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The measurement of willingness to pay for mass cancer screening with whole-body PET (positron emission tomography)

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Objective: Recently, we have seen an increase in the number of studies that measured the willingness to pay (WTP) for medical services using the contingent valuation method (CVM) and evaluated the benefits of these services. This study aimed to measure the general public's WTP for cancer screening with positron emission tomography (PET) and to determine consumer characteristics that may affect their WTP. ***Methods:*** A questionnaire survey of males and females living in Japan aged between 40 and 59 years was conducted via the Internet. A total of 274 individuals accepted the offer to participate and were enrolled in the study. The study participants were divided into two groups: Group A (n = 138) and Group B (n = 136). Group A was provided only with information about the PET procedure and the high cancer detection rate; Group B was provided with additional information regarding the possibility of 'false negative' and 'false positive' results and the fact that the efficacy of PET screening for reducing mortality has not yet been demonstrated. Participants were then asked to answer their WTP for cancer screening with PET by payment cards approach. ***Results:*** The overall average amount consumers were willing to pay for PET cancer screening was $103.7 (n = 274). The average value in Group A was $107.3, the average value in Group B was $100.0 and there was no statistically significant difference between the groups. The results of categorical regression analysis showed that household annual income was the only significant factor affecting WTP. ***Conclusions:*** Our study showed that household annual income affected the WTP for cancer screening with PET and therefore the demand for PET screening would be limited to the high-income group. Negative information about PET did not reduce the WTP. This finding suggests that test subjects mainly evaluated the high detection rate of PET screening and the 'reassurance' value of receiving negative screening results.

Key words: willingness to pay, contingent valuation method, cancer screening, positron emission tomography

INTRODUCTION

CANCER SCREENING using FDG-PET (^{18}F-fluorodeoxyglucose-positron emission tomography) began in some Japanese institutions at the expense of test subjects in 1994 and has since spread throughout the country. Some studies have reported a high cancer detection rate using PET screening.[1–3] Results of screenings conducted in 11 Japanese PET institutions have shown that the cancer detection rate using PET screening alone is 0.92%. This rate is much higher than the detection rate of conventional cancer screening programs (0.10%).[2] However, the effectiveness of cancer screening cannot be evaluated adequately by examining only the detection rate. To date, there is no evidence indicating that cancer screening with PET reduces mortality.

Moreover, PET screening has some limits, and it is accepted that the rate of false negative results is high. A report by Yasuda et al. found that 358 of 526 malignant tumor cases received positive results by PET screening. The remaining 168 cases received negative PET results, but were diagnosed with cancer by other procedures such as CT, MRI or ultrasonography.[2] Additionally, low specificity and low true-positive predictive values also pose

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problems when screening for cancer. It has been shown that FDG is accumulated physiologically and is accumulated in inflammatory lesions.[2,4] Therefore, it is necessary to combine PET with other procedures. Today, most PET facilities conduct general health screening using multiple modalities such as PET, CT, and MRI.

The outcomes of cancer screening include prolonged survival and reduced cancer mortality rates by early detection and treatment of disease. To quantify these outcomes accurately, a long-term follow-up research and comparison of the cancer mortality rate should be conducted in subject groups who have received the screening and have not received it.

The outcomes of cancer screening may also include other variables. In general, medical services may provide consumers with a non-health outcome as well as the health outcome. Many subjects of cancer screening are healthy individuals and receive negative results, and thus, their health condition does not change. Does this mean that the cancer screening does not bring any benefits to the subjects? The answer is 'No,' because they may receive 'reassurance,' i.e. non-health outcome such as 'peace of mind,' by confirming that there is no sign of cancer in their bodies.

We conducted an empirical study for quantifying the comprehensive benefits of PET screening by the contingent valuation method (CVM). CVM evaluates the consumers' willingness to pay (WTP) for services in a hypothetical market so as to assess the economic value of goods/services. In CVM, populations are presented with well-described situations about the service being valued, and asked their willingness to pay for it. This methodology, the theory of which is based on welfare economics, can quantify comprehensive benefits of services from the consumers' viewpoint. Although CVM was originally developed in the field of environmental economics, it has been also applied to the healthcare field in recent years. Many theoretical and empirical studies on CVM for healthcare services have already been conducted, and studies on the validity and reliability of the measurement of WTP are rapidly increasing in number.[5–10]

Only a few studies have been conducted to measure the WTP for PET screening. A study of 87 patients suspected of having lung cancer following CT examination was conducted by Papatheofanis to measure the WTP for PET as a close examination.[11] To the best of our knowledge, however, no study has been conducted to measure the WTP for cancer screening with PET in the general population. The aim of this study was to measure the WTP for PET cancer screening and to determine consumer characteristics that may affect WTP.

MATERIALS AND METHODS

Sample collection

This study is based on a computer-assisted questionnaire survey that utilized the Internet. The study population included both males and females living in Japan aged between 40 and 59. The survey was conducted in cooperation with a private Internet research company, in which approximately 218,000 Internet users are registered as monitor members. From approximately 59,000 members aged between 40 and 59, 740 individuals were selected using a stratified random sampling method based on age and sex. Emails offering participation in the questionnaire survey were sent to all the selected individuals on December 21, 2005 and participants were then able to access the questionnaire via the web site by clicking on the URL address in the email they had received. The questionnaire cover letter stated that 1) all data would be maintained anonymously, 2) the personal information of the participants would be protected completely, 3) all responses would be used only for academic purposes and 4) all individuals would be allowed to participate in the survey and withdraw from it voluntarily. The individuals who agreed to participate in the survey were able to respond to the questionnaire by entering the answers directly on the

Table 1 Information sheets and questions regarding WTP

Information sheet A

Positron Emission Tomography (PET) is a radiodiagnostic procedure, which is used for the diagnosis of diseases including cancer. Results of a study conducted in Japan showed that the cancer detection rate was 0.92% in PET cancer screening, while only 0.10% in conventional screening programs.

In performing PET, a test subject is administered with a chemical substance resembling glucose (^{18}F-FDG) via intravenous injection in the arm. After lying in bed for about an hour, whole-body imaging is performed using a positron camera. Imaging takes about 30 to 60 minutes.

Information sheet B

(The following information was added to the information contained in Sheet A)

Some types of cancer cannot be detected by PET screening as the intake of FDG varies according to disease characteristics. PET is suitable for diagnosis of diseases of the lung, breast, colon, pancreas, head and neck cancers, as well as malignant lymphoma. However, it is not suitable for diagnosis of diseases such as stomach, kidney, bladder, prostate, liver, biliary tract cancers, and leukemia. FDG can be accumulated in normal tissues, inflammatory lesions and cancer tissues; therefore, additional examinations are required to differentiate cancerous tissue from normal tissue.

It is not known exactly how much the cancer mortality rate may be reduced by PET screening.

Question regarding WTP

What is the maximum amount you would be willing to pay for PET cancer screening? Before giving an answer, please take into consideration the fact that paying for the screening will result in a reduction in the amount of money available for other goods or services.

Options: $0, $100, $300, $600, $900, $1,200, $1,500, $2,000

Table 2 Sample characteristics

Age	
40–49	135
50–59	139
Sex	
Male	137
Female	137
Household annual income ($)	
–39,999	53
40,000–59,999	53
60,000–79,999	65
80,000–99,999	58
100,000–	45
History of admission	
0	95
1	97
2	47
3 or more	35
Self-rated health status	
Very good or Good	69
Average	125
Below average or Bad	80

response form on the web site. A control system was programmed into the questionnaire, so that the participants were not allowed to proceed to the next question when they failed to answer a question or invalid answers were provided. Of the 740 people invited to participate in the survey, 274 (37%) responded.

Sample characteristics

The questionnaire included questions about age, sex, household annual income, number of hospitalizations and a self-rated health status, which was divided into five levels: very good, good, average, below average and bad.

'Information Sheet' about cancer screening with PET

Participants were provided with information about PET cancer screening and then asked to reply to the questions asking WTP for a course of the screening (Table 1). The "information sheet" (A or B) consisted of the objective facts based on the evidence on cancer screening with PET. In Sheet A, only the PET procedure and data concerning the high cancer detection rates were listed. In Sheet B, additional information was included such as the possibility of 'false negative' and 'false positive' results, and the fact that the efficacy of PET screening for reducing mortality has not yet been demonstrated. The participants (n = 274) were randomly assigned to either Group A (n = 138) or Group B (n = 136) and provided with Sheet A or Sheet B, respectively.

WTP questionnaire formats include open-ended questions, payment card, bidding game and dichotomous choice.[5] In this study, the payment card method was employed as participants could perform it relatively easily.[10] The payment vehicle was assumed to be out-of-pocket payment. Participants who replied that their WTP would be $0 were asked an additional question regarding their willingness to receive the screening for free.

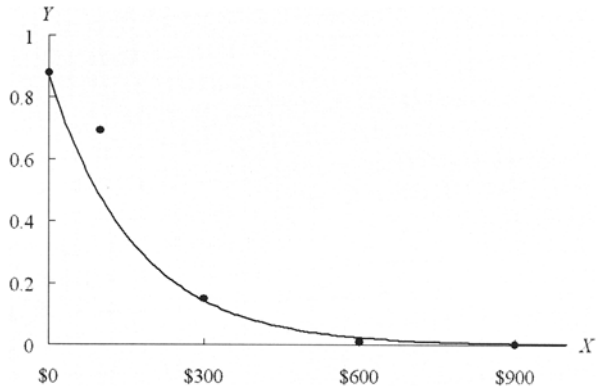

Fig. 1 Demand curve of cancer screening with PET. X: the prices presented, Y: the ratios of individuals who were willing to pay the presented prices
$Y = \alpha \cdot e^{\beta X}$, $\alpha = 0.870$, $\beta = -6.03 \times 10^{-3}$, $R^2 = 0.979$

Estimated demand curve of PET screening

The estimated demand curve of PET screening was created according to the distribution of WTP. The variable X denoted the prices presented on payment cards, while Y denoted the ratios of individuals who were willing to pay the presented prices. The values were plotted on an X-Y plane and approximated on the basis of the following function:

$Y = \alpha \cdot e^{\beta X}$ where α and β are constants. The coefficient of determination of approximate expression, R^2 was calculated.

Factors affecting WTP

Mean values of WTP were compared between Groups A and B using the Mann Whitney U test. Furthermore, the mean values of five groups divided by their annual incomes were compared using the Kruskal Wallis test. Assuming that WTP was a dependent variable, categorical regression analysis was performed to determine the factors that affected WTP. Independent variables included age, sex, household annual income, type of information sheet provided to the participants (A or B), number of hospitalizations and self-rated health status.

All statistical analyses were performed using statistics software SPSS ver.14.0 (SPSS Ltd., Chicago, USA). A p value less than 0.05 was considered to be significant. The exchange rate was assumed to be 110 yen for the US dollar.

RESULTS

Sample characteristics

The average age of participants was 48.8 ± 5.7 years, and the average household annual income was US $72,262 ±

Table 3 Comparison of the mean WTP

		Mean WTP ($)
Type of Information	Sheet A	107.3
	Sheet B	100.0
Household annual income*	–$39,999	77.4
	$40,000–$59,999	79.3
	$60,000–$79,999	101.5
	$80,000–$99,999	127.6
	$100,000–	135.6

*p < 0.05

Table 4 Categorical regression analysis

	Beta	F value	p value
Age	0.086	2.046	0.154
Sex	–0.034	0.316	0.575
Type of Information	–0.030	0.247	0.619
History of admission	0.082	1.764	0.185
Self-rated health status	0.093	2.272	0.105
Household annual income**	0.169	7.810	0.006

**p < 0.01

36,617 (mean ± SD). Participant characteristics are outlined in Table 2.

WTP for cancer screening with PET

The average WTP value was $103.7 in all participants (n = 274), where 84, 149, 38, 2, and 1 person(s) chose the options of $0, $100, $300, $600 and $900, respectively. However, no one chose the $1,200, $1,500, or $2,000 options. Of the 84 individuals who chose a WTP of $0, 34 replied that they would receive screening if the program were offered free of charge, while 51 replied that they would not receive it even if it were free. The estimated demand curve of PET screening according to the distribution of WTP is shown in Figure 1.

Factors affecting WTP

The mean WTP of Group A was $107.3 while the WTP of Group B was $100.0. No statistically significant difference was observed between the groups. Further to this, when we compared the mean values of five groups divided by household annual income, our results showed that the WTP values increased significantly in the groups with higher income (p = 0.034) (Table 3).

The results of categorical regression analysis showed that the only significant factor affecting WTP was household annual income (p = 0.006). Therefore, age, sex, type of information, history of admission and self-rated health status were not significant factors in participants WTP for PET screening (Table 4).

DISCUSSION

Elicitation methods for CVM

There are various elicitation methods for CVM such as open-ended questions, bidding games, payment cards, and dichotomous choices.[5,10] Under the open-ended questions, the participants are invited to perform their own WTP valuation, unbounded and unprompted. It imposes a large burden on the respondents and is likely to produce substantial non-responses. In bidding games, participants are asked whether they are willing to pay the given bid, which is raised or lowered depending on their answers like an auction process. This method underlies the risk of "starting point bias": the first bid influences the maximum WTP. The payment cards method offers respondents to select their own WTP from the listed prices. It underlies the risk of "range bias": the range of the presented prices affects the WTP responses. In the dichotomous choice approach, participants are randomly split into multiple sub-samples, each sub-sample receiving a different price. Participants were asked whether they are willing to pay the nominated bid. As the nominated money amount is increased, the proportion of respondents willing to pay the bid is expected to decrease. This approach can avoid all of the above biases, but it requires much more samples than other methods.

This study utilized the payment card method for questioning participants, as it requires a relatively small sample. In this study, WTP responses were a little maldistributed in the lower amounts. This finding suggests that the range of the presented amounts was somewhat broad.

Construct validity

There is one simple proposition ('construct') from economic theory: most goods have a positive income elasticity that means, other things being equal, higher income is associated with higher WTP. The logic of construct validation is to determine whether the empirical data are consistent with theoretical construct.[13] In this study, income was proved to be a statistically significant factor affecting WTP, which was consistent with both the theoretical construct and the results of previous studies.[10]

Relationship between negative information and WTP

To improve the screening participation rate and the effectiveness of cancer screening, it is necessary to adequately inform test subjects. It is necessary to provide information on the screening procedure and the performance of the screening. Furthermore, problems associated with the screening program should also be presented.

Participants in Group A received insufficient information only on the PET screening procedure and the high detection rate of cancer. On the other hand, participants in Group B received negative information such as the possibility of a 'false negative' or 'false positive' result and the unproven efficacy of screening for reducing mortality. Our results revealed that negative information did not reduce the WTP of the participants. Therefore, PET

screening may provide test subjects with 'reassurance value' derived from the positive information about the high detection rate. Negative information, such as false positive/negative results and failure to demonstrate a mortality-reducing effect, did not seem to be important enough to counteract the effect of the positive information.

Value of measuring WTP

The measurement of WTP for cancer screening with PET is considered useful for the following reasons:

1) By measuring WTP, the benefits of medical services that include health and non-health outcomes can be evaluated comprehensively. The non-health outcomes include 'reassurance value.'[14,15]

2) WTP can be applied to cost-benefit analyses (CBA) as the benefit. For the full economic evaluation of health care programs, both the costs and outcomes should be quantified. Cost effectiveness analyses (CEA) may provide information only on the productive efficiency of health outcomes, while CBA may provide decision-makers with information on the allocative efficiency as well by indicating the costs and outcomes in monetary values.[12] However, data have not yet been published that show how the costs for cancer screening with PET are exactly accounted for in Japan. Thus, in future studies it is important to accurately calculate the costs to perform CBA on PET screening.

3) The demand curves of medical services can be estimated by measuring WTP, which is useful from the viewpoint of health care marketing. In Japan, the actual expense of cancer screening with PET is supposed to be approx. $800 on average ($600 to $1,200) (unpublished data). When the X value of 800 was substituted in the approximate expression shown in Figure 1, the Y value is estimated to be 0.007. This value shows that less than 1% of the study participants would be willing to receive PET screening at a charge of $800. This study demonstrated that household annual income affected the WTP for cancer screening with PET and therefore the demand for PET screening would be limited to the high-income group.

Mass cancer screening with PET is provided at the expense of test subjects. In the present study, eighty-four respondents chose the option of $0 for PET screening; thus, approximately 30% of the respondents attached no value on this procedure. There might be possible reasons why some Japanese people place such a low value to this health screening. In Japan, most medical services are publicly provided and financial support is given to the medical service field using public insurance and taxes to reduce patient co-payment. Furthermore, the official prices of medical services are relatively low compared to those of other advanced nations, and Japanese patients can freely access any medical services at a low price. These situations might cause the respondents' strategic behavior of answering a low amount of WTP.

Limitations of this study

WTP may be affected by several other factors that were not examined in this study, such as subjects' knowledge about PET, the degree of concern about health, and family history of cancer. WTP of subjects who had good knowledge of PET could not have been affected by the additional information in sheet B. Subjects' concern about health might be relevant to their marital status, family make-up, and occupational status. Information on the health risk of radiation exposure from PET was not provided. It is necessary to consider these factors in future studies, as they might affect WTP.

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