherapy. The MDT approach has been practiced for years in many countries. Studies from the US, Germany, UK, and Australia have demonstrated that an MDT that integrates surgeons, tumor physicians, radiology physicians, psychologists, physiatrists, and dietitians is capable of improving the quality of life for cancer patients, lowering the cost of health care, and increasing the survival rate.[16–19] In light of these findings, the Taiwan Bureau of National Health Insurance has implemented "multidisciplinary team care for cancer patients" since April 2003 to enhance the quality of cancer diagnosis and treatment. The Bureau emphasizes an MDT approach that provides a complete cancer treatment scheme for patients.

Thus, the current study investigated the influence of the participation/non-participation of patients in MDT care on survival with selection bias removed by a matching method. Furthermore, this

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Table 1
Bivariate analysis: before and after propensity score (PS) matching.

Variables	Before PS matching					After PS matching				
	Non-participants		Participants		*P*-value	Non-participants		Participants		*P*-value
	N	%	N	%		N	%	N	%	
Sex					<0.001					0.423
Female	1558	9.75	232	6.56		411	6.63	220	7.10	
Male	14417	90.24	3305	93.44		5787	93.37	2879	92.90	
Missing	1	–	0	–		0	–	0	–	
Age (years)					<0.001					0.354
⩽24	175	1.10	32	0.90		62	1.00	26	0.84	
25 – 34	542	3.39	119	3.36		218	3.52	102	3.29	
35 – 44	3021	18.91	743	21.01		1245	20.09	600	19.36	
45 – 54	5345	33.46	1289	36.44		2252	36.33	1129	36.43	
55 – 64	3595	22.50	766	21.66		1397	22.54	693	22.36	
65 – 74	2198	13.76	399	11.28		741	11.96	373	12.04	
⩾75	1100	6.89	189	5.34		283	4.57	176	5.68	
Average age (M, SD)	54.05	12.42	52.79	11.80		52.89	11.70	53.29	11.88	
Premium-based monthly salary (NTD)					0.369					0.562
Insured dependant	3089	19.34	662	18.72		1124	18.13	602	19.43	
⩽17,280	3562	22.30	754	21.32		1403	22.64	653	21.07	
17,281 – 22,800	6206	38.85	1417	40.06		2464	39.75	1230	39.69	
22,801 – 28,800	962	6.02	237	6.70		380	6.13	207	6.68	
28,801 – 36,300	707	4.43	151	4.27		283	4.57	129	4.16	
36,301 – 45,800	917	5.74	215	6.08		356	5.74	189	6.10	
45,801 – 57,800	228	1.43	48	1.36		85	1.37	41	1.32	
57,801 – 72,800	197	1.23	33	0.93		60	0.97	30	0.97	
⩾72,801	108	0.68	20	0.57		43	0.69	18	0.58	
Urbanization of hospital location					<0.001					0.544
Level 1	7327	45.86	1555	43.96		2899	46.77	1431	46.18	
Level 2&3	6991	43.76	1634	46.20		2651	42.77	1327	42.82	
Level 4&5	1536	9.61	343	9.70		631	10.18	336	10.84	
Level 6&7	122	0.76	5	0.14		17	0.27	5	0.16	
Charlson comorbidity index					<0.001					0.651
⩽3	6722	42.08	1368	38.68		2391	38.58	1163	37.53	
4 – 6	2767	17.32	559	15.80		1058	17.07	509	16.42	
7 – 9	4099	25.66	1016	28.72		1741	28.09	902	29.11	
10 – 12	2242	14.03	551	15.58		950	15.33	496	16.01	
⩾13	146	0.91	43	1.22		58	0.94	29	0.94	
Catastrophic illness/injury					<0.001					0.141
Without	1210	7.57	203	5.74		336	5.42	192	6.20	
With	14766	92.43	3334	94.26		5862	94.58	2907	93.80	
Treatment method					<0.001					0.783
Surgery	6458	40.42	810	22.90		1653	26.67	810	26.14	
Radiology therapy	589	3.69	149	4.21		242	3.90	139	4.49	
Chemotherapy	132	0.83	10	0.28		18	0.29	10	0.32	
Surgery + radiology therapy	3549	22.21	1068	30.20		1813	29.25	911	29.40	
Surgery + chemotherapy	760	4.76	88	2.49		168	2.71	88	2.84	
Radiology therapy + chemotherapy	303	1.90	69	1.95		109	1.76	63	2.03	
Surgery + radiology therapy + chemotherapy	4185	26.20	1343	37.97		2195	35.41	1078	34.79	
Level of hospital					<0.001					0.901
Medical center	11756	73.59	2326	65.76		4392	70.86	2182	70.41	
Regional hospital	3934	24.62	1163	32.88		1732	27.94	880	28.40	
District hospital	286	1.79	48	1.36		74	1.19	37	1.19	
Ownership of hospital					<0.001					0.308
Non-public	4901	30.68	529	14.96		1111	17.93	529	17.07	
Public	11075	69.32	3008	85.04		5087	82.07	2570	82.93	
Sex of attending physician					0.002					0.222
Female	1113	6.97	299	8.45		450	7.26	203	6.55	
Male	14861	93.02	3238	91.55		5747	92.72	2896	93.45	
Missing	2	0.01	0	–		1	0.02	0	–	
Age of attending physician					<0.001					0.158
⩽34	2327	14.57	445	12.58		872	14.07	423	13.65	
35 – 44	6779	42.43	1649	46.62		2717	43.84	1404	45.30	
45 – 54	5565	34.83	1155	32.65		2204	35.56	1042	33.62	
55 – 64	1244	7.79	273	7.72		377	6.08	218	7.03	
⩾65	61	0.38	15	0.42		28	0.45	12	0.39	
Average age (M, SD)	43.42	7.87	43.05	8.91		43.30	7.60	42.78	9.07	
Hospital's annual patient volume of oral cavity cancer					<0.001					0.719
Low service volume (⩽902)	7831	49.02	1961	55.44		3338	53.86	1682	54.28	
High service volume (>902)	8145	50.98	1576	44.56		2860	46.14	1417	45.72	

Table 1 (*continued*)

Variables	Before PS matching					After PS matching				
	Non-participants		Participants		*P*-value	Non-participants		Participants		*P*-value
	N	%	N	%		N	%	N	%	
Attending physician's annual patient volume of oral cavity cancer					0.005					0.623
Low service volume (⩽113)	8088	50.63	1884	53.27		3205	51.71	1620	52.27	
High service volume (>113)	7888	49.37	1653	46.73		2993	48.29	1479	47.73	

study analyzed the various effects of MDT care on patients with oral cavity cancer.

Materials and methods

Study design

This retrospective and longitudinal cohort study analyzed the Cancer Dataset in the National Health Insurance Research Database (from 1997 to 2007) published by the Taiwan National Health Research Institutes and provided by the Bureau of National Health Insurance of Taiwan. The database included the medical records of all individuals insured by national health insurance in Taiwan. At the end of 2009, a total of 23,026,000 people were insured, constituting 99.59% of Taiwan's population.[20]

Selection of participants

To investigate the difference in survival rates of patients with oral cavity cancer associated with MDT care since April 2003, this study utilized patients diagnosed with oral cavity cancer from 2004 to 2007 (first three digits of ICD-9-CM: 140, 141, 143–146, 148, 149) as the parent group. Monitoring was continued until 2008, and 436 patients who died within 1 month of confirmed diagnosis were excluded.

To reduce selection bias arising from participation/non-participation in MDT care, the study employed the propensity score (PS) matching method to evaluate the likelihood of participating in MDT care for each patient. Propensity score was conditional probability of each patient participating MDT care based on pre-treatment variables and it was calculated based on 13 covariates listed in Table 1 by logistic regression. The objective was to balance the participation and non-participation groups to reduce bias of participation selection and obtain better participation effect on the outcome of compliance. To obtain a 1:2 matching for each MDT propensity score, the study took two non-MDT patients with scores closest to each MDT propensity score; some MDT propensity scores may be outliers on the MDT propensity scores and no close non-MDT scores would be available. After the PS matching, 3099 MDT care participants and 6198 non-MDT care participants were included in the study.

Methods of measurement

The study subjects were categorized into seven scales on the basis of the urbanization of their locations of residence. Scale 1 denotes the highest degree of urbanization, and scale 7 denotes the lowest degree of urbanization. The amount of services provided by primary hospitals and visiting staffs was divided into high-volume and low-volume categories based on the median. The extent of comorbidity was classified using five levels according to the Charlson Comorbidity Index (CCI)[21] adapted by Deyo.

After dividing subjects into MDT care participation and non-participation groups, a Cox proportional hazards model was employed to analyze the relative risks of death of MDT care participants/non-participants with controlled variables and weekly observation, wherein the independent variables included demographic profile, health condition, treatment method, hospital, visiting staff, and MDT participation status; the dependent variable was patient survival and time. Meanwhile, a survival curve of MDT participants/non-participants was plotted with the survival curve adjusted for controlled variables, and the study subjects were further divided into groups based on age and the extent of comorbidity to investigate the influences of MDT care on the survival of patients with different characteristics.

Results

Characteristics of the study subjects

As shown in Table 1, the MDT participants and non-participant groups exhibited significant differences ($P < 0.05$) in gender, age, the degree of urbanization of the hospital location, the CCI value, the presence of catastrophic illness and injury, the treatment method, the level of the hospital, ownership of the hospital, the age and sex of attending physicians, and the hospital's and attending physician's annual volumes of patients with oral cavity cancer before PS matching; however, no significant difference between these two groups regarding any of these factors was observed after PS matching.

Main results

The results obtained using the Cox proportional hazards model indicated that the risk of death among MDT care participants was 0.84-fold (95% CI = 0.78–0.90) of that of the non-participants (Table 2). The risk of death in males was higher than that in females (HR = 1.20, 95% CI = 1.04–1.38), and the risk of death increased progressively with age. The risks of death among patients aged 65–74 (HR = 3.61, 95% CI = 1.16–11.27) and over 75 years old (HR = 5.60, 95% CI = 1.79–17.52) were higher than that among patients less than 25 years old. The risk of death was lower for patients with a higher premium-based monthly salary (HR = 0.40 for the highest income group). Regarding the health condition of the patients, the risk of death significantly increased as the severity of the comorbidity increased (HR = 1.53 for the $4 \leqslant CCI \leqslant 6$ group vs. 3.91 for the $CCI \geqslant 12$ group), and the risk of death in patients with catastrophic illnesses was 1.22-fold higher than that in patients without catastrophic illness (95% CI = 1.12–1.33).

The treatment methods varied according to the cancer stage of the patient. The present study considered the differences in treatment methods between cancer stages. The patients receiving only surgery served as the reference group. The risk of death for the patients receiving surgery in conjunction with radiotherapy was 2.33-fold higher (95% CI = 2.05–2.65) than that of the reference group, and those receiving chemotherapy had a 3.04-fold higher risk (95% CI = 1.83–5.04) than the reference group. Additionally, patients receiving radiotherapy only, surgery in conjunction with

Table 2
Related Factors of Survival for Oral Cavity Cancer Patients.

Variables	Before PS matching (*N* = 19,513)				After PS matching (*N* = 9,230)					
	Adj. HR	95% CI		*P*-value	Unadj. HR	*P*-value	Adj. HR	95% CI		*P*-value
Participation status of multidisciplinary team care										
Non-participants (reference)										
Participants	0.79	0.74	0.84	<0.001	0.88	<0.001	0.840.78	0.90	<0.001	
Sex										
Female (reference)										
Male	1.36	1.24	1.49	<0.001	1.37	<0.001	1.201.04	1.38	0.014	
Age (years)										
⩽24 (reference)										
25 ~ 34	2.35	1.64	3.36	<0.001	2.27	0.002	2.640.84	8.32	0.098	
35 ~ 44	2.33	1.67	3.26	<0.001	2.54	<0.001	2.56	0.82	7.97	0.106
45 ~ 54	2.34	1.67	3.27	<0.001	2.69	<0.001	2.54	0.82	7.92	0.107
55 ~ 64	2.44	1.75	3.41	<0.001	2.66	<0.001	2.67	0.86	8.31	0.091
65 ~ 74	3.23	2.31	4.51	<0.001	3.50	<0.001	3.61	1.16	11.27	0.027
⩾75	4.92	3.51	6.91	<0.001	5.02	<0.001	5.60	1.79	17.52	0.003
Premium-based monthly salary (NTD)										
⩽17,280 (reference)										
Insured dependant	0.88	0.82	0.94	<0.001	0.84	<0.001	0.86	0.78	0.95	0.004
17,281 ~ 22,800	0.82	0.78	0.87	<0.001	0.78	<0.001	0.80	0.74	0.87	<0.001
22,801 ~ 28,800	0.70	0.62	0.78	<0.001	0.61	<0.001	0.69	0.59	0.81	<0.001
28,801 ~ 36,300	0.73	0.64	0.83	<0.001	0.66	<0.001	0.78	0.65	0.93	0.005
36,301 ~ 45,800	0.55	0.48	0.62	<0.001	0.51	<0.001	0.61	0.52	0.73	<0.001
45,801 ~ 57,800	0.52	0.41	0.67	<0.001	0.47	<0.001	0.61	0.44	0.85	0.003
57,801 ~ 72,800	0.65	0.50	0.84	0.001	0.50	<0.001	0.68	0.46	1.00	0.049
⩾72,801	0.43	0.29	0.65	<0.001	0.35	<0.001	0.40	0.23	0.69	0.001
Urbanization of residence area										
Level 1 (reference)										
Level 2&3	1.02	0.96	1.08	0.576	1.05	0.293	1.04	0.96	1.13	0.356
Level 4&5	1.07	1.00	1.15	0.060	1.14	0.008	1.04	0.94	1.15	0.431
Level 6&7	1.08	1.00	1.18	0.065	1.19	0.004	1.04	0.93	1.18	0.489
Charlson comorbidity index										
⩽3 (reference)										
4 ~ 6	0.85	0.78	0.93	0.001	1.99	<0.001	1.53	1.35	1.73	<0.001
7 ~ 9	1.52	1.42	1.62	<0.001	4.23	<0.001	2.80	2.51	3.11	<0.001
10 ~ 12	1.56	1.46	1.67	<0.001	4.89	<0.001	2.91	2.61	3.25	<0.001
⩾12	2.00	1.68	2.39	<0.001	6.86	<0.001	3.91	3.20	4.78	<0.001
Catastrophic illness/injury										
Without (reference)										
With	1.39	1.31	1.47	<0.001	1.50	<0.001	1.22	1.12	1.33	<0.001
Treatment method										
Surgery (reference)										
Radiology therapy	3.70	3.29	4.16	<0.001	5.36	<0.001	3.40	2.84	4.07	<0.001
Chemotherapy	4.28	3.42	5.36	<0.001	5.91	<0.001	3.04	1.83	5.04	<0.001
Surgery + radiology therapy	2.74	2.54	2.96	<0.001	3.63	<0.001	2.33	2.05	2.65	<0.001
Surgery + chemotherapy	5.10	4.56	5.69	<0.001	5.28	<0.001	3.97	3.24	4.87	<0.001
Radiology therapy + chemotherapy	3.94	3.37	4.60	<0.001	5.88	<0.001	4.12	3.25	5.22	<0.001
Surgery + radiology therapy + chemotherapy	5.16	4.81	5.55	<0.001	6.74	<0.001	4.43	3.92	5.02	<0.001
Level of hospital										
Medical center (reference)										
Regional hospital	0.96	0.90	1.02	0.138	1.26	<0.001	0.91	0.84	0.98	0.016
District hospital	0.98	0.82	1.17	0.799	1.47	0.004	1.11	0.84	1.47	0.449
Ownership of hospital										
Non-public (reference)										
Public	1.10	1.04	1.17	0.001	1.18	<0.001	1.25	1.14	1.37	<0.001
Sex of attending physician										
Female (reference)										
Male	1.10	1.01	1.20	0.039	0.99	0.875	1.12	0.98	1.27	0.095
Age of attending physician										
⩽34 (reference)										
35 ~ 44	1.08	1.00	1.16	0.041	1.27	<0.001	1.09	0.98	1.22	0.101
45 ~ 54	1.06	0.98	1.15	0.139	0.99	0.842	1.08	0.96	1.21	0.213
55 ~ 64	1.10	0.99	1.23	0.081	1.32	<0.001	1.17	1.00	1.37	0.045
⩾65	0.95	0.62	1.45	0.818	0.88	0.665	0.81	0.46	1.44	0.477
Hospital's annual patient volume of oral cavity cancer										
Low service volume (⩽902) (reference)										
High service volume (>902)	0.88	0.83	0.94	<0.001	0.75	<0.001	0.89	0.82	0.96	0.004
Attending physician's annual patient volume of oral cavity cancer										
Low service volume (⩽113) (reference)										
High service volume (>113)	0.76	0.72	0.81	<0.001	0.65	<0.001	0.79	0.73	0.86	<0.001

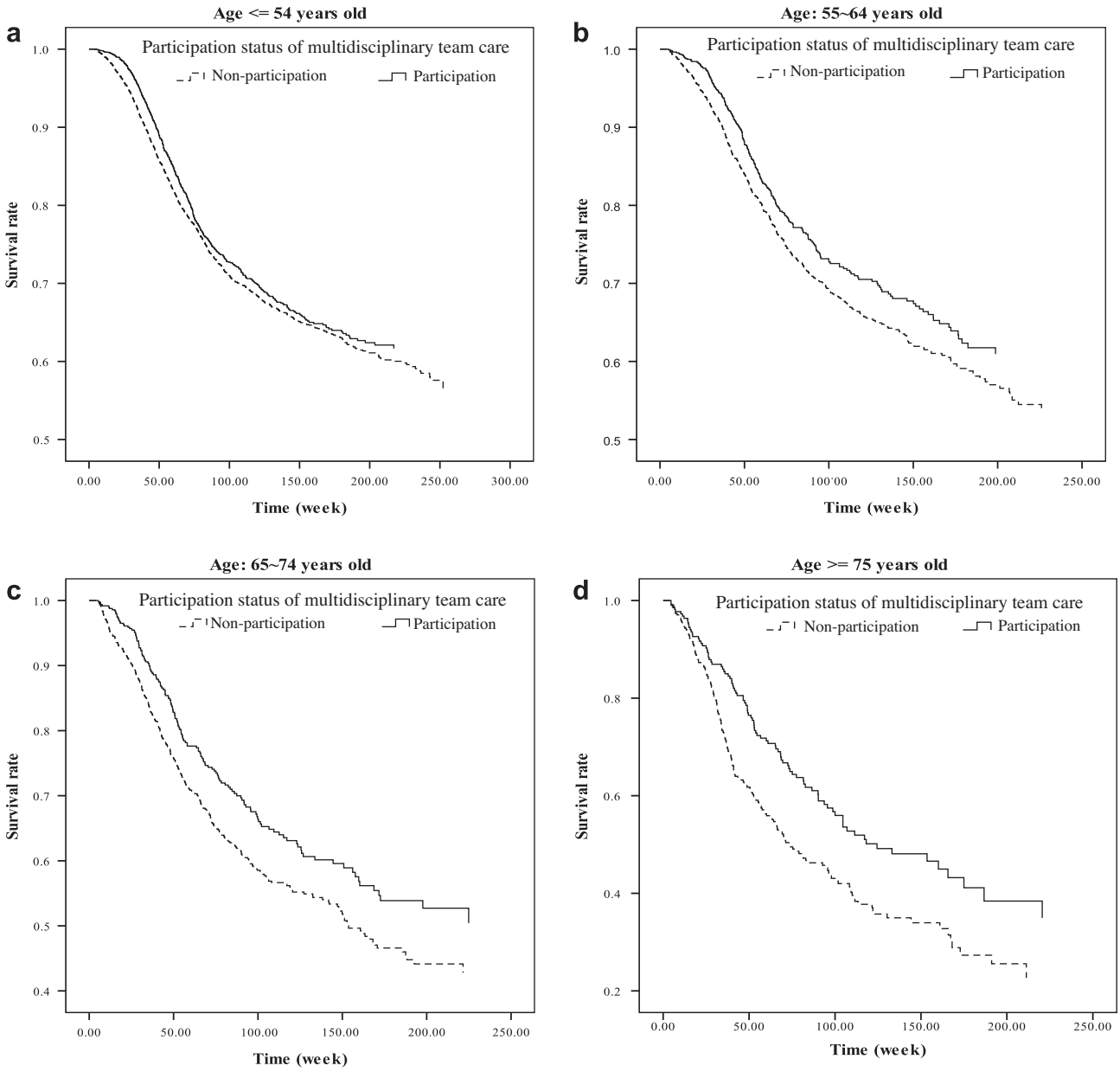

Figure 1 Survival curves of matched MDT care participants/non-participants according to age. The adjusted survival curves were controlled by sex, premium-based salary, urbanization of residence area, CCI, catastrophic illness, treatment method, level of hospital, ownership of hospital, sex or age of attending physician, and hospital's or attending physician's annual patient volume of oral cavity cancer. (a): Patients $\leqslant$ 54 years old (HR = 0.90, 95% CI = 0.82–0.99, P = 0.023); (b): Patients aged 55–64 years old (HR = 0.81, 95% CI = 0.70–0.94, P = 0.006); (c): Patients aged 65–74 years old (HR = 0.75, 95% CI = 0.62–0.90, P = 0.003); (d): Patients $\geqslant$ 75 years old (HR = 0.65, 95% CI = 0.49–0.85, P = 0.002).

chemotherapy, radiochemotherapy, and surgery in combination with radiochemotherapy had a 3.40- (95% CI = 2.84–4.07), 3.97- (95% CI = 3.24–4.87), 4.12- (95% CI = 3.25–5.22), and 4.43-fold (95% CI = 3.92–5.02) higher risk of death than the reference group, respectively. Regarding the level of the hospitals, the risk of death of patients treated in regional hospitals was significantly lower than that of patients treated in medical centers (HR = 0.91, 95% CI = 0.84–0.98), and the risk of death of patients treated in public hospitals was 1.25-fold higher than that of patients treated in private hospitals (95% CI = 1.14–1.37). Patients who were treated by attending physicians aged 55–64 years old had a 1.17-fold higher risk of death than those treated by the attending physicians under 34 years of age (95% CI = 1.00–1.37). Moreover, compared to patients treated by hospitals and physicians with a lower annual patient volume, those treated by hospitals (HR = 0.89, 95% CI = 0.82–0.96) and physicians (HR = 0.79, 95% CI = 0.73–0.86) with a higher annual patient volume had lower risks of death.

To investigate the influences of MDT care on patients with different characteristics, the present study further divided the study subjects into four groups according to age (under 54, 55–64, 65–74, and over 75 years old). The effectiveness of MDT care in different age groups was compared, and the survival curves of the participants/non-participants of these four groups were plotted (Fig. 1). The results indicated that after controlling for other variables, the difference in survival rates between MDT participants and non-participants increased with age (respective HR = 0.90, 0.81, 0.75, and 0.65 for the under 54, 55–64, 65–74, and over 75 years age groups, respectively, $P < 0.05$), which indicates that the positive effects of MDT care are more prominent among older patients. In addition to age, the study divided the study subjects

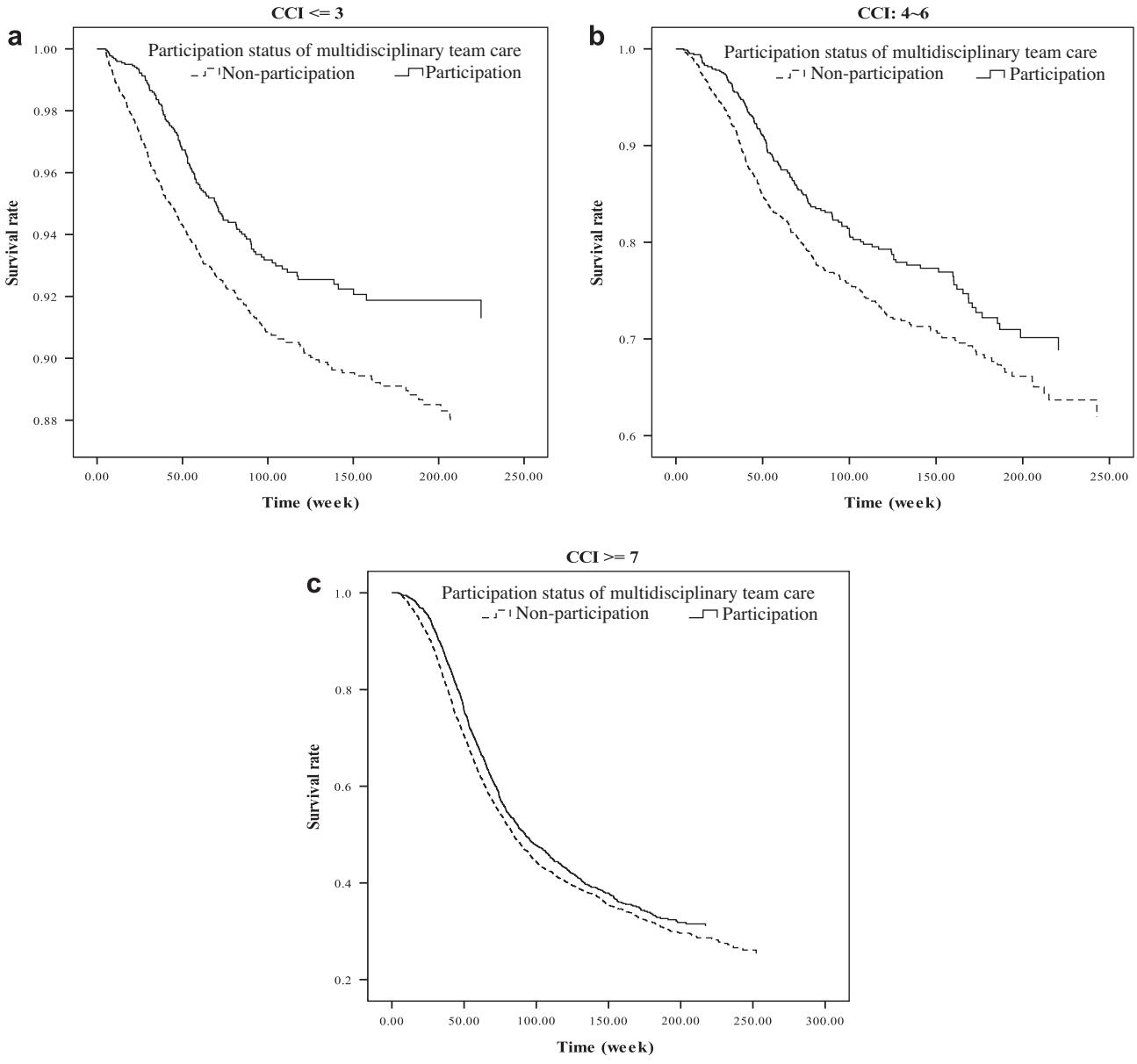

Figure 2 Survival curves of matched MDT care participants/non-participants according to CCI values. The adjusted survival curves were controlled by sex, age, premium-based salary, urbanization of residence area, catastrophic illness, treatment method, level of hospital, ownership of hospital, sex or age of attending physician, hospital's or attending physician's annual patient volume of oral cavity cancer. (a): The CCI $\leqslant$ 3 group (HR = 0.68, 95% CI = 0.56–0.84, $P < 0.001$); (b): The 4 $\leqslant$ CCI $\leqslant$ 6 group (HR = 0.74, 95% CI = 0.61–0.89, $P = 0.002$); (c): The CCI $\geqslant$ 7 group (HR = 0.89, 95% CI = 0.82–0.96, $P = 0.004$).

into three groups according to the extent of comorbidity as follows: CCI $\leqslant$ 3, 4 $\leqslant$ CCI $\leqslant$ 6, and CCI $\geqslant$ 7. The results demonstrated that the difference of survival rates between MDT participants and non-participants decreased as the extent of comorbidity increased (respective HR = 0.68, 0.74, and 0.89 for the CCI $\leqslant$ 3, 4 $\leqslant$ CCI $\leqslant$ 6, and CCI $\geqslant$ 7 groups, respectively, $P < 0.05$) (Fig. 2), indicating that the positive effects of MDT care are more prominent among patients with less severe comorbidities. The present study also investigated subjects with/without catastrophic illness (Fig. 3). Although no significant differences ($P > 0.05$) were observed regarding the effectiveness of MDT care between the MDT care participants and non-participants with catastrophic illness, MDT participants without catastrophic illness had a significantly lower risk of death than non-participants without catastrophic illness (HR = 0.83, 95% CI = 0.77–0.89), suggesting that the positive effects of MDT care are more prominent among patients without catastrophic illness.

Discussion

To eliminate the interfering factors related to patient inclination to participate in MDT care, PS matching was adopted to reduce selection bias. The results indicated that patients with oral cavity cancer who participated in MDT care had a 1.20-fold lower risk of death than the non-participants, suggesting that patients with oral cavity cancer who participated in MDT care had a lower death rate than the non-participants when the interfering factors were controlled. In other words, the implementation of MDT care in Taiwan actually increased the survival rate of patients with oral cavity cancer. This finding matches the findings of several past studies that investigated the correlation between MDT care and the survival rates of patients with other types of cancers. Tripathy reported that MDT care lowered the death rate of patients with breast cancer, improved patient quality of life, and reduced health care costs.[22] The study conducted by Junor, Hold, and Gills on 533

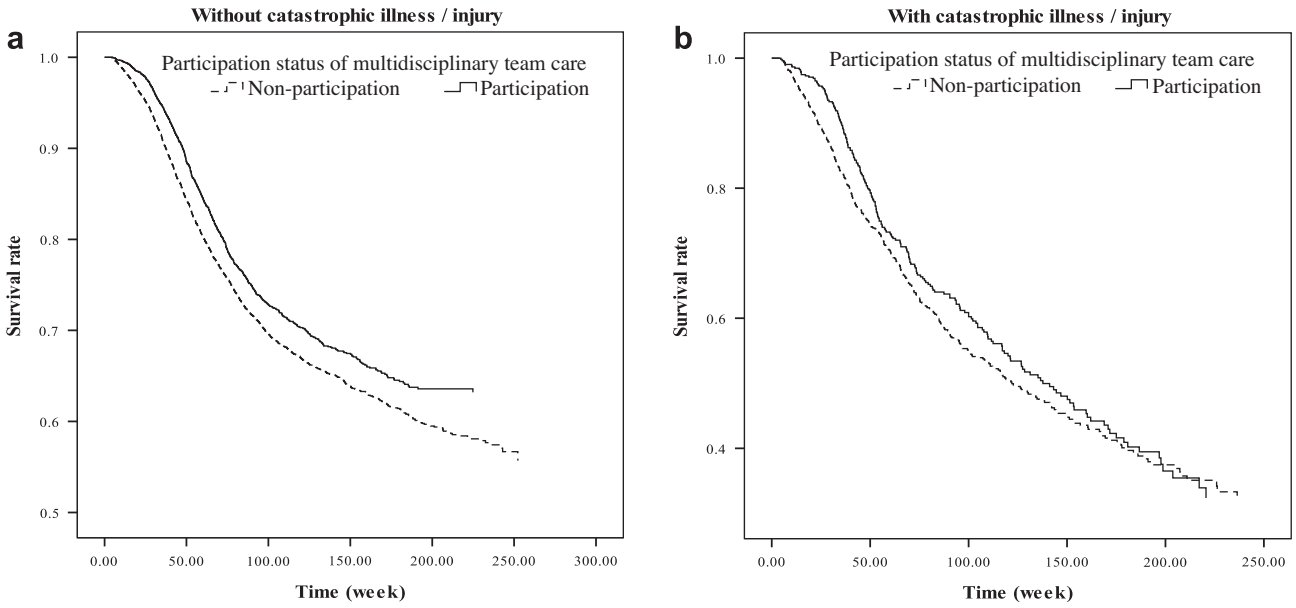

Figure 3 Survival curves of matched MDT participants/non-participants according the presence of catastrophic illness. The adjusted survival curves were controlled by sex, age, premium-based salary, urbanization of residence area, CCI, treatment method, level of hospital, ownership of hospital, sex or age of attending physician, hospital's or attending physician's annual patient volume of oral cavity cancer. (a): Patients without catastrophic illness (HR = 0.83, 95% CI = 0.77–0.89, $P < 0.001$); (b): Patients with catastrophic illness (HR = 0.88, 95% CI = 0.75–1.04, $P = 0.130$).

Scottish patients with ovarian cancer indicated that MDT care significantly enhanced survival[23]; another study of non-small cell lung cancer indicated that the adoption of MDT care improved the duration of survival from 3.2 to 6.6 months,[24] suggesting that MDT care can increase the survival rates of cancer patients.[16–19]

To evaluate the variation caused by PS matching, the survival of the unmatched patients with oral cavity cancer was further analyzed. The results indicated that the risk of death unmatched patients who participated in MDT care was 0.79-fold (95% CI = 0.74–0.84) of that of the unmatched patients who did not participate in MDT care. However, when the interfering factors were controlled more strictly, the HR increased to 0.84. The proportion of unmatched MDT care participants with catastrophic illnesses was lower than that of the corresponding non-participants, suggesting that a greater proportion of unmatched MDT care participants were in good health. Thus, the present study adopted PS matching to control the health conditions and other traits of the MDT participants/non-participants, which provided a more accurate comparison of survival between two groups.

No consensus was reached regarding the role gender plays in the survival of patients with oral cavity cancer in previous studies. Some studies reported that gender had no significant influence on survival,[25,26] whereas others concluded that males have a higher risk of death.[3,4] After matching and controlling for relevant variables, the results of the present study indicated that the risk of death for males was significantly higher than that for females (HR = 1.20, 95% CI = 1.04–1.38, $P = 0.014$). The results also suggested that the risk of death increases with increasing age (HR = 2.64 and 5.60 for the 25–34- and $\geqslant$75-year-old age groups, respectively). However, the positive effects of MDT care were more prominent among older patients (Fig. 1). In addition, the risk of death decreased as income increased (HR = 0.40 for the highest income group). The results agreed with the findings of previous studies in that low SES and higher age were related to poor prognosis among patients with oral cavity cancer,[5] whereas wealthier and younger patients have a higher survival rate.[6–8]

The present study revealed that the risk of death was lower among patients treated by hospitals or physicians serving high annual volumes of patients, which matched the results reported by Luft et al. who reported that patients treated by hospitals or physicians serving high volumes of patients were found to have a lower risk of death.[14] This is inferred to be due to a learning theory in that ongoing accumulated attending experiences gained by the hospitals or physicians serving high annual volumes of patients help to improve the attending efficiency and results, which in turn lead to a lower risk of death for the patients they treat.

Finally, it can be inferred from the results that the factors affecting the survival of patients with oral cavity cancer include participation/non-participation in MDT care, personal traits, SES, health conditions, treatment methods, and the characteristics of the hospitals and physicians. Furthermore, the effects of MDT care are more prominent among older patients and patients with less severe comorbidities or no catastrophic illnesses.

Limitations

The study used PSM method to control the MDT and non-MDT groups in characteristics, health status and treatment methods, but some other unmeasured factors that might correlate with mortality, such as lifestyle or cancer stage, were limited by this secondary data and hence were not included in the analysis model. Previous study pointed out lifestyle like poor oral hygiene, which might be caused by consumption of tobacco, alcohol or betel nut, influenced patient survival.[9–11] In addition, tumor type, size, and location, which constitute cancer stage, are the related factors with cancer survival.[12] These are the limitation of the present study.

Conflict of interest statement

None declared.

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