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The Information Effect of Medical Examination on Individual Health Promotion Behaviors: Evidence from Korea

Jae Young Lim
(Associate Professor, Department of Food and Resource Economics, Korea University)

개인의 건강증진행위에 대한 건강검진의 정보효과: 한국의 경우를 중심으로

임 재 영
(고려대학교 식품자원경제학과 부교수)

* 임재영: (e-mail) jylimecon@korea.ac.kr, (address) Korea University, Anam-dong, Seongbuk-gu, Seoul 136-701, Korea

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ABSTRACT

This paper demonstrates empirically that individuals who monitor indicators of their current cardiovascular health status by undergoing medical examinations are more likely to invest in their own health than those who do not observe such monitoring protocols.

Using data from the 2001 National Health and Nutrition Examination Survey of Korea in a structural econometric model, this paper attempts to control the endogeneity problem inherent to the individual decision as to whether to undergo medical examinations, and provides estimation results showing that increased individual health awareness via medical examinations exerts a statistically significant positive effect on health investments.

From the policy perspective, the estimation results of this paper may provide a rationale supporting the health policy of free provision of health examination services to the insured via National Health Insurance.

본 연구에서는 개인이 건강검진을 통해 혈압수치 등과 같은 자신의 현재 심혈관 계통의 건강 상태에 대하여 잘 알고 있을수록, 건강검진을 받지 않은 사람에 비해 자신의 건강을 위하여 운동과 같은 건강증진행위에 더 많은 투자를 하려 한다는 것을 실증적으로 분석하고자 한다.

이를 위하여 본 논문에서는 2001년 국민건강영양조사 자료를 이용하여 bivariate probit 모델의 구조적 계량경제모형을 구축하고, 개인이 가입한 전 국민 의료보험의 유형, 즉 직장 혹은 지역 의료보험 가입 여부를 도구변수로 하여 건강검진 수검 여부에 대한 개인별 의사결정과 관련된 내생성 문제를 통제하였다. 추정 결과, 개인이 건강검진을 통해서 자신의 건강 상태에 대해 더 많은 정보를 보유할수록 건강증진을 위한 투자를 더욱 더 많이 한다는 것이 통계적으로 유의하게 나타났다.

보건정책적 관점에서 본 논문의 실증 결과는 현재 무상으로 이루어지고 있는 국가건강검진서비스 제공 정책의 정책적 효과를 입증하기 위해 사용될 수 있다고 판단되어 동 사업 수행의 정당성 확보에 활용될 수 있을 것으로 사료된다.

Ⅰ. Introduction

Cardiovascular disease has become the leading cause of death in several countries, and is currently responsible for more than 40% of fatalities in the United States. Developing countries, including India and China, are currently experiencing an "epidemic" of heart disease and stroke, a trend which is expected to impede economic expansion. This "epidemiological transition" – the shift away from infectious and nutritional deficiency diseases to chronic diseases – arises both from an aging population and from a shift in behavioral patterns attendant to urbanization. Sedentary lifestyles, the consumption of a high fat diet, and smoking, for example, all increase the probability that a person will develop a cardiovascular illness.

It is, however, possible to prevent cardiovascular (CV) disease. The probability of acute complications is substantially lower in individuals who engage in health maintenance activities, such as exercise[1]. However, medical care can do very little to prevent the onset of these conditions, and the capacity for policy to promote CV health is thus quite limited, which suggests that deterrence remains in the hands of the individual (Connolly and Kesson, 1996).

Unfortunately, however, many high-risk people still do not take adequate precautions in this regard, despite the great deal of public information disseminated to educate individuals about the need for health maintenance[2]. In fact, the population appears to essentially be divided into two main groups – those in good health who maintain their health, and those in poor health who take few, if any, precautions. It appears, then, that causality flows in one direction--from behavior to health outcome--and that health behavior is influenced profoundly by individual preference. Although individuals at higher risk of illness have a strong incentive to maintain their health, they appear to take fewer precautions overall. This pattern indicates that optimizing behavior, in which those who benefit more from an activity are more likely to participate in that activity, is either weak or does not occur. Economic reasoning appears to be inconsistent with observed behavior.

Imperfection in the optimization process may help to explain this inconsistency, and correcting these imperfections may require a launching of precautionary efforts across individuals in an optimal manner, which may in the aggregate affect health maintenance. Specifically, individuals at high risk for CV illnesses may make few preventive efforts, as they do not possess complete information regarding their current CV health status. Many of the risk factors associated with behavior-related diseases, particularly CV illness, are unobservable; thus, an individual may, at best,

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1 According to a previous report (Chae, 1997), exercising one to two times per week reduced the risk of heart attack by 36 percent. The risk fell by 38% for those who exercised three to four times per week.

2 The American Heart Association (1998) has reported that 33% of overweight men and 41% of overweight women are not physically active during their leisure time.

approximate her[3] return to prevention without medical advice simply by undergoing a medical exam. As a consequence, she may make health investment decisions that would be obviously suboptimal if her health were known.

Thus, this study explores the impact of medical exams when they are utilized as brokers of information regarding patients' health status. As such, the medical exams should affect a patient's demand for preventive inputs by revealing individual-specific information to her and thus altering her information set in terms of her own health status. Patients value this information, and it improves their ability to select other inputs optimally.

This approach differs from those of preceding studies (Kenkel, 1990; Viscusi, 1991; Chen et al., 1995; Hsieh et al., 1997) concerning the behavioral impact of changes in health risk perception that focus on the receipt of *general* risk information, including product hazard warnings. In the case of behavior-related illnesses, such as CV illness, *general* health risks associated with certain behaviors can be regarded as those which are not individually tailored to the patient's idiosyncratic characteristics, and thus a repeat of these warnings will probably do little to affect a patient's information set. Thus, it appears unlikely that a given patient will alter her behavior upon the receipt of *general* health information. However, each person receives different information from undergoing a medical exam, and thus an individual's health status knowledge should be expected to exert individual effects on patients' preventive efforts.

This study contributes to the relevant literature regarding preventive health care, in that it redefines the role of medical exams in the promotion of long-term health. The demand for preventive care arises, in theory, when health inputs reduce either the probability or the consequences of future illness (Ehrlich and Becker, 1972). In specific regard to CV disease, however, an individual's risk of illness is affected less by medical care and more by what the patient does for herself (Newhouse and Friedlander, 1980). Thus, in the case of behavior-related illnesses, the link between preventive health care and health promotion depends critically on the information effect of patient's health status knowledge on her health maintenance behaviors. Based on the above-described context, this study sought to empirically evaluate this hypothesis by estimating the effect of medical exams on exercise efforts.

However, one more thing that should be taken into consideration is that, as individuals receive information on the basis of their choice to undergo medical exams, it is possible that those who receive information via medical examinations differ from individuals in the uninformed group in some way that is not observed by the researcher. If this is in fact the case, the variable of whether to undergo a medical exam may be picking up the effect of some omitted variable with which it is correlated. Furthermore, the endogeneity of this variable might introduce bias into the estimation results. Thus, it is very important to control the individual decision regarding undergoing medical exams in exploring the information effects of medical examinations on individual health investment.

Therefore, this paper might be relevant in that this study attempts to control for

[3] In this paper, a consumer of medical service, including a medical exam, is denoted as a female for the sake of convenience.

the possible endogeneity of individuals' choice to undergo medical exams in a robust econometric way, and also in that this paper assesses the information effect of undergoing medical exams on a patient's demand for non-medical health inputs, such as exercise, with the control of unobserved individual characteristics that might affect her decision to undergo a medical exam.

This paper is organized as follows. Section II describes the empirical model. Section III discusses the important characteristics of the data and presents the relevant descriptive statistics. The empirical results are analyzed in section IV. Section V provides the conclusions of this research.

Ⅱ. Empirical Model

The following estimable model represents the demand for exercise;

$$x_i^* = \beta_0' Z_i + \beta_1' H_i + \beta_2 I_i + \rho_1 \nu_i + \varepsilon_i \tag{1}$$

$$\begin{cases} x_i = 1 & if\ x_i^* > 0 \\ x_i = 0 & otherwise\ (x_i^* \le 0) \end{cases}$$

where x_i^* represents the level of exercise selected by individual i and x_i is the indicator which represents the existence of regular or strenuous exercise. In this paper, the level of exercise is measured via two considerations: i) does the individual make the decision to engage in any exercise on a regular basis, and ii) does the individual engage in strenuous exercise on a regular basis? If an individual engages in activity at least one time per week and for more than 20 minutes each time, her value of x_i equals one, and on the same basis, if an individual engages in strenuous exercise at least one time per week and for more than 30 minutes each time, her x_i value equals one. Hence, the variable x_i is dichotomous. These two different measurements may capture not only an individual's behavior in engaging in any exercise, but also the degree of difficulty or intensity with which the individual exercises on a regular basis. The Z_i is a vector of exogenous socio-demographic variables that influence an individual's health investment, such as exercise decisions, H_i is a vector of variables influencing pre-exam health status, such as the number of chronic diseases during given periods, I_i indicates that individual i has undergone a medical exam to obtain information regarding her health status prior to making her exercise decisions, ν_i represents permanent unobservable individual characteristics, and ε_i represents white noise and is assumed to be a normally distributed error term.

Considering that certain factors may complicate the process by which consistent estimates of parameters are acquired, it appears highly likely that the unobservable characteristics included in ν_i may be correlated with some of the observed explanatory variables in the model. For example, a person's preference with regard to exercise is closely associated with her past health investment decisions, and thus with the probability of undergoing a medical exam. In order to control for the effect of unobserved heterogeneity and obtain robust estimates of the parameters of the model, this study utilized maximum likelihood techniques to estimate the relevant equation system. This study estimated an equation explaining a person's decision to undergo medical exams jointly with an equation representing a person's decision to engage in any exercise on a regular basis, and to engage in strenuous exercise if she does exercise.

A latent variable was specified for the observed discrete outcomes of the individual's medical exams. An individual's decision to undergo a medical exam ($I_i = 1$ if she undergoes medical exam, $I_i = 0$ if she does not) is expressed as follows:

$$I_i^* = \delta_0' Z_i + \delta_1' H_i + \delta_2 K_i + \rho_2 \nu_i + \eta_i \tag{2}$$

$$\begin{cases} I_i = 1 & if\ I_i^* > 0 \\ I_i = 0 & otherwise\,(I_i^* \le 0) \end{cases}$$

where K_i represents an individual's health insurance type ($K_i = 1$ if she has an employee insurance program, $K_i = 0$ if she has a self-employed insurance program). The Korean national health insurance program includes two types of insurance programs--an employee insurance program and a self-employed insurance program. Even if the two different programs have almost identical coverage ranges and coinsurance rates, they differ to some degree in terms of the method by which insurance premiums are charged, and the specific requirements regarding compulsory medical exams for the insured. ν_i represents permanent unobservable individual characteristics, and η_i represents white noise and is also assumed to be a normally distributed error term.

In the estimation process above, the estimation of equation (2) requires a variable that affects the decision to undergo a medical exam, but does not directly influence a person's choice to engage in regular exercise or in strenuous exercise. In other words, identification relies on exclusion restrictions. Hence, in this paper, the variable K_i is employed to identify equations (1) and (2). In Korea, in order to preserve worker's productivity, the employers strongly require employees to undergo medical exams, and the costs of this are partially subsidized by the Korean central government. Hence, whether a person is enrolled in an employee insurance program may have some impact with regard to an individual's decisions to undergo medical exams. This variable is, however, probably related only indirectly to the exercise decision. As a matter of fact, in the estimation process, whether a person is enrolled in an employee insurance program is only weakly correlated with the exercise decision. Thus, a variable indicating whether a person has an employee insurance program is included in the medical exam equation, but is not included in the other equations. However, in order to confirm the validity of this variable as an instrumental variable (IV), the Weak IV test and Overidentifying restriction test

(Wooldridge, 2002: Stock and Watson, 2003) would be conducted, and the results would be introduced.

Furthermore, as mentioned above, in order to avoid obtaining biased estimates of the parameters of interest, it is necessary to account for unobserved heterogeneity in the estimation process. Hence, in regard to this matter, in the process of estimating equations (1) and (2), I attempted to ameliorate endogeneity bias using the bivariate probit model. The bivariate probit model fits maximum-likelihood two equation probit models, and thus it is utilized in the joint estimation of equations (1) and (2). The bivariate probit model is predicated on the assumption that the error terms in equation (1) and (2) evidence a joint, bivariate normal distribution.

This method is an attractive feature of this model, considering the particular situation this paper seeks to analyze: it is fairly simple to imagine that an individual inclination to undergo medical exams is related in some way with the attitude of the person in terms of performing health maintenance protocols, such as exercise, and vice-versa. Additionally, considering that such features may constitute a source of endogeneity bias, they may benefit from joint estimation, which establishes the bivariate model in order to ameliorate endogeneity bias (Greene, 1997). Specifically, if the coefficient of correlation (ρ) between the error terms in these two equations does not equal zero, owing to the inherent statistical and structural endogeneity, we are ready to confirm the existence of the endogeneity of an individual's decision to undergo a medical examination. Therefore, after estimating the above two equations using the bivariate probit model, the test result of the hypothesis of $\rho = 0$ might be considered evidence of endogeneity, and furthermore if the endogeneity is shown to be extant, the joint estimation of equation (1) and (2) using the bivariate probit model might make produce more robust estimation results.

Ⅲ. Data and Descriptive Statistics

The data utilized here were obtained from the 2001 National Health and Nutrition Examination Survey (NHANES) of Korea. The 2001 NHANES interviewed 13,200 households in the country, which represented the entire nation. The dataset contains detailed information regarding health and health behaviors, and includes sufficient economic and socio-demographic information to permit the empirical estimation of the model mentioned above. The NHANES was conducted in 1998, 2001, 2005, and 2007-8. Even if we have more recent data, such as 2005 and 2007-8, the reason that the 2001 data is utilized is that the method used to define regular and strenuous exercise was considerably different when the 2005 data was collected. Specifically, in the 2001 data, individuals who engaged in activity at least one time per week for more than 20 minutes per time *in the past one month* were considered to have engaged in regular exercise. Furthermore, with regard to strenuous exercise, the 2001 NHANES asked respondents how frequently each respondent engaged in strenuous exercise, such as running, *over the past one month*. Individuals who engage in strenuous activity at least one time per week and for more than 30 minutes each time were considered to have engaged in regular strenuous exercise. In the 2005 and 2007-8 data, however, no survey questions asked respondents about whether or not they engaged in regular exercise, which is shown in the 2001 data. Additionally, with regard to strenuous exercise, the 2005 and 2007-8 data asked how many days the respondent engaged in a high or medium degree of strenuous activity for more than 10 minutes *in the most recent week*. Additionally, the 2005 and 2007-8 data asked how many days the respondent walked for more than 10 minutes *in the most recent week*. Considering that the goal of this paper was to estimate the information effect of medical examination on individual health investments such as regular or strenuous exercise, if the 2005 and 2007-8 data were employed in this paper, it is highly plausible that the researcher would arbitrarily define the concepts of regular or strenuous exercise, since these activities have yet to be clearly defined[4].

In this paper, the age range is restricted to an age range of 18-65, because the population below 18 and above 65 are generally dependent family members, whose decision-making processes may be affected by other family members.

As mentioned above, this study evaluates the effect of information regarding individual health status on two measures of exercise − the probability of an individual engaging in any exercise and the probability of an individual engaging in strenuous exercise on a regular basis. The 2001 NHANES attempted to determine whether each respondent engaged in regular physical activity over the past one month. Individuals who engage in activity at least one time per week and for more than 20 minutes each time were considered to have engaged in regular exercise. Furthermore, the NHANES asked how often each respondent engaged in strenuous exercise, such as running, over the past one month. Individuals who engaged in strenuous activity at least one time per week and for more than 30 minutes each time were considered to have engaged in regular strenuous exercise.

In addition to these key variables, the NHANES included detailed information regarding the individual's health status. This study utilizes a measure of self-reported health status, as well as the number of chronic diseases a patient experienced over the past one-year period. The measure of the number of chronic diseases an individual has experienced captures the individual risk of illness.

Furthermore, this study attempted to control for other individual health-related behaviors such as smoking and drinking, and the respondent's beliefs regarding the utility of undergoing a medical exam. It is reasonable to surmise that these factors may operate as confounding factors in an individual's decision regarding exercise. In the NHANES, each respondent is asked about the degree of caring for her health status and to which the respondent agreed that medical exams provide great utility to the recipient.

Table 1 presents descriptive statistics for the subsample who underwent a

[4] According to the reviewer's comments, I estimated the information effect of medical examination on the individual probability of engaging in strenuous exercise using the 2007-8 data and applying identical estimation methods. I defined strenuous exercise by regarding the individuals who engaged in exercise at least one day in the most recent week for more than 10 minutes each time. Even if a different dataset is used, the estimation results are fairly similar to the ones in this paper. The estimation results are available upon request.

Table 1. Descriptive Statistics for Sub-sample

Variable[5]	Underwent Medical Exam		Did not undergo Medical Exam	
	Mean	St. Dev.	Mean	St. Dev.
Choice Variable				
Any Exercise	0.373	0.473	0.254	0.421
Any Strenuous Exercise	0.339	0.484	0.230	0.435
Socio-Demographic Variables				
Age	41.084	11.529	37.913	12.203
Sex (0: female, 1: male)	0.527	0.499	0.407	0.491
Marital Status	0.785	0.410	0.691	0.462
Education	5.053	1.123	4.899	1.118
Number of Family member	3.580	1.234	3.624	1.257
Whether to enroll employee health insurance	0.651	0.476	0.402	0.490
Health Status Variables				
Subjective Health Status (5: excellent, 4: very good, 3: good, 2: fair, 1: poor)	3.454	0.808	3.514	0.785
Number of Chronic Diseases	1.075	1.367	0.856	1.255
Economic Variables				
Living cost per month (Korean 10,000 Won of 2001 price level)	143.344	81.766	127.224	73.352
Monthly Income (Korean 10,000 Won of 2001 price level)	219.134	127.580	186.147	112.444
Subjective living level (5: very affordable, 4: affordable, 3: just fit to income, 2: poor, 1: very poor)	2.811	0.600	2.683	0.640
Control Variables				
Degree of caring her health (4: never care about, 3: little care about, 2: sometimes care about, 1: always care about)	2.075	0.715	2.198	0.740
Degree of agreeing to undergo medical exam provides great utility (5: strongly disagree, 4: sometimes disagree, 3: neither disagree nor agree, 2: sometimes agree, 1: strongly agree)	2.209	0.778	2.018	0.667

5 The parenthesis represents the name of variable used in the estimation process.

medical exam as compared to those who did not. The subsample of respondents who underwent a medical exam evidenced a high probability of engaging in any exercise and of engaging in strenuous exercise compared to the other group who did not undergo a medical exam. This pattern may reflect the difference between the two groups with regard to overall health status. For example, the subjective health status of those who underwent medical exams was poorer than the other group, and this group was more likely to have experienced chronic disease in the past year. This difference suggests that poorer health status may cause a patient to undergo a medical exam to precisely diagnose her disease before utilizing curative medical services, rather than regularly checking her health status as a preventive strategy. The two groups also evidence different socio-demographic characteristics. Those respondents who underwent medical exams were older, more highly educated, and more likely to be enrolled in an employee insurance program, which is consistent with the characteristics of this type of insurance in Korea, as previously mentioned, and also have higher incomes. This subsample also contains a lower proportion of females.

Regarding the difference between the two groups with regard to overall health status, one more important thing should be considered in terms of the plausibility of reverse causality, which suggests that individual decisions about exercise might affect whether the respondent undergoes a medical exam. On one hand, considering that decisions about exercise might represent individual preferences to maintain good health status, individuals who engaged in regular exercise would more frequently undergo medical exams than others. On the other hand, ill health status originating from insufficient exercise might cause losses of income or losses of employment, which should limit access to health services, such as medical exams. Hence, if we fail to control for reverse causality, the estimation results might not be consistent.

Therefore, in this regard, the key factor in controlling reverse causality is to consider the dynamic aspects of health status through health investment. Unfortunately, the dataset employed in this study represented merely one wave of cross-sectional format. Even if a data limitation exists, the reverse causality problem was controlled in this paper as follows:

Firstly, if the receipt of information from a medical examination precedes the exercise decision, we can avoid the plausibility of reverse causality. Fortunately, the NHANES is appropriate to this timing. Each person was initially asked whether she underwent a medical examination *within the past two years*, and was then asked about her exercise choices *over the past one month*. Furthermore, the NHANES also include information as to when a respondent underwent a medical exam within the past two years. Therefore, by excluding the observation as to who underwent a medical exam within the past one month, I attempted to make the dataset appropriate to the control of the reverse causality problem. Thus, the sample satisfying this timing scheme contains 6,509 observations.

Secondly, I divided the total sample into five subgroups according to the respondents' subjectively evaluated health status in order to conduct the sensitivity check. As mentioned above, the individual health status might confound the information effect of the medical exam on exercise level. Hence, in this paper, the same estimation model was applied to each subgroup and the estimation results in each subgroup were utilized to confirm the robustness of estimation results derived from the total sample.

IV. Estimation Results

This section presents the estimation results. Depending on whether or not to treat the endogeneity bias inherent to undergoing medical exam is treated, two different methods are applied in the estimation process. In Model 1, the probabilities of engaging in any regular exercise and in strenuous exercise are estimated independently from the probability of undergoing a medical exam by applying a simple probit model, which suggests that the endogeneity of undergoing a medical exam was not controlled. Model 2, however, attempts to reduce endogeneity bias by applying bivariate probit methods. As mentioned earlier, in the process of applying the bivariate probit method, the two equations were jointly estimated, and the hypothesis of coefficient of correlation (ρ) between the error terms in these two equations being equal to zero was tested in order to recognize the endogeneity bias.

1. The Case of Regular Exercise

In the case of regular exercise, the estimation results are shown in Table 2. First of all, with regard to the test for the existence of endogeneity bias, it was shown to be extant. According to the estimation results of Model 2, the Wald test of $\rho = 0$ was rejected with a 5% level of statistical significance, which suggests that the endogeneity problem of individual choice on medical exam does indeed exist; hence, it is natural to surmise that the estimation results of Model 2 are more robust than those of Model 1.

In the estimation results of Model 2, it appears that undergoing a medical exam exerts a statistically significant positive effect on the probability of an individual engaging in any regular exercise, which suggests that the information effect of medical exam on the individual decision to exercise does indeed exist. Specifically, based on the estimation results above, we can readily calculate the marginal effect of the variable of whether to undergo a medical exam, which is shown at the third column of Model 2. According to the calculation, individuals who underwent medical exam show higher probability of doing regular exercise by 11.23% than others who didn't. In terms of elasticity, the result above can be reinterpreted that the 1% increase in the rate of undergoing medical exam is shown to raise the probability of doing regular exercise by 0.29%.

Several variables representing social-economic aspects have been shown to exert significant impacts on the probability of engaging in regular exercise. This probability appears to increase with a person's age, education, and income level.

Table 2. Estimation Result(I): The Case of Regular Exercise

Variable	Model 1 (Simple Probit) No endogeneity controlled		Model 2 (Bivariate Probit) endogeneity controlled		
	Coefficient	s.e.	Coefficient	s.e.	Marginal Effect
CONSTANT	-1.5471***	0.3231	-1.3971***	0.3458	
Socioeconomic Variables					
Age	0.0135***	0.0024	0.0135***	0.0020	0.0021
Sex	0.0817**	0.0362	0.0832***	0.0361	0.0157
Marital Status	-0.0299	0.0463	-0.0300	0.0457	-0.0349
Education	0.1472***	0.0213	0.1474***	0.0213	0.0264
Number of Family Members	-0.0473***	0.0156	-0.0472***	0.0155	-0.0061
Health state Variables					
Subjective Health Status	0.0815***	0.0259	0.0815***	0.0259	0.0346
Number of Chronic Diseases	-0.0102	0.0158	-0.0102	0.0158	-0.0011
Economic Variables					
Living cost per month	0.0010***	0.0003	0.0010***	0.0003	0.0008
Monthly Income	0.0003*	0.0002	0.0003*	0.0002	0.0001
Subjective living level	0.0825***	0.0322	0.0819***	0.0319	0.0561
Control Variables					
Degree of caring her health	-0.0377	0.0255	-0.0376	0.0254	-0.0076
Degree of agreeing to undergo medical exam provides great utility	-0.1101***	0.0318	-0.1283***	0.0347	-0.1255
Whether to undergo medical exam					
Health Exam	0.4280**	0.1874	0.5378***	0.2060	0.1123
ρ			0.1838**	0.1035	
N	6,509		6,509		

Note: *=statistically significant at the 0.1 level; **=statistically significant at the 0.05 level; ***=statistically significant at the 0.01 level

Furthermore, according to the calculation of marginal effects of those variables, the increases in the marginal probabilities are 0.0021, 0.0264, and 0.0001, respectively. Additionally, the degree to which one agrees that medical exams provide great utility is demonstrated to exert a significant effect on the probability of engaging in regular exercise.

2. The Case of Strenuous Exercise

In the case of engaging in strenuous exercise, as presented in Table 3, the endogeneity bias was still shown to be extant. According to the estimation results of Model 2, the Wald test result of $\rho = 0$ showed that it was rejected with a statistical significance level of 5%, thus suggesting that the estimation results of Model 2 were still more robust than those of Model 1.

Concerning the information effect of medical exams on engaging in strenuous exercise, the similar but more strengthened results with controls for endogeneity bias were derived. With no controls for endogeneity bias, it appears that undergoing medical exams exerts a positive effect on the probability of engaging in strenuous exercise, but the statistical significance is not guaranteed. However, controlling for endogeneity bias yields a significant change in the estimation result. With Model 2 using the bivariate probit method, the estimate remains positive but the statistical significance is now guaranteed, which suggests that undergoing a medical exam also exerts a statistically significant effect on an individual's decision to engage in strenuous exercise. Hence, the empirical results presented in this section support the prediction of the information effect of a medical exam. Based on the estimation results above, we calculate the marginal effect of the variable of whether to undergo a medical exam which is shown at the third column of Model 2. According to the calculation, individuals who underwent medical exam show higher probability of doing regular exercise by 11.55% than others who didn't. In terms of elasticity, the result above can be reinterpreted that the 1% increase in the rate of undergoing medical exam is shown to raise the probability of doing regular exercise by 0.31%.

Several variables representing social-economic aspects have been shown to exert significant impacts on the probability of engaging in strenuous exercise in a fashion similar to that in the case of regular exercise.

3. The Validity of the Instrumental Variable

As mentioned above, the estimation of Model 2 using the bivariate probit method requires a variable that influences the decision to undergo a medical exam, but does not directly affect a person's choice to engage in regular exercise or strenuous exercise in order to identify the equation system. In this paper, for that matter, whether or not a person is enrolled in an employee health insurance program is employed as an instrumental variable.

The validity of the instrumental variable might be tested by i) instrument relevance and ii) instrument exogeneity (Stock and Watson, 2003). Hence, to assess

Table 3. Estimation Result (II): The Case of Strenuous Exercise

Variable	Model 1 (Simple Probit) No endogeneity controlled		Model 2 (Bivariate Probit) endogeneity controlled		
	Coefficient	s.e.	Coefficient	s.e.	Marginal Effect
CONSTANT	-1.4957***	0.3219	-1.5469***	0.3390	
Socioeconomic Variables					
Age	0.0048**	0.0020	0.0048**	0.0020	0.0007
Sex	0.2244***	0.0356	0.2239***	0.0356	0.0673
Marital Status	-0.0643	0.0456	-0.0642	0.0452	-0.0486
Education	0.1768***	0.0215	0.1767***	0.0213	0.0381
Number of Family Members	-0.0266*	0.0514	-0.0267*	0.0152	-0.0010
Health state Variables					
Subjective Health Status	0.0867***	0.0258	0.0868***	0.0253	0.0377
Number of Chronic Diseases	-0.0262	0.0160	-0.0261*	0.0158	-0.0067
Economic Variables					
Living cost per month	0.0010***	0.0003	0.0009***	0.0003	0.0008
Monthly Income	0.0002	0.0002	0.0001	0.0002	0.0001
Subjective living level	0.0688**	0.0318	0.0690**	0.0317	0.0532
Control Variables					
Degree of caring her health	-0.0830***	0.0254	-0.0830***	0.0252	-0.0237
Degree of agreeing to undergo medical exam provides great utility	-0.0775**	0.0315	-0.0712**	0.0342	-0.1270
Whether to undergo medical exam					
Health Exam	0.1981	0.1854	0.3108***	0.0956	0.1155
ρ			0.0739**	0.0404	
N	6,509		6,509		

Note: *=statistically significant at the 0.1 level; **=statistically significant at the 0.05 level; ***=statistically significant at the 0.01 level

Table 4. Probit Estimation Result of Undergoing Medical Examination

Variable	Coefficient	s.e
CONSTANT	6.4512***	1.1230
Socioeconomic Variables		
Age	0.0212**	0.0106
Sex	0.1052	0.1954
Marital Status	0.2282	0.2559
Education	0.1801	0.1141
Number of Family Member	-0.0839	0.0878
Employee Health Insurance	0.5129***	0.1240
Health state Variables		
Subjective Health Status	-0.0680	0.1417
Number of Chronic Diseases	-0.0210	0.0801
Economic Variables		
Living cost per month	0.0040**	0.0020
Monthly Income	0.0019*	0.0010
Subjective living level	0.2696*	0.1544
Control Variables		
Degree of caring her health	-0.0494	0.1403
Degree of agreeing to undergo medical exam provides great utility	-1.2208***	0.0702
Likelihood Ratio Test statistic	42.17***	
Overidentifying restrictions test statistic	0.002	
N	6,509	

Note: *=statistically significant at the 0.1 level; **=statistically significant at the 0.05 level; ***=statistically significant at the 0.01 level

the relevance of the instrumental variable, two different criteria were employed. The first was whether the instrument variable exerts an impact on an individual's decision regarding medical exams. In this regard, the probit estimation results associated with undergoing medical exams are provided in Table 4.

The variable expressing whether a person is enrolled in an employee health insurance program was shown to exert a statistically significant effect on the probability of undergoing a medical exam. According to previous researches (Wooldridge, 2002; Stock and Watson, 2003), the t-ratio or z-ratio of the instrumental variable must be more than 3.3 for it to work well as an instrumental variable. Given this criterion, the z-ratio of variable KHI was 4.13, which satisfies this condition. The second one is to utilize the Weak IV test. Stock and Watson (2003) suggested that computing the *F*-statistic testing the hypothesis that the coefficients on the instruments are all zero provides a measure of the information content contained in the instrument. In this paper, however, the model specification is not a linear format in which the F-statistic cannot be calculated. Hence, by performing the likelihood ratio test, I attempted to investigate whether the information content of the instrumental variable was sufficient to explain an individual's decision with regard to medical exams. The test statistic was 42.17 as shown at Table 4, and this is sufficiently large to reject the null hypothesis that the value of likelihood under having the instrumental variable as a covariate is identical to the value under not having the instrumental variable.

Regarding the exogeneity of the instrumental variable, the overidentifying restriction test method was employed. In the estimation process, we have a single included endogenous variable and only one instrument. Hence, if the overidentifying restriction test statistic is exactly zero, it is natural to surmise that the coefficients in the equation system are exactly identified. The test statistic was 0.002, as shown in Table 4, and its statistical significance was not guaranteed. Therefore, based on the test results mentioned above, we can conclude that the instrumental variable used in this paper works well.

Even if the instrumental variable is shown to satisfy the two statistical tests above, the use of the instrumental variable must be intuitively accepted. Specifically, individuals who enrolled in employee health insurance programs might be more exposed to risky health environments such as job stress or might create a better atmosphere in which more health-related information can be collected from colleagues. Furthermore, considering that many firms currently support their workers' activities; those workers would tend to spend more time in regular or strenuous exercise. Hence, this instrumental variable might be correlated with omitted variables and thus with the dependent variable, which suggests that the estimation results should not be robust Therefore, concerned the estimation results of this paper, even if several statistical tests were utilized for confirming the wellness of instrumental variable, it is required to contemplate the point mentioned above.

4. Sensitivity Check

This paper also involved a sensitivity check to assess whether the estimation results above might be insensitive to individual health status. The total sample was divided into 5 subgroups according to respondents' subjectively evaluated health

Table 5. Sensitivity Check

Health Status	Regular Exercise		Strenuous Exercise	
	Coefficient	s.e.	Coefficient	s.e.
Excellent (373)[a]	0.4708**	0.2027	0.3319**	0.1459
Very Good (3,224)	0.3998**	0.1882	0.3099**	0.1566
Good (2,168)	0.3271*	0.1790	0.2991**	0.1512
Fair (675)	0.2981	0.1875	0.2550*	0.1538
Poor (69)	0.1994	0.1987	0.1889	0.1599

Note: *=statistically significant at the 0.1 level; **=statistically significant at the 0.05 level; ***=statistically significant at the 0.01 level [a]: the number of sample

status and the same estimation model was applied in both cases--regular exercise and strenuous exercise. The estimation results shown in Table 5 were obtained via the application of the bivariate probit model, taking into consideration of the endogeneity of individual decisions regarding medical exams.

Even if, in the group with comparatively poor health status, the statistical significance of the effect of undergoing medical exams on the probability of doing regular or strenuous exercise was not guaranteed even endogeneity was controlled, the direction of that effect was consistent with the results of this paper. Furthermore, the effect of strenuous exercise was significant in all groups, with the exception of the poor health status group. Considering that the probability of doing strenuous exercise might be influenced more profoundly by individual health status than that of regular exercise, this sensitivity check might help bolster the notion that the reverse causality problems might be not sufficiently serious to render the estimation results in this paper inconsistent.

However, the test results shown above might also suggest that the information effect of medical examination is great in individuals with good health status, and conversely suggests that this effect cannot be guaranteed in individuals in poor health. Considering that the object of providing free medical examinations is to improve public health status, the rationale of supporting this policy would be somewhat constrained. In this regard, it might prove beneficial to consider that the reason for undergoing medical examinations can differ between individuals in good health and those in poor health. Whereas, in healthy individuals, the reason for undergoing medical exams is to maintain favorable health status and to detect critical diseases such as cancer in its early stages, in the case of unhealthy people, medical exams are primarily used to find conclusive evidence of a specific disease, as these individuals generally visit a doctor only because they are experiencing some health problem. Even if an information effect of medical exam exists even in those in poor health, those individuals' poor health status is clearly not sufficient inducement to engage in regular or strenuous exercise. Furthermore, considering the total sample was divided on the basis of the respondents' subjectively evaluated health status, some sample selection bias might be inherent to this study. For example while the sample size of the group whose health status was "very good" was 3,224, only 69 respondents were placed in the "poor" health group. Therefore, the test results above should be interpreted with great care.

V. Conclusion

This study attempted to evaluate the information effect of medical examinations on individual health promotion behaviors, most notably exercise. Specifically, this paper empirically demonstrates that individuals who monitor indicators of their current CV health status, such as blood pressure, are more likely to invest in their own health than those who don't engage in such monitoring behaviors.

The estimation results provide evidence that individuals who make informed decisions by undergoing medical exams tend to engage in regular and strenuous exercise more frequently than those who do not. Specifically, given control of individual choice as to whether to undergo medical examinations, individuals who undergo medical examinations tend to evidence higher levels of health promotional behavior performance than others who elect not to undergo medical examinations.

In terms of policy perspective, policies designed to increase access to medical exams may increase health maintenance behaviors via this information effect. In particular, the Korean national health insurance system provides insured individuals with free access to medical exams. e information effect of this policy.

However, with regard to interpreting the results of this paper, the following point should be mentioned. As discussed previously, because the dataset used in this study represented merely one wave of a cross-sectional format, we should take into careful consideration of the possibility of reverse causality. Even if the study used several different methods to control or compensate for this problem, in order to make clear the causal pathway of the information effect of medical exam on health promotion behavior, the dynamic aspect of health status should be properly considered. Therefore, in this context, a longitudinal dataset is clearly appropriate, and should be utilized in future of investigating this topic.

Furthermore, concerned the interpretation of the results derived in this paper, we should consider the credibility of medical exams. Unfortunately, if the information from medical exams is positively false, the recipient should pay unnecessary monetary and psychological costs. Hence, even if this paper demonstrates the information effect of medical exams on individual health promotion behaviors, we should be careful in interpreting the results.

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