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Does social participation accelerate psychological adaptation to health shocks? Evidence from a national longitudinal survey in Japan

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Abstract

Purpose It is well-known that people psychologically adapt to health shocks over time and social participation (SP) has a favourable impact on health. Combining these two understandings, the current study addresses how psychological adaptation to major health shocks was affected by SP experience one year prior to the initial diagnosis.

Methods Data were collected from a twelve-wave nationwide panel survey conducted from 2005 to 2016, starting with 34,240 individuals aged 50–59 years. Individuals who were initially diagnosed with cancer, stroke, heart disease or diabetes at any time between the second and twelfth waves and kept diagnosed as such were focused on. Random-effects models were estimated to examine how baseline SP prior to the diagnosis affected the pace of change in psychological distress, which was measured using Kessler 6 (K6) scores (range 0–24; *M* 3.3 SD 4.2), following immediate responses to the initial diagnosis.

Results Baseline SP enabled or accelerated psychological adaptation to major health shocks. It is noted that the pace of decline of the K6 score per year after the immediate responses was 0.20 for cancer and 0.09 for diabetes (both $p < 0.001$) among men with baseline SP, in contrast with non-significant and limited changes among those without it. While the results for women were more mixed than those for men, the former results confirmed favourable impacts of baseline SP on psychological adaptation to health shocks in general.

Conclusions The results highlight a favourable impact of SP on psychological adaptation to health shocks.

Keywords Health shocks · Japan · Psychological adaptation · Random-effects model · Social participation

Introduction

It is widely known that individuals tend to adapt psychologically to health shocks over time; however, the extent of their adaptation may depend on the specific types of health shocks and well-being outcomes [1–11]. Earlier studies have observed the process through which psychological well-being returns towards its baseline levels after an immediate response to a health shock. Such studies mainly focused on the onset of chronic illness [7, 8, 11], serious injury or pain [3, 9] and long-term disability [5, 10] as health shocks and reveal that adaption varies across health impairments [12].

An interesting question regarding psychological adaptation is why some individuals adapt to health shocks more promptly and completely than others. Studies have observed that several factors—personality traits [13, 14] and other innate attitudes (e.g. coping [3, 8], internal locus of control [15], and perceptions of independence/dependence [16]), childhood experiences [17] and previous health conditions [18]—can affect the pace and magnitude of adaptation. In addition to these studies, one study [19] presented a theory that considers adaptation to be a by-product of the accumulation of 'hedonic capital', which comprises all the psychological resources that are available to an individual. Hedonic capital may include social relationships with partners, friends and colleagues, as well factors such as self-esteem, status and meaningful work [19].

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It is reasonably argued that social participation (SP), such as participation in community work, sports/hobby clubs and volunteer activities, can favourably affect a person's adaptation to health shocks, since SP may be a key aspect or product of hedonic capital. Further, SP has been known to have a favourable impact on health, particularly among the elderly. Several studies have demonstrated that SP experiences prevent the onset of functional disability [20–23], psychological distress [24–26], cognitive impairment [27–29] and delayed mortality among the elderly [30, 31]. Interactions with others in the society or community, which are considered to be core aspects of SP and also closely related to the concept of hedonic stock, are expected to accelerate adaptation to health shocks, as well as preventing their onset [32].

The novelty of the current study is that it examines the impact of SP on psychological adaption to health shocks. Specifically, it examines whether and the extent to which SP experiences accelerate adaptation to the health shocks of cancer, stroke, heart disease or diabetes, using data obtained from twelve-wave, population-based surveys in Japan. To this end, individuals who were initially diagnosed with each of the four diseases at any time between the second and twelfth waves and kept diagnosed as such were exclusively examined in this study. To mitigate the potential bias caused by reverse causation, that is, the possibility of diseases affecting SP, the study focuses on the effect of SP experiences one year prior to the initial diagnosis on the response to health shocks. For example, if an individual was initially diagnosed as cancer during the fifth wave, his/her SP experiences during the fourth wave were considered. The present study hypothesises that baseline SP increases the pace of psychological adaptation to health shocks. Furthermore, the study investigates how the effect of SP on adaptation may vary across types of diseases and genders, as suggested by some earlier studies [12, 15].

Methods

Study sample

The current study used twelve-wave panel data that were obtained from a nationwide population-based survey titled 'The Longitudinal Survey of Middle-Aged and Older Adults', which was conducted by the Japanese Ministry of Health, Labour, and Welfare (MHLW) annually from 2005 to 2016. Nationwide samples of the first wave were collected in November 2005 using a two-stage random sampling procedure. First, 2515 districts were randomly selected from the 5,280 districts that were included in the MHLW's nationwide population-based 'Comprehensive Survey of the Living Conditions of People on Health and Welfare', which was conducted in 2004. The 5,280 districts were, in turn, randomly selected from approximately 940,000 national census districts. Second, 40,877 residents aged 50–59 years as of October 30, 2005 were randomly selected from each of the selected 2515 districts based on the population of each district. The questionnaires were manually distributed to the participants' homes; completed by the participants by November 2, 2005; and manually collected several days thereafter. A total of 34,240 individuals responded (response rate: 83.8%) to the survey.

The second to twelfth waves of the survey were conducted in early November each year from 2006 to 2016, and 22,748 individuals continued participating in the study until the twelfth wave (average attrition rate per wave: 4.0%). No new respondents were added after the first wave. The Statistics Law of Japan required the survey to be reviewed from statistical, legal, ethical and other perspectives. The authors obtained the survey data from the MHLW with the ministry's official permission; hence, this study did not require ethical approval.

The data of individuals who were initially diagnosed with cancer, stroke, heart disease or diabetes at any time between the second and twelfth waves and kept diagnosed as such were used for the statistical analysis. Observations for which no diagnosis was reported or no answer was provided were excluded from the analysis. Individuals who were diagnosed with any of the aforementioned diseases during the first wave were removed from the analysis because the number of years since the initial diagnosis could not be identified for these individuals. After excluding the data that were missing key variables, the data of 3602; 2265; 5100; and 7925 observations of 1378; 793; 1558; and 1998 individuals diagnosed with cancer, stroke, heart disease and diabetes, respectively, were used in the study.

Measures

Diseases and psychological distress

Four types of diseases, that is, cancer, stroke, heart disease and diabetes, were considered based on respondents' answers to the question whether they had been diagnosed with any of them by a medical doctor during the time of the survey. Kessler 6 (K6) scores were used to measure psychological distress [33, 34]. Preceding studies [35, 36] have revealed the reliability and validity of K6 scores in psychological analyses of Japanese people. In the present study, the respondents were required to answer the following six-item psychological distress questionnaire: 'During the past 30 days, how often did you feel: (a) nervous; (b) hopeless; (c) restless or fidgety; (d) so depressed that nothing could cheer you up; (e) that everything was an effort; and (f) worthless?' This was rated on a five-point Likert scale (0 = *none of the time* to 4 = *all of the time*). Thereafter, the sum of

the reported scores (range 0–24) was calculated and defined as the K6 score. Higher K6 scores reflect higher levels of psychological distress. K6 scores greater than or equal to 5 and 13 have been found to be correlated with mood/anxiety disorders and serious mental illness, respectively, in Japanese people [35, 36].

Social participation

To measure SP, it was considered whether the participant had participated in each of the following six types of social activities one year prior to the initial diagnosis: (a) hobby or entertainment; (b) sports or physical exercises; (c) community activities; (d) childcare support, or educational or cultural activities; (e) support for the elderly; and (f) others (multiple answers permitted). For each activity, the respondents were asked to answer whether they participated in it alone or with others (such as friends and neighbours). A binary variable of SP was constructed by allocating 1 to respondents who reported participating in at least one of the six activities at baseline—whether they participated in it alone or with others—and 0 to those who did not participate in any activity.

This relatively simple definition is expected to highlight the importance of SP by enabling a comparison of results among the respondents who had participated in at least one activity and those who had not participated in any social activity. To examine the sensitivity of the results to the definition of SP, two alternative definitions, in addition to the benchmark definition, were considered. Definition I defined SP as participation in at least two of the six activities. Definition II defined SP as participation with others (i.e. not alone) in at least one of the six activities; that is, this definition excluded those who participated alone whenever they participated in any activity.

Covariates

Household spending, educational attainment, having a job, having a spouse and age in the first wave were considered as covariates. Household spending, which was used as a proxy for household income, was adjusted for household size by dividing it with the square root of the number of household members [37–39]. Thereafter, it was categorised into quartiles. Educational attainment was categorised as high school or below, junior college, college or above and so on. Further, binary variables for each age (50–59) in the first wave were constructed; for example, the binary variable for age 50 was constructed by allocating 1 to respondents who were 50 years old in the first wave and 0 to others. A set of these binary variables were used as covariates to control for cohort-specific effects.

Statistical analyses

Regression model analyses were conducted on the entire sample to examine how baseline SP affected the evolution of K6 score following the initial diagnosis, focusing on two potential effects: (1) effect on the pace of adaptation and (2) effect on the immediate impact of the diagnosis. Specifically, a linear random-effects regression model was estimated to explain the K6 score after the initial diagnosis:

$$K6\ \text{score}_{it} = \alpha + \beta_1 t + \beta_2\ \text{baseline}\ \ \text{SP}_i \times t + \beta_3\ \text{baseline}\ \ \text{SP}_i + \beta_4\ \text{baseline}\ K6\ \ \text{score}_i + \sum_j \beta_{5j}\ \text{covariates}_{ijt} + e_i + u_{it},$$

for individual i, and the number of years that had elapsed since the initial diagnosis t (which is zero at the initial diagnosis). In this model, a binary variable of baseline SP and its interaction term with years since the initial diagnosis, baseline K6 score and a set of covariates were used as explanatory variables. The variables e_i and u_{it} indicate the individual-level fixed effect and the error term, respectively. The random-effects model assumes that e_i is independent of all explanatory variables, whereas the fixed-effects model allows e_i to be correlated with them [40]. The Hausman test conducted in the current study showed that the null hypothesis that e_i were not correlated with the explanatory variables could not be rejected, confirming that the random-effects model was preferable to the fixed-effects one [40].

In this model specification, the coefficient of years (β_1) indicates the pace of adaptation for individuals without SP. The coefficient of the interaction term (β_2) is expected to be significantly negative if baseline SP accelerates adaptation. The value of $\beta_1 + \beta_2$, which is indirectly computed from the regression results, indicates the pace of adaptation of individuals with SP. The coefficient on baseline SP (β_3) was considered as well: a negative value indicates that baseline SP moderated the immediate impact of the diagnosis. The coefficient on baseline K6 score (β_4) is expected to be positive. The model was estimated for each disease and each gender, and they were estimated using two different conditions of SP. The software package Stata (StataCorp. Ver. 15) was used for the statistical analysis.

Results

Table 1 summarises the key characteristics, which were observed in the first wave, of the respondents included in the statistical analysis. More than a half of all respondents had graduated from high school, whereas more than 80% of

Table 1 Key features of the respondents used in statistical analyses

	Men	Women	All
Prevalence (%)			
Educational attainment			
Junior high school	17.3	16.8	16.8
High school	52.2	61.7	56.1
Junior college	2.6	12.9	6.8
College	27.7	6.7	19.2
Other	0.6	0.6	0.6
Having a job	93.7	66.0	82.5
Having a spouse	88.2	87.1	87.8
Self-rate health			
Very good	5.5	5.0	5.3
Good	26.2	25.3	25.8
Somewhat good	43.1	42.9	43.0
Somewhat poor	18.7	20.3	19.4
Poor	4.9	5.2	5.1
Very poor	1.5	1.2	1.4
K6 score ≥ 5	25.7	31.0	27.8
K6 score ≥ 13	3.3	3.8	3.5
Age (years)			
M[a]	55.1	55.0	55.1
SD[b]	2.7	2.7	2.7
Household spending[c] (monthly, thousand yen)			
M	205.4	186.8	198.0
SD	233.7	144.8	203.0
K6 score (range 0–24)			
M	3.0	3.6	3.3
SD	4.1	4.2	4.2
No. of individuals	2822	1932	4754

Evaluated in wave 1

[a]Mean

[b]Standard deviation

[c]Household-size adjusted

them had a paid job and slightly less than 90% of them were married. Approximately 6.5% of the respondents assessed their health as being very poor or poor, whereas nearly one-fourth had mood/anxiety disorders.

Table 2 presents the numbers of individuals who had experienced the initial diagnosis of each disease and their baseline K6 scores by baseline SP. For all diseases, more than 70% of the respondents had participated in at least one social activity one year prior to the initial diagnosis. Further, it is noted that K6 scores among individuals with SP were lower by 0.9–1.8 points than those without SP.

Table 3 summarises regression model results. It includes the estimated pace of change in K6 score per year for individuals with SP ($\beta_1+\beta_2$), along with its standard error, both of which were computed from the regression results. It is observed that men with SP experienced adaptation to all diseases, which was indicated by a significantly negative value of $\beta_1+\beta_2$ for all diseases, whereas men without SP experienced adaptation to stroke alone. Among men with SP, the estimated pace of adaptation per year—that is, the absolute value of $\beta_1+\beta_2$—ranged from 0.06 (heart disease) and 0.20 (cancer). It is unclear how clinically important this pace of adaptation is. However, its magnitude is non-negligible if the adaption continues for some years, especially for those whose K6 scores were close to their thresholds for mood/anxiety disorders (5) or serious mental illness (13) [35, 36].

The difference in the pace of change in K6 score between men with and without SP was significantly high for cancer and diabetes. For women, baseline SP allowed adaptation to cancer and heart disease and prevented K6 score from increasing for stroke, whereas SP allowed K6 score to increase slightly for diabetes.

Figures 1 and 2 graphically explain the results depicted in Table 3 by illustrating the predicted changes in K6 score since initial diagnosis for each disease for men and women, respectively. In these figures, the differences in the immediate change in K6 scores at initial diagnosis (year 0) reflect the estimated value of β_3. The subsequent changes in K6 score were projected based on the estimated values of β_1 (for non-SP) and $\beta_1+\beta_2$ (for SP). The mean of the predicted immediate change in K6 score for individuals without SP was used as a benchmark for comparison, and all variables other than years that elapsed since the initial diagnosis were assumed to be unchanged.

As seen in Fig. 1, the curves for men with SP display similar patterns for all diseases; clearly, the curves have downward slopes after ascending at initial diagnosis, which confirms adaptation. The impact of SP is most significant on the curve for cancer, whose slope is slightly positive for individuals without SP. Further, an accelerated adaptation by SP is observed for diabetes. For stroke and heart disease, the curves for both types of individuals are nearly parallel following immediate ascent, which suggests the absence of accelerated adaptation by SP. For women, Fig. 2 reveals that SP enabled adaptation to cancer and stroke, whereas it modestly accelerated adaptation to heart disease. However, no adaptation occurred for diabetes.

Table 4 depicts how the estimation results depended on the definition of SP. If SP is defined as participation in two or more social activities (Definition I), both the difference in the change per year since initial diagnosis (β_2) and the effect of SP on the immediate impact (β_3) were non-significant for all diseases, with the single exception of β_2 for diabetes among men. If SP is restricted to participation with others (Definition II), β_2 remained significant in most cases and β_3 changed from non-significant to significant for heart disease among both men and women.

Table 2 Numbers of individuals who experienced the initial diagnosis of each disease between the second and twelfth waves, their baseline K6 scores by baseline social participation (SP)

	Men		Women		All	
	SP	Non-SP	SP	Non-SP	SP	Non-SP
Cancer ($N=1378$)						
No. of individuals	626	140	507	105	1133	245
K6 score						
M[a]	2.9	4.2	3.7	5.5	3.3	4.7
SD[b]	(3.8)	(4.7)	(4.1)	(5.6)	(4.0)	(5.1)
Stroke ($N=793$)						
No. of individuals	352	128	229	84	581	212
K6 score						
M	3.2	4.9	3.8	4.7	3.4	4.8
SD	(4.2)	(5.8)	(4.1)	(5.4)	(4.1)	(5.6)
Heart disease ($N=1558$)						
No. of individuals	784	199	451	124	1235	323
K6 score						
M	3.3	4.6	4.0	5.7	3.5	5.0
SD	(4.1)	(5.4)	(4.1)	(6.2)	(4.1)	(5.7)
Diabetes ($N=1998$)						
No. of individuals	941	290	566	201	1507	491
K6 score						
M	3.0	4.1	3.6	4.5	3.2	4.3
SD	(4.0)	(4.9)	(4.1)	(4.8)	(4.0)	(4.9)

Evaluated one year prior to the initial diagnosis

[a]Mean

[b]Standard deviation

Table 3 Comparison of immediate and subsequent changes in K6 scores in response to the initial diagnosis of individuals with baseline social participation (SP) and those without it

	Change per year since the initial diagnosis						Effect of SP on the immediate impact		N[b]
	SP		Non-SP		Difference				
	$\beta_1+\beta_2$	95% CI[a]	β_1	95% CI	β_2	95% CI	β_3	95% CI	
Men									
Cancer	-0.20^{***}	(−0.28, −0.12)	0.01	(−0.16, 0.18)	-0.21^{*}	(−0.40, −0.02)	-0.85^{*}	(−1.57, −0.14)	766
Stroke	-0.18^{***}	(−0.27, −0.10)	-0.19^{***}	(−0.32, −0.05)	0.00	(−0.16, 0.16)	−0.14	(−0.99, 0.72)	480
Heart disease	-0.06^{*}	(−0.10, −0.01)	−0.07	(−0.15, 0.01)	0.01	(−0.08, 0.10)	−0.43	(−0.94, 0.08)	983
Diabetes	-0.09^{***}	(−0.12, −0.06)	−0.02	(−0.08, 0.04)	-0.07^{*}	(−0.14, −0.01)	-0.50^{*}	(−0.93, −0.07)	1231
Women									
Cancer	-0.15^{***}	(−0.23, −0.07)	0.09	(−0.08, 0.25)	-0.23^{*}	(−0.42, −0.05)	−0.44	(−1.29, 0.42)	612
Stroke	−0.07	(−0.20, −0.07)	0.25^{***}	(0.07, 0.43)	-0.32^{***}	(−0.54, −0.10)	−0.40	(−1.37, 0.57)	313
Heart disease	-0.14^{***}	(−0.21, −0.06)	−0.03	(−0.16, 0.09)	−0.10	(−0.25, 0.04)	−0.63	(−1.43, 0.18)	575
Diabetes	0.04	(−0.00, −0.09)	−0.01	(−0.09, 0.07)	0.05	(−0.04, 0.14)	−0.26	(−0.83, 0.30)	767

To conserve space, estimated coefficients on other variables have not been reported

$^{***}p<0.001$, $^{**}p<0.01$, $^{*}p<0.05$

[a]Confidence interval

[b]Number of individuals

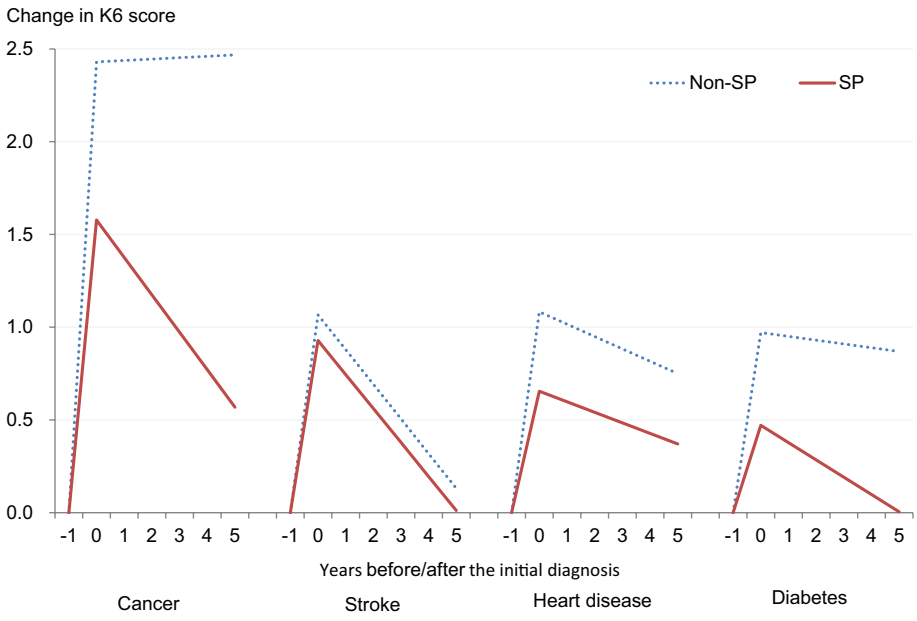

Fig. 1 Comparison of the predicted evolutions of K6 score between individuals with baseline social participation (SP) and those without it: the case of men. *Note* The differences in the immediate change in K6 score at the initial diagnosis (year 0) reflect the estimated value of β_3. The subsequent changes per year in K6 score were projected based on estimated values of β_1 (for Non-SP) and $\beta_1+\beta_2$ (for SP). The mean of the predicted immediate change in K6 score for those without SP was used as a benchmark for comparison, and all variables other than the years that had elapsed since initial diagnosis were assumed to be unchanged

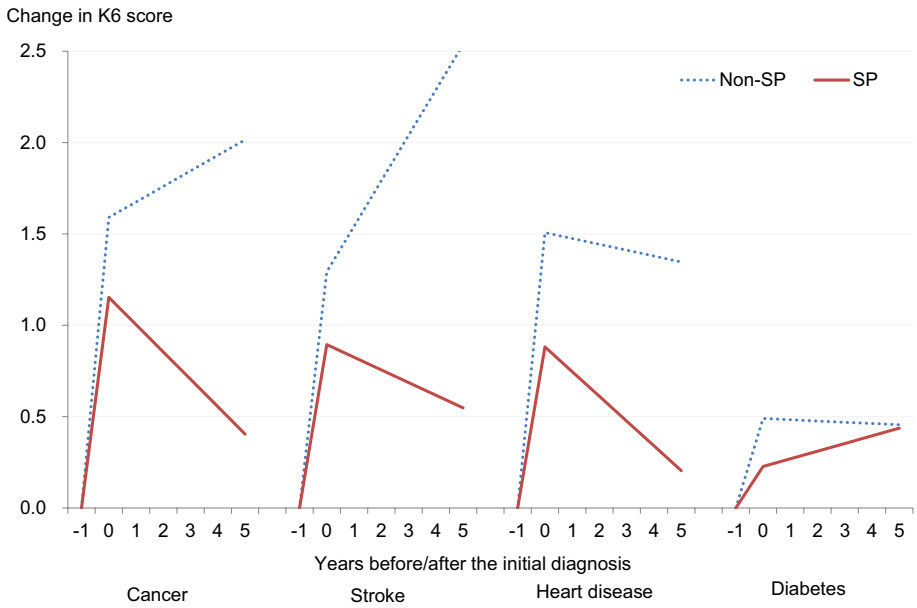

Fig. 2 Comparison of the predicted evolutions of K6 score between individuals with baseline social participation (SP) and those without it: the case of women. *Note* See note to Fig. 1

Discussion

The current study uses a dataset obtained from twelve-wave, nationwide surveys in Japan to examine how SP experience at baseline affects psychological adaptation to major health shocks. The survey enabled us to identify the timing of initial diagnosis for four diseases and the number of years that have elapsed since. To mitigate the potential biases arising from simultaneity, the study focussed on SP experiences prior to the initial diagnosis.

The estimation results showed that SP experience at baseline enabled or accelerated individuals' psychological adaptation to major health shocks, which is consistent with the favourable effects of SP on health that have been observed by several earlier studies [20–31]. Men with baseline SP displayed smooth adaptation to each of the four diseases, whereas those without SP displayed it only towards stroke. These results suggest that baseline SP enabled, rather than simply accelerated, men's adaptation to major diseases. The results were more unclear for women, with no adaptation being observed among women to diabetes. However, baseline SP allowed adaptation to cancer and heart diseases in women, similar to that in men, and prevented the psychological distress resulting from stroke.

Table 4 Comparison of the estimated results for different definitions of social participation (SP)

	Base model[a]		Definition I[b]		Definition II[c]		N^f
	Coef.[d]	95% CI[e]	Coef.	95% CI	Coef.	95% CI	
Difference in the change per year since the initial diagnosis (β_2)							
Men							
Cancer	−0.21*	(−0.40, −0.02)	−0.30	(−0.61, 0.02)	−0.23***	(−0.38, −0.07)	766
Stroke	0.00	(−0.16, 0.16)	−0.11	(−0.38, 0.15)	0.04	(−0.10, 0.19)	480
Heart disease	0.01	(−0.08, 0.10)	−0.08	(−0.21, 0.05)	−0.01	(−0.09, 0.07)	983
Diabetes	−0.07*	(−0.14, −0.01)	0.01	(−0.07, 0.09)	−0.03	(−0.09, 0.02)	1231
Women							
Cancer	−0.23*	(−0.42, −0.05)	−0.14	(−0.35, 0.06)	−0.16*	(−0.32, 0.00)	612
Stroke	−0.32**	(−0.54, −0.10)	−0.17	(−0.50, 0.16)	−0.34***	(−0.56, −0.13)	313
Heart disease	−0.10	(−0.25, 0.04)	−0.16	(−0.36, 0.04)	0.03	(−0.10, 0.16)	575
Diabetes	0.05	(−0.04, 0.14)	0.10	(−0.03, 0.23)	0.03	(−0.05, 0.11)	767
Effect of SP on the immediate impact (β_3)							
Men							
Cancer	−0.85*	(−1.57, −0.14)	0.18	(−1.99, 2.34)	−0.62*	(−1.23, 0.00)	766
Stroke	−0.14	(−0.99, 0.72)	1.10	(−1.44, 3.65)	−0.44	(−1.21, 0.33)	480
Heart disease	−0.43	(−0.94, 0.08)	0.07	(−0.93, 1.07)	−0.60***	(−1.05, −0.16)	983
Diabetes	−0.50*	(−0.93, −0.07)	−0.99***	(−1.72, −0.26	−0.60***	(−0.98, −0.22)	1231
Women							
Cancer	−0.44	(−1.29, 0.42)	−0.38	(−2.60, 1.83)	−0.38	(−1.09, 0.34)	612
Stroke	−0.40	(−1.37, 0.57)	−0.59	(−3.00, 1.81)	−0.28	(−1.18, 0.61)	313
Heart disease	−0.63	(−1.43, 0.18)	0.24	(−1.21, 1.70)	−1.33***	(−2.03, −0.63	575
Diabetes	−0.26	(−0.83, 0.30)	−0.31	(−1.37, 0.74)	−0.30	(−0.82, 0.21)	767

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

[a]SP was defined as participation in one or more social activities (see the results depicted in Table 3)

[b]SP was defined as participation in two or more social activities

[c]SP was defined as participation in any social activity with others

[d]Coefficient

[e]Confidence interval

[f]Number of individuals

Previous studies have demonstrated that individuals' personality and other inborn attitudes [13–15], childhood experiences [17] and earlier health conditions [18] can affect the pace and magnitude of their adaptation to health shocks. The current study demonstrated that baseline SP is another key factor that can affect adaptation, which provides new insights for understanding the adaptation process.

These favourable effects of SP on adaptation are particularly noteworthy, since the potential changes in SP after the initial diagnosis were ignored in the current regression analyses, which focused on baseline SP alone. Two interpretations are possible for this trend: it can be argued that baseline SP experience may have a long-lasting and positive impact on adaptation, whereas it is also probable that baseline SP may reflect the individual attributes that contribute to adaptation. In any case, the finding that baseline SP experience enabled a significant reduction in psychological distress for most diseases, along with the mixed results that were obtained in individuals lacking such experience, highlights the importance of SP in realising psychological adaptation. This supports the perspective that SP is a key outcome of hedonic capital that enhances resilience to health shocks [19].

However, it is noted that the effect of SP on adaptation varied according to types of diseases and gender, as observed by previous studies [12, 15]. SP significantly accelerated the adaptation to cancer in both men and women; however, mixed results were obtained for other diseases. Identifying the explanations for these differences is beyond the scope of the current study. However, this study's observations indicate the possibility that psychological aspects of adaptation differ according to types of diseases and gender, thereby influencing the effect of SP on adaptation to the health shocks.

The sensitivity analyses based on different definitions provided additional insights for understanding the effect of

SP on adaptation. The result that the effects of SP became non-significant if the definition of SP was narrowed to participation in two or more social activities suggests that participation in any social activity is more important for adaptation than participating in multiple activities. The result that limiting SP to participation with others tended to make the effects of SP more significant suggests that interactions with others form a key factor enabling the favourable effects of SP on adaptation. It also underscores the importance of interactions with others as a core aspect of SP [32].

The current study had several limitations, in addition to the observations being limited to middle-aged Japanese people, which required us to be cautious in making generalisations. First, since SP experience at baseline was focused on to mitigate simultaneity biases, it disregarded the changes in SP following the diagnosis. To check the robustness of the estimation results, the models were re-estimated by replacing a binary variable of SP one year before the initial diagnosis with that of SP in the first wave. Results (which are available on request) remained largely intact, albeit somewhat more mixed, probably because SP had a long-lasting effect. Further, the odds ratio of the current SP in response to the baseline SP was calculated to be more than 25 for both men and women.

Second, it can be argued that SP is endogenously determined by personality traits (e.g. extraversion, openness and neuroticism), family relationships, educational attainment, and/or other individual attributes. Although some individual attributes were controlled for in the current study, it may be inappropriate to treat SP as an exogenous experience. Even if this is the case, the results suggest that baseline SP experience can be a reliable predictor of future responses to health shocks.

Third, this study does not consider the possibility of occurrence of co-morbidities or multi-morbidities; it focused on the initial diagnosis of each disease alone. If individuals experience two or more diagnosed diseases, their psychological adaptation process probably differs from that for a single diagnosed disease.

Despite these limitations, the results emphasise that SP has a favourable impact on psychological adaptation to health shocks, which implies that policy intervention to support SP is desirable from the public health perspective, particularly for middle-aged individuals, who are prone to various chronic diseases and disabilities. Such a policy intervention is expected to be very effective in enhancing the adaptation to the diagnosis of cancer for both men and women. In addition, the result that participation in at least one social activity enabled or accelerated adaptation implies that policy measures should emphasise the reduction of risk of social isolation.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

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