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Factors affecting participation in health checkups: Evidence from Japanese survey data

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ABSTRACT

Multiple factors influence individuals to get health checkups. This study investigates key determinants of the health checkup decision by using 2696 Japanese respondents' data from a questionnaire survey entitled "Preference Parameters Study" that was conducted in four countries by the Global Centers of Excellence program at Osaka University. In the Probit and OLS regressions, other than relevant personal attributes being identified, the hyperbolic discounter dummy and its interaction terms with respondents' health behaviors were also included as independent variables. The results suggest that some socio-demographic variables such as gender, age, income, household size, occupational status, educational level are significant. In addition, hyperbolic discounters are found to be more likely than non-hyperbolic discounters to seek health checkups, which indicates that the effect of time preference on health checkup behavior differs significantly among the different types of time discount structures.

1. Introduction

Japan is a rapidly aging society. In 2015, 26.7% of the Japanese population was 65 years of age or older. Relative to most other countries in the world, this is an extremely high figure. (For comparison, the rate is 21.2% in Germany, 19.1% in France, 17.8% in the United Kingdom, 14.8% in the United States, 13.4% in Russia, and 9.6% in China.) Under such circumstances, a variety of social problems such as increasing medical expenses and elder-to-elder nursing care (i.e., elderly persons caring for the elderly) have emerged.

As part of the approach to dealing with these problems, efforts to prevent disease and promote health among the insured and their dependents have received increasing emphasis. According to Japanese Ministry of Health, Labor and Welfare, the implementation of data-driven health plans to reduce medical expenses is progressing [1,2]. These plans are regarded as an effort by health insurers to become more efficient and effective businesses by using a large amount of electronically managed information that tracks such events as medical checkups. At the same time, a mechanism that allows individuals to make efforts to improve their own health is also needed. It can be expected to delay the need for nursing care and prevent serious illness.

Getting routine health checkups to prevent illness and maintain good health is considered one of the most effective measures to alleviate many of the problems associated with aging. The familiar health checkup program in Japan is composed of the Specific Health Checkup (SHC) and Specific Health Guidance (SHG). These two elements are part of an insurance system that was instituted in 2008 for all public health insurance members from age 40 to 70 years [3]. SHC is a health examination intended to prevent chronic diseases (i.e., the diseases associated with one's lifestyle, such as diabetes and hypertension), which have been increasing rapidly in recent years in Japan. SHG is the support provided to those who are judged likely to develop chronic diseases based on the results of their health checkups. Fig. 1, provides the implementation rate of SHC, the percentage of SHG operations, and the percentage of persons completing SHG from 2008 to 2014, of which the data were obtained from the Ministry of Health, Labor and Welfare Publications [4]. As shown in the figure, although the implementation rate for SHC has been increasing year by year, it is still low. On the other hand, while the percentage of individuals following SHG is decreasing, the proportion of those who complete the guidance is increasing.

Through a health checkup and the medical report that follows, an individual is able to assess his/her health condition and take

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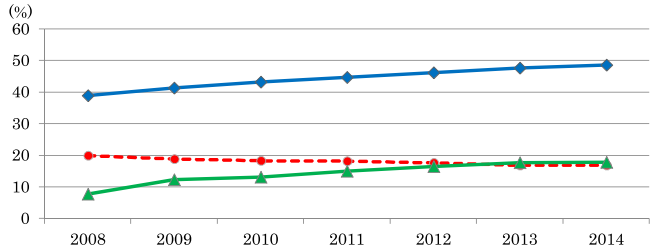

Fig. 1. The implementation rate of Specific Health Checkup (blue), the percentage of Specific Health Guidance operation (red), and the percentage of persons completing Specific Health Guidance (green). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

remedial steps if necessary. For those whose results are not good, changes in lifestyle activities (e.g., eating habits, exercise, etc.) are likely needed. Even for those whose examinations indicate no health problems, simply knowing their status can be useful. The very act of deciding whether to get a health checkup would appear to be related to one's awareness of maintaining health and preventing disease.

In the current study, we aim to identify those factors that affect an individual's participation in health checkups. While a number of studies have been conducted on this issue in Japan [5–8], most have focused on socio-demographic factors. At the same time, several studies on time preference have reported that an individual's time preference can be associated with his/her health-related behaviors [9,10]. Thus, it is considered that time preference may be an important factor affecting one's decision to get a health checkup. Hyperbolic discounting indicates people have higher discount rates for short horizons but have lower discount rates for longer horizons, and people will take time-consistent action. Therefore, it is expected that if one has a hyperbolic discount, he/she may postpone going to a health checkup, and it is possible that the opportunity to manage his/her health status is hindered. In addition, we also consider the interaction between hyperbolic discounting and health behaviors (e.g., smoking, drinking, engaging in physical exercise, etc.) as well as the individual's socio-demographic factors. Importantly, the interaction between time preference and health behaviors is seldom considered in the previous studies, which could be viewed as a contribution to the literature. Moreover, given that the cancer mortality rate in Japan is high and many individuals can benefit from aggressive cancer screening, we also analyze those factors affecting participation in cancer screenings. For cancer screening in Japan, there are organized screening program and opportunistic screening program. Organized screening is conducted as a public policy aimed at lowering cancer mortality rate, and it is health checkup done by municipality in Japan. Meanwhile, opportunistic screening is conducted by medical institutions (e.g., medical checkups) and its form is diverse.

2. Literature review

2.1. Factors affecting participation in health checkups

A number of studies have examined factors affecting the decision to seek a health checkup. Looking at differences between those who elected to have a health examination and those who did not, Iwasaki et al. [5] reported that socio-demographic factors, lifestyle factors, and an individual's medical history were important factors influencing the checkup decision. Funahashi et al. [6] found that men who did not have a medical examination had lower household incomes than those who had an exam. They also found that among the men who had not had a medical examination, few were self-employed or were regular employees. In addition, it has been found that the availability of support from the people close to an individual affects the individual's health checkup rate [7]. Mitsuhashi et al. [8] analyzed the relationship between participation of the elderly in medical examinations and their social support. They found that those elderly who had medical checkups had a greater connection to society through, for example, their membership in a neighborhood association or having close friends and relatives.

Educational level also appears to affect health checkup behavior. Yoshida et al. [11] showed that a low educational level was related to the non-consultation of health examinations in the case of men. Differences in the behavior of men and women with respect to their participation in health examinations has also been reported. Men who did not receive medical examinations had a weak relationship with those familiar to them, a feature not seen in women [6]. Concerning the effect of age, Mitsuhashi et al. [12] reported that one's subjective health condition affected the health examination decisions of the elderly.

2.2. Time preference and health-related behavior

In the studies mentioned in the preceding section, factors such as personal attributes and lifestyle were examined; in general, there are few studies consider the time preference of the individual. However, several studies suggest that time preference, especially hyperbolic discounting, affects health-related behaviors [9,10].

We consider the time discount factor of the hyperbolic type is following:

$$f(t) = (1 + kt)^{-\gamma/k} \tag{1}$$

where $t \geq 0,\ \gamma \geq 0,\ k > 0$. Here, γ and k are constants, and t represents delay in gain. The time discount rate $\rho(t)$ can then be defined as $-f'(t)/f(t)$. That is,

$$\rho(t) = -\frac{f'(t)}{f(t)} = \frac{\gamma}{1 + kt}. \tag{2}$$

Unlike exponential discounting, hyperbolic discounting is a time-inconsistent model of discounting. It indicates that people have higher discount rates for short horizons but have lower discount rates for longer horizons [9,10,13,14].

With respect to the effect of hyperbolic discounting on health-related behavior, Kang and Ikeda [9] reported that respondents who were less patient (i.e., respondents with hyperbolic discounting) tended to have worse health-related attributes. In addition, Ikeda et al. [10] found that time discounting was associated with body weight via hyperbolic discounting. That is, individuals with hyperbolic discounting are more likely to have high body weight. Further, Yamane et al. [15] stated that socio-emotional status affected impulsivity in intertemporal choice.

Regarding the connection between time preference and checkup-seeking behavior, Fang and Wang [16] used United States data to show a close relationship between the two. In their study, the authors showed that the women who were identified to have the present bias had a tendency not to undertake mammography.

However, in addition to the time preference, we need to control for the possibility that the act of getting health checkups may be influenced by health-related behavior such as smoking and exercising. Accordingly, in the current study we investigate the determinants of getting health checkups by considering the interaction between hyperbolic discounting and health-related behavior (i.e., smoking, drinking, and engaging in physical exercise), which is seldom conducted in the above-mentioned studies. Meanwhile, we also analysis the factors affecting participation in cancer screening, which aims at investigating whether associations

of hyperbolic discounting with checkup participation are varied between health checkup and cancer screening.

3. Methods

3.1. Methodology

To examine the determinants of health check-up behavior, the following specification was considered:

$$\begin{aligned} CHECKUPi_j &= \alpha_j + \beta_M M_j + \beta_{BMI} BMI_j + \beta_A A_j + \beta_I I_j + \beta_S S_j + \beta_P P_j + \beta_{self} self_j \\ &+ \beta_{ft} full_j + \beta_{pa} part_j + \beta_w w_j + \beta_u u_j + \beta_C C_j + \beta_{ho} \text{hospital} + \beta_{he} \text{health} \\ &+ \beta_{SMOKING} SMOKING_j + \beta_{SPORT} SPORT_j + \beta_{DRINKING} DRINKING_j \\ &+ \beta_{HD} \text{hyperbolic dummy}_j + \beta_{SM_{HD}} SMOKING\_\text{hyperbolic dummy}_j \\ &+ \beta_{SP_{HD}} SPORT\_\text{hyperbolic dummy}_j + \beta_{DR_{HD}} DRINKING\_\text{hyperbolic dummy}_j + \mu_j \end{aligned} \quad (3)$$

where *CHECKUPi* ($i = 1, 2, 3$) is the dependent variable; specifically, *CHECKUP1* is the probability of getting health checkups, *CHECKUP2* is the number of health checkups undertaken, and *CHECKUP3* is the probability of having a cancer screening. *M* is male, *BMI* is body mass index, *A* is age, *I* is income, *S* is household size, *P* is population size of the area in which the respondent lives, *self* is self-employed, *full* is full-time employed, *part* is part-time employed, *w* is housewife, *u* is unemployed, *C* is a college graduate dummy, *hospital* indicates whether the respondent has been hospitalized within the past year, and *health* is a subjective health anxiety dummy. *SMOKING* is a binary variable for the frequency of smoking, *SPORT* is a binary variable for the frequency of participating in sports, *DRINKING* is a binary variable indicating the frequency of drinking alcohol, hyperbolic dummy is a binary variable indicating whether or not the respondent is a hyperbolic discounter. In addition, α is the constant term and μ is the error term. βs are coefficients of each variable and *j* is the respondent index.

To analyze the impact of being a hyperbolic discounter or non-hyperbolic discounter on the health checkup behavior of a respondent, we create terms for the interaction of HD and the respondent's health-related behavior (i.e., *SMOKING_hyperbolic dummy*, *SPORT_hyperbolic dummy*, and *DRINKING_hyperbolic dummy*). With the addition of these interaction terms to the regression models, the coefficients of *SMOKING*, *SPORT*, *DRINKING* represent the influence of these factors on the health checkup behavior of non-hyperbolic discounters, while the coefficients of interaction terms will indicate the impact on the dependent variable of *SMOKING*, *SPORT*, and *DRINKING* for hyperbolic discounters.

3.2. Data

The data used in this study were obtained from a questionnaire survey entitled "Preference Parameters Study" that was conducted in four countries by the Global Centers of Excellence (Global COE) program at Osaka University: in Japan from 2004; in the U.S. from 2005; in India from 2009; and in rural and urban areas in China from 2006 and 2007. In the current study, we selected the sample from the 2010 and 2011 surveys in Japan, because of the reason that questions related to health checkup participation were only asked in the 2011 questionnaire. In 2010 the total number of surveys was 6134 and the effective collection number was 5386 (recovery rate 87.8%), while in 2011 the total number was 5316 and the effective collection number was 4934 (recovery rate 92.8%).

The key question, "Did you participate in the following health checkups *in the last year?*" was asked in the 2011 questionnaire in Japan; therefore, we used the answers to this question for the dependent variables in our regressions and the other answers from the 2010 questionnaire for the independent variables. Consequently, we further selected the sample of which the respondents answered both the 2010 and 2011 questionnaires. As a result, the number of participants used in *CHECKUP1* and *CHECKUP2* regressions (i.e., the regressions of taking any health checkups and number of health checkups taken) was 2696, while it was 2135 in *CHECKUP3* regression (i.e., the regression of taking cancer screening).

Our sample consisted of 1470 men (54.53%) and 1226 women (45.47%), which has no statistical difference from the official male-female ratio in 2010 (48.86% versus 51.14%) provided by The Portal Site of Official Statistics of Japan (chi2 = 0.7212, p = 0.396, d.f. = 1). The respondents ranged in age from 21 to 77 (mean age = 50, S.D. = 12.39). In our sample, there was majority of households (71.71%) that consisted of two to four persons. Comparing to the average household size in 2010 in Japan (i.e., 2.59 persons per household), the average household size in our sample (i.e., 3.51 persons per household with S.D. = 1.42) is statistically larger (t = 33.4845, p = 0.000, d.f. = 2695). With respect to employment status, about 80.93% of the respondents were self-employed or employed full- or part-time. The unemployment rate in the sample is 6.42%, which is higher than the official rate of 2.8% in 2017. In addition, the average monthly income in our sample is 237.5 thousand JP yen, which is considerably lower than the average in 2010 in Japan (i.e., 323 thousand JP yen).

3.2.1. Questions regarding health checkups

We treated *CHECKUP1*, *CHECKUP2*, and *CHECKUP3* as the dependent variables. Based on responses to Q1 and Q2 as presented in Appendix 1, *CHECKUP1* equals 1 if the respondent had any health checkups or cancer screenings within the past year (i.e., if the respondent selected any of the choices except 6 in Q1 and 7 in Q2), and 0 otherwise. The checkups included in this study are (1) those organized by local municipality; (2) those organized by the respondent's employer or labor union of the employer; (3) those organized by the respondent's school; and (4) the medical checkups in addition to (1)-(3) or other checkups. In addition, cancer screenings include stomach cancer, lung cancer, uterine cancer, breast cancer, colon cancer, and other cancer examinations. *CHECKUP2* indicated the number of health checkups taken; its value was assigned by combining a simple count of the number of checkups indicated by the respondent in Q1 and the number of cancer screenings indicated in Q2. *CHECKUP3* indicated the behavior of respondents who received any cancer screenings *in addition to* other health checkups. For those who had at least one health checkup (i.e., *CHECKUP1* = 1), *CHECKUP3* was coded 1 if the respondent checked any cancer screenings in Q2, and 0 otherwise. We run Probit models for *CHECKUP1* and *CHECKUP3* and Ordinary Least Squares (OLS) regression for *CHECKUP2*. The same independent variables were used in each of these three regressions.

3.2.2. Questions regarding time preference

Time preference was assessed from responses to Q3 and Q4 as presented in Appendix 2. Q3 and Q4 were questions about intertemporal choices. We used it to measure time preference and to classify a respondent as a hyperbolic discounter or a non-hyperbolic discounter. In Q3, we elicited time preference based on the respondent's choices in the following situation: "Let's assume you have two options to receive some money. You may choose Option A, to receive \10,000 today, or Option B, to receive a different amount in seven days. Compare the amounts and timing in Option A with Option B and indicate which you would prefer for each of the 9 alternatives." In Q4, the respondents were asked to make choices in the following scenario: "Let's assume you have two options to receive some money. You may choose Option A, to receive \10,000 in ninety days, or Option B, to receive a different amount in ninety-seven days. Compare the amounts and timing in Option A with B and indicate

which you would prefer to receive for each of the 9 alternatives." Respondents were asked to make choices regarding the receipt of money at a point in time close to the present (Q3) and the receipt of money at a relatively distant point in time (Q4). Respondents seeking higher interest rates for transactions close to the present time (Q3) were considered to be more current-oriented.

Following previous studies [17,18], we measured the time discount rate (DR) as the mean of the interest rate at the point at which there was a shift in the preferred option from A to B [17,18]. For example, if a respondent chose Option A for an interest rate from −10% to 10% and then shifts to Option B for a rate from 40% to 5000%, his/her time discount rate was calculated as 25%—the mean of 10% and 40%. We excluded from the analysis respondents whose answers went back and forth between Option A and Option B and whose time discount rate was a negative value. By comparing a respondent's time discount rate from Q3 (i.e., DR1) and his/her time discount rate from Q4 (i.e., DR2), we classified the respondent as either a hyperbolic discounter (if DR1 > DR2) or a non-hyperbolic discounter (if DR1≦DR2). Accordingly, we created a hyperbolic dummy as a binary variable coded 1 if the respondent is a hyperbolic discounter and 0 otherwise.

3.2.3. Questions regarding other variables

The following health-related variables were also created. *SPORT* was a dummy variable that took the value 1 if the respondent exercised at least once a week and 0 otherwise. *SPORT* indicates whether the respondent has frequent exercise opportunities. *SMOKING* was a dummy variable with a value of 1 if the respondent smokes at least sometimes and 0 otherwise. This variable signifies whether the respondent has a habit of smoking cigarettes. *DRINKING* was also a dummy variable; it took the value 1 if the respondent sometimes drinks alcohol and 0 otherwise. This variable indicates whether the respondent has a habit of drinking alcoholic beverages.

The following variables, some of which have been used in previous studies, were also included in the regressions: gender, BMI, age, monthly income, household size, population size, occupational status, college graduate, hospital, and health anxiety. For gender, a male dummy was created and added to the model. BMI was defined as weight in kilograms divided by the square of height in meters and expressed in units of kg/m^2. Monthly income was set by the respondent's answer to the question, "What was your approximate salary in 2009 (including business income if you are self-employed)?" Age was determined by the respondent's birth year information. Household size was defined as the number of family members, which was used as an indicator of the respondent's support from the people around him/her. In previous research, Takahashi et al. [7], the presence of supportive family members and/or familiar friends or having connections to the local community was deeply involved in the decision to have a medical examination. Population size indicate the size of area in which the respondent lives. It took the value of 4 if the respondent lives in a government designated city with a population of more than 700,000, 3 if he/she lived in a city with a population of 100,000 to 700,000, 2 if he/she lived in a city with a population less than 100,000, and 1 if he/she lived in a town or village with a population less than 50,000. Regarding occupational status, we created dummies for self-employed, full-time, part-time, housewife, and unemployed. A college graduation dummy was added to represent educational level, based on responses to the following: "Please indicate the highest level of education (or equivalent) completed by you. If you are still in school, check the level you are in now." Finally, to indicate the health condition of the respondent, we included in the model the hospitalization history of the respondent during the past year as well as a subjective assessment of the respondent's health anxiety. Table 1 summarizes the descriptive statistics for all the variables.

Table 1
Descriptive statistics for all variables used in the regressions.

Continuous variable	Mean	Std. Dev.	Min	Max
number of health checkups taken	1.3306	0.8914	0	4
age	50.34347	12.39097	21	77
monthly income (10 thousand JP yen)	23.75371	18.37232	0	99
household	3.508902	1.424903	1	10
population size	2.8303	0.8945	1	4
health anxiety	3.1880	1.0454	1	5
BMI	22.75274	3.282124	14.8721	58.59375

Category variable	Freq.	Percentage
taking health checkups =1	2,135	79.19
=0	561	20.81
taking cancer screening =1	1,470	54.53
=0	1,289	47.81
male =1	1,470	54.53
=0	1,226	45.47
self-employed =1	358	13.28
=0	2,338	86.72
full-time =1	1,295	48.03
=0	1,401	51.97
part-time =1	529	19.62
=0	2,167	80.38
housewife =1	216	8.01
=0	2,480	91.99
unemployed =1	173	6.42
=0	2,523	93.58
college graduate =1	795	29.49
=0	1,901	70.51
hospital =1	178	6.6
=0	2,518	93.4
hyperbolic discounter =1	406	15.06
=0	2,290	84.94
smoking =1	694	25.74
=0	2,002	74.26
sport =1	1,695	62.87
=0	1,001	37.13
drinking =1	1,531	56.79
=0	1,165	43.21

Note: For the categorical variables, "1″ mean "yes" and "0″ mean "no".

4. Results

4.1. Results for getting health checkups

The marginal effects obtained from our Probit and OLS regressions are reported in Table 2. With respect to having health checkups, being *male* has a significant and negative marginal effect, indicating that males are less likely than females to participate in health checkups. The marginal effects of both *age* and *income* are significant and positive, implying that these two attributes raise the probability of getting health checkups. It is clear that the greater the age, the higher the risk of getting sick, which leads to a greater acceptance of health checkups among older people. The results also indicate that respondents with larger families are more likely to get health checkups. Taken together, our results reveal the same tendencies shown in previous studies: that men often did not undergo health checkups and high-income earners were more likely to seek health consultations [6], and that the larger the family size, the more positive the impact on the individual's decision to get health checkups [7,8]. Regarding occupational status, a respondent who is self-employed, employed part-time, unemployed, or a housewife is less likely to have health checkups. In contrast, full-time employed respondents are more likely to get health checkups. The sign of the college graduate dummy is significant and positive, indicating that the higher the level of education, the more likely it is that the respondent will get a medical examination. This result is

Table 2
Marginal effects of the Probit and OLS regressions.

	(1)		(2)		(3)	
	taking health checkups		number of health checkups taken		taking cancer screening	
male	−0.0486	**	−0.2414	***	−0.2038	***
	(0.0205)		(0.0429)		(0.0251)	
age	0.0039	***	0.0194	***	0.0113	***
	(0.0007)		(0.0014)		(0.0008)	
monthly income	0.0012	*	0.0037	***	0.0024	***
	(0.0007)		(0.0012)		(0.0007)	
household	0.0113	**	0.0421	***	0.0293	***
	(0.0053)		(0.0114)		(0.0070)	
self-employed	−0.2102	***	−0.4648	***	0.0406	
	(0.0227)		(0.0569)		(0.0369)	
full-time	0.0985	***	0.2265	***	0.0533	*
	(0.0234)		(0.0520)		(0.0317)	
part-time	−0.0549	**	−0.1063	*	0.0086	
	(0.0268)		(0.0624)		(0.0364)	
housewife	−0.1755	***	−0.3414	***	0.1297	**
	(0.0322)		(0.0833)		(0.0569)	
unemployed	−0.1272	***	−0.2983	***	0.0530	
	(0.0345)		(0.0827)		(0.0526)	
college graduate	0.0505	***	0.0703	*	0.0191	
	(0.0183)		(0.0364)		(0.0217)	
population size	−0.0043		−0.0395	**	−0.0298	***
	(0.0080)		(0.0175)		(0.0106)	
BMI	0.0033		0.0025		−0.0030	
	(0.0025)		(0.0052)		(0.0031)	
hospital	0.0847	***	0.1985	***	0.0576	
	(0.0316)		(0.0647)		(0.0400)	
health anxiety	−0.0017		0.0088		0.0142	
	(0.0073)		(0.0158)		(0.0095)	
hyperbolic discounter	0.1233	***	0.2566	***	0.0623	
	(0.0390)		(0.0770)		(0.0475)	
smoking	−0.0886	***	−0.2253	***	−0.0482	**
	(0.0182)		(0.0400)		(0.0244)	
smoking × hyperbolic discounter	0.0011		0.0337		0.0724	
	(0.0477)		(0.1045)		(0.0644)	
sport	0.0403	**	0.1263	***	0.0682	***
	(0.0171)		(0.0368)		(0.0220)	
sport × hyperbolic discounter	−0.0239		−0.0680		−0.0531	
	(0.0442)		(0.0883)		(0.0537)	
drinking	0.0664	***	0.1411	***	0.0319	
	(0.0166)		(0.0369)		(0.0224)	
drinking × hyperbolic discounter	−0.1316	***	−0.2875	***	−0.0535	
	(0.0430)		(0.0871)		(0.0531)	
Observations	2696		2696		2135	
R-squared			0.158			

Robust standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.

consistent with the results of earlier studies [11]. The effect of having been hospitalized in the past year is significant, as well, with respondents in this situation having a higher probability of getting health checkups.

Representing the key factor in this study, *hyperbolic discounter* dummy marginal effect was significant and positive, which suggests that individuals with a hyperbolic discounting function are more likely than non-hyperbolic discounters to get health checkups. As for the interaction terms, the coefficient of the *DRINKING_hyperbolic* dummy was significant and negative, indicating that in the group of hyperbolic discounters, the influence of drinking alcohol on getting health checkups was smaller than that in the group of non-hyperbolic discounters. On the other hand, *SPORT*, *DRINKING*, and *SMOKING* represented the influence of these health-related variables on the probability of getting checkups in the group of non-hyperbolic discounters. Probit regression results thus suggested that in the group of non-hyperbolic discounters, respondents who have the habit of engaging in sports and drinking alcohol were more likely to get health checkups but smokers are less likely.

4.2. Results for the number of health checkups

To check the robustness of our Probit results, we conducted an OLS regression on the number of health checkups taken. As shown in Table 2, such demographic variables as gender, age, income, household size, occupational status, level of education, and hospitalization within the past year were significantly estimated with the same signs as in the Probit regression. Population size is significant and negative in the OLS regression, indicating that residents in smaller cities, towns or villages have more health checkups. In addition, the OLS estimates of the *hyperbolic* dummy, health-related variables, and their interaction terms have the same signs and significance results as the Probit estimates.

4.3. Results for cancer screening

The rightmost column of Table 2 shows the marginal effects of the Probit regression results related to cancer screenings. The first result was that, for housewives, the likelihood of getting a cancer screening was significantly higher than the likelihood of having

a normal (routine) health checkup. Secondly, we also found that in the case of cancer screening, the *hyperbolic discounter* dummy and its interactions with the health-related variables were not significant—a result that differs from what was found for normal checkups. This result implied that time preference didn't affect one's behavior with regard to getting a cancer screening. Thirdly, the magnitudes of the significant influences of gender, age, income, and household size are larger in the regression on cancer screening than in the regression on health checkups. Taken together, these differences support the proposition that getting a cancer screening involves a somewhat different set of influences than is the case for other types of health checkups.

5. Conclusion

In this study, Japanese survey data was used to empirically investigate the determinants of an individual's participation in health checkups. In contrast to many previous studies, we included in our regression models variables representing an individual's time preference and the interaction between time preference and health-related behavior. Consistent with results reported in previous studies, we find that certain personal attributes do indeed influence health checkup behaviors. Females, individuals earning higher incomes, and those having higher levels of education are more likely to get health checkups. Moreover, since the higher the age, the higher the risk of illness, older individuals have a greater probability of getting health checkups. Additionally, individuals having more family members and who are more connected to their community are more likely to have a health checkup, suggesting the importance of positive involvement with family and neighbors.

Importantly, the hyperbolic discounting, which is introduced into the regression models as another personal attribute, is significant and positive in its effect on an individual's participation in health checkups. Our result suggests that hyperbolic discounters are more likely to have health checkups than non-hyperbolic discounters, which is not in accordance with the results in [16]. There are several possible explanations for this. Since hyperbolic discounters show a tendency to engage in unhealthy behavior, they tend to be unhealthy and therefore may be more inclined to actively seek health checkups. Another possible explanation is that hyperbolic discounters may get health checkups to assess their health status, which serves as the basis for controlling their behavior. In addition, we used the discount rate for money in this study. It is suggested that discount rates for money and health are different [19–21]. Therefore, the hyperbolic discounters defined in our study based on the discount rate for money might behave differently from those defined by the discount rate for health. Consequently, to verify our results, collecting respondents' data of the discount rate for health is necessary in the future.

According to the results of taking cancer screening, policy decision makers would do well to take the differences between getting a cancer screening and getting other types of health checkups into account when designing policies intended to stimulate participation in cancer screening. In addition, with respect to the associations of hyperbolic discounting with checkup participation are varied between health checkup and cancer screening. a possible explanation could be made based on the corresponding marginal effects of female on the participations. From Table 2, we can see that the probability of females undertaking cancer screening is four times as large as that in health checkups. Indeed, our raw data reflects this result. Among the respondents who participated in the health checkups, 74.46% of females undertook the cancer screening, while 59.37% of males undertook it. Combining this with the fact that less females were hyperbolic discounters in the sample of getting cancer screening (i.e., 136 females versus 204 males), the differences appeared in the associations of hyperbolic discounting with participations in health checkup and cancer screening are probably due to the gender difference in hyperbolic discounters. Having that said, we leave this issue open and welcome any efforts to further explore this issue at much deeper extent.

Based on the results associated with our health-related variables and their interactions with the hyperbolic discounting dummy, we find that hyperbolic discounters and non-hyperbolic discounters differ significantly with regard to the influence of the various health-related variables on the probability of getting health checkups. This suggests the need to consider time preference when formulating policy to encourage health checkups. In addition, from a clinical standpoint, it is effective to carry out efforts that make it easier for medical examinations to be conducted for both hyperbolic discounters and non-hyperbolic discounters. Because most health-related variables are previously known in the clinics or hospitals, it might be possible for the medical institutions to make different plans that aim at positively affecting those who are difficult to undertake health checkups.

Knowing what factors influence participation in health checkups is critical to the creation of a system and an environment that makes it more likely that individuals will get health checkups. Establishing an efficient system that makes people aware of their own health condition through regular checkups is likely to lead to cost-effective measures such as health maintenance and disease prevention that will help alleviate many of the problems related to aging in Japan.

Finally, there are two limitations in the current study. Firstly, instead of using the discount rate for money in the current study, it might be more accurate to use that for health, because these two rates possibly affect people's participation in health checkups in different directions. Secondly, to control the health condition of the respondent, we included in the model the hospitalization history of the respondent during the past year. However, this variable is the history of hospitalization only in the past one year, the results may differ when it is viewed over longer periods. Moreover, it is ideal to know the respondents' history of diseases because this measure is more accurate for indicating the respondents' health conditions. Therefore, there is room for improvement in the future.

Competing interests

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.healthpol.2018.10.013.

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