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Examining the effect of underlying individual preferences for present over future on lung cancer screening participation: a cross-sectional analysis of a Korean National Cancer Screening Survey

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ABSTRACT

Objectives This study aimed to examine the effect of underlying individual preferences for the present over that for the future on lung cancer screening participation.

Setting We analysed the data from the Korean National Cancer Screening Survey in 2018.

Participants 4500 adults aged 20–74 years old participated in the study.

Design In this cross-sectional survey, multivariate logistic regression analysis was carried out to examine the association between subjects' intention to participate in lung cancer screening and individual preferences. The underlying individual preferences were measured on the basis of the self-reported general willingness to spend money now in order to save money in the future and general preferences with regard to financial planning.

Primary outcome measure Intention to participate in lung cancer screening.

Results Individuals eligible for lung cancer screening who place less value on their future were around four times less likely to report an intention to participate in lung cancer screening than were those who valued their future (OR 3.86, 95% CI 1.89 to 7.90). A present-biassed individual (one with a tendency for immediate gratification) was also about four times less likely to report an intention to participate in screening than an individual with no present bias (OR 0.26, 95% CI 0.12 to 0.57).

Conclusions Underlying individual preferences regarding the present and future significantly affect individuals' intention to participate in lung cancer screening. Hence, provision of incentives may be necessary to encourage the targeted heavy smokers who may have a strong preferences for the present over future.

Strengths and limitations of this study

- ► One major challenge that policymakers are facing is the expectedly low participation rates because individuals targeted for lung cancer screening are less likely to be interested in health and in participating in screening.
- ► This is the first study to provide a behavioural economics perspective on the impact of individual time preferences on lung cancer screening participation, which could be used in designing or tailoring more effective public health policy to improve expectedly low participation rates in lung cancer screening.
- ► This study might be limited in that the analysis is based on individuals' intention to participate in lung cancer screening rather than actual lung cancer screening participation.

INTRODUCTION

Lung cancer accounts for nearly a quarter of all cancer deaths worldwide. The 5-year survival rate for lung cancer is low, ranging between 10% and 20%.[1] This is because lung cancer is generally asymptomatic before it advances to later stages.[2] The key to improving lung cancer mortality is to detect cancers early, when they are treatable, and it is widely accepted that lung cancer screening has the potential to aid early detection. A recent European Union position statement urged countries to start planning for the implementation of lung cancer screening programme with low-dose CT,[3] a recommendation that is also shared by a number of medical societies in Europe.[4 5]

The success of lung cancer screening programmes depends on a number of factors, including availability and quality of experienced radiologists or CT scanners, but one major challenge that is consistently faced by experts is the expectedly low screening participation.[6 7] Lung cancer screening targets high-risk groups with a lengthy history of smoking and has probable low socioeconomic status. These specific characteristics of lung cancer screening target population put

potential participation rates at risk more than those in any other types of cancer screening, as targeted individuals are less likely to be interested in health and thus less likely to participate in screenings.[8] Consequently, political interventions may be necessary to encourage participation in order to maximise the effectiveness of lung cancer screening when implemented. This study aimed to provide a behavioural economics perspective of individual time preferences for the present versus the future with regard to lung cancer screening participation. Our findings could be used in designing or tailoring more effective public health policy.[9 10]

A characteristic of targeted individual's decision to participate in lung cancer screening is that this decision is intertemporal.[11] An individual trades off immediate rewards (eg, a relaxing nap in the afternoon) for a delayed but generally larger future benefits (eg, early detection of cancer). In the decision theory, these intertemporal decisions are determined by individual time preferences. An individual who discounts the future more heavily (ie, high time preference) is less likely to participate in screening.[12] Furthermore, recent studies on behavioural economics have shown that people generally exhibit some degree of present bias, which refers to the tendency for immediate gratification.[13] The presence of present bias could prohibit individuals from adopting healthy behaviours as they most likely opt for immediate rewards from engaging in unhealthy behaviours when faced with a set of choices of larger future benefits from adopting healthy behaviours.[14]

A large strand of literature have highlighted the role of time preference and present bias in understanding general health behaviours such as smoking,[15] adolescents' health behaviours,[16] alcohol consumption,[17] obesity[18 19] and drug abuse,[20] but the effect of individual time preferences on an individual's decision to participate in lung cancer screening is unknown. This is the first study to report the importance of underlying individual preferences for present over future in individual's intention to participate in lung cancer screening.

METHODS

The data were collected from the Korean National Cancer Screening Survey (KNCSS). The survey targets a representative sample eligible (on the basis of the recommendations of the national cancer screening guidelines) for national cancer screening programmes including gastric cancer, colorectal cancer, breast cancer, cervical cancer and liver cancer screening. The survey provides detailed information regarding screening participation rates, demographics and health behaviours. The first wave of KNCSS was conducted in 2004, but the survey only included a question regarding savings plans, spending habits and the respondent's intention to participate in lung cancer screening in 2018. Hence, we used data of 4500 individuals from the 2018 survey.

Of the 4500 individuals included in the survey, 205 were eligible for lung cancer screening on the basis of the National Lung Screening Trial (NLST) criteria. Participants who were eligible were current or former smokers (who quit smoking within the past 15 years) aged between 55 and 74 years with at least a 30 pack-year smoking history.[21] Of the 4500 individuals, 421 were eligible for lung cancer screening on the basis of the Dutch-Belgian Randomized Lung Cancer Screening Trial (NELSON) selection criteria. Current or former smokers (those who quit less than or equal to 10 years ago) aged between 50 and 74 years who had smoked more than 15 cigarettes per day for at least 25 years or who had smoked more than 15 cigarettes per day for at least 30 years were eligible.[22] We also analysed the impact of underlying individual preferences on an individual's intention to participate in lung cancer screening among 734 ever-smokers aged 50 years or older. These criteria were similar to those of the UK Lung Health Check programme with the exception of age.[23] Ever-smokers were defined as individuals who had smoked more than 5 packs of cigarettes during their lifetime.

Logistic regression was primarily used to model the relationship between an individual's intention to participate in lung cancer screening and individual preferences, controlling for demographics. The intention to participate in lung cancer screening is a binary dependent variable, which was given a value of 1 if the survey participant intended to participate.

The demographic variables included age, sex, settlement (rural area or city), income and education, all factors known to be related to individual health behaviours.[24] Individuals were classified as lower income if the monthly household income was less than 3 million Korean won, which is approximately equivalent to US$3000. Individuals were classified as having a lower educational attainment if they did not finish middle school. This is approximately equivalent to ninth grade in the USA.

Individual time preferences were measured on the basis of an individual's general tendency to trade off for the present over the future and an individual's financial planning horizon, similar to that in previous studies.[25–28]

Individual time preferences were measured on the basis of the participants' self-reported general willingness to trade off spending for now in order to save for the future: 'Are you generally willing to save something today in order to benefit from that in the future or are you not willing to save something today for the future in order to benefit from spending in today?' Participants answered using a 7-point scale, where 7 indicates the lowest degree of time preference (ie, more willing to save for future and hence more patient). Scores between 1 and 3 were grouped together and classified as higher time preferences (less patient), whereas scores between 4 and 7 were grouped together and classified as lower time preferences (more patient). The term 'patience' is occasionally used to describe the degree of time preferences

in the manuscript. A higher time preference indicates less patience and a lower time preference indicated more patience.[29]

Individual present bias was measured on the basis of participants' answers to the question on financial planning: 'In planning your/your family's saving and spending, which of the following time periods is more important to you?' Participants were asked to choose one of the following options: I do not think about the future and only think about the present, the next week, the next few months, the next year, the next 2–4 years, the next 5–10 years and more than 10 years. Participants who chose the first two options were classified as present-biassed individuals.

The statistical power in the analysis of the NLST-eligible lung cancer screening targets was a concern because of the small sample size. This concern was somewhat minimised during analysis of the effect of time preference on intention to participate in lung cancer screening as the estimated effect of time preference was large and at a significance level of 5%. All statistical analyses were performed using STATA software V.14 (Stata Corp. L.P., College Station, Texas, USA).

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting or dissemination plans of our research.

RESULTS

Table 1 shows the characteristics of the survey sample by lung cancer screening eligibility. Most NLST-eligible individuals were male and 25.9% of all NLST-eligible participants were aged 65 years or older. Of the 205 NLST-eligible individuals, 84 (41.0%) were in the lower income group and 59 (28.8%) were in the lower educational attainment group. Approximately 20.5% of NLST-eligible individuals lived in a rural area. The proportion of residents living in rural areas and that of individuals with lower incomes and lower educational attainment were significantly higher in both the NLST-eligible group and the NELSON-eligible group than in the non-smokers group (p<0.01).

A low socioeconomic status was associated with a higher time preference. About 26.5% and 14.3% of participants with lower educational attainment had higher time preferences and were present biassed, respectively, but only 12.7% and 7.3% of participants with higher educational attainment had higher time preferences and were present biassed, respectively. Likewise, about 27.2% and 14.4% of participants with a lower income had higher time preference or were present biassed but only 10.7% and 6.3% of participants with a higher income had higher time preferences and were present biassed. Associations between the socioeconomic status and individual time preferences and present bias were all statistically significant (p<0.01), as determined by χ^2 test. Rural areas had a higher proportion of individuals with higher time preferences and present bias. Of rural residents, 17.7% had a higher time preference, but of urban residents, 13.7% had a higher time preference (p=0.013). Further, 10.2% of rural residents had present bias but 7.8% of urban residents had present bias (p=0.046). Age was also associated with individual time preferences. About 27.4% (15.7%) of older individuals had higher time preferences (present bias) but only 12.6% (7.2%) of younger individuals had higher time preferences (present bias) (p<0.01).

Table 2 shows the results of regression analysis examining the association between the intention to participate

Table 1 Characteristics of the sample by lung cancer screening eligibility

Variables	NLST eligible* N=205 N (%)	NELSON eligible† N=421 N (%)	Ever-smokers‡ N=734 N (%)	Non-smokers N=3360 N (%)
% of older (≥65 years)	53 (25.9)***	73 (17.3)***	142 (19.4)***	329 (9.8)
% of male	201 (98.1)***	416 (98.8)***	703 (95.8)***	665 (19.8)
% of living in rural area	42 (20.5)***	70 (16.6)***	102 (13.9)	395 (11.8)
% of lower income	84 (41.0)***	132 (31.4)***	224 (30.5)***	692 (20.6)
% of lower educational attainment	59 (28.8)***	79 (18.8)***	132 (18.0)***	348 (10.4)
% of intends to participate	179 (87.3)***	367 (87.2)***	645 (87.9)***	2479 (73.8)
% of higher time preference	33 (16.1)	60 (14.3)	112 (15.3)	486 (14.5)
% of present-biassed	28 (13.7)***	44 (10.5)*	66 (9.0)	269 (8.0)

P values are evaluated using the χ^2 test; ***p<0.01; **p<0.05; *p<0.10.
*An individual considered eligible on the basis of the NLST inclusion criteria (aged 55–74 years with at least a 30 pack-year smoking history and who quit smoking within 15 years).
†An individual considered eligible on the basis of the NELSON inclusion criteria; current or former smokers (those who quit less than or equal to 10 years ago) aged between 50 and 74 years who had smoked more than 15 cigarettes per day for at least 25 years or who had smoked more than 15 cigarettes per day for at least 30 years.
‡Ever-smokers are individuals aged 50 years or older who have smoked more than 5 packs of cigarettes during their lifetime.
NELSON, Dutch-Belgian Randomized Lung Cancer Screening Trial; NLST, National Lung Screening Trial.

Table 2 Effect of individual time preferences on intention to participate in lung cancer screening by screening eligibility

	NLST* (N=205)	NELSON† (N=421)	Ever-smokers‡ (N=734)	Non-smokers (N=3360)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Older (age ≥65 years)	0.91 (0.32 to 2.56)	1.74 (0.66 to 4.57)	1.02 (0.53 to 1.96)	0.90 (0.67 to 1.22)
Male	1.73 (0.18 to 17.10)	1.31 (0.15 to 11.58)	1.10 (0.39 to 3.06)	1.27** (1.04 to 1.56)
Living in rural area	1.44 (0.49 to 4.22)	1.05 (0.46 to 2.37)	0.61 (0.34 to 1.10)	0.84 (0.67 to 1.07)
Lower income	0.37** (0.14 to 1.00)	0.50* (0.24 to 1.07)	0.81 (0.48 to 1.39)	1.03 (0.83 to 1.28)
Lower educational attainment	1.27 (0.39 to 4.10)	0.57 (0.24 to 1.34)	0.95 (0.49 to 1.83)	0.86 (0.64 to 1.16)
Time preference				
Higher (less patient)	Reference	Reference	Reference	Reference
Lower (more patient)	4.51*** (1.66 to 12.27)	3.86*** (1.89 to 7.90)	2.75*** (1.60 to 4.75)	1.59*** (1.29 to 1.96)

The table reports the relationship between self-reported measures of time preference and cancer screening participation controlling for demographics. Logistic regression was used for the analysis. The dependent variable is the binary variable that takes on a value of 1 if the individual intends to participate in the lung cancer screening.
*NLST criteria refer to an individual aged between 55 and 74 years with at least a 30 pack-year smoking history (who quit within 15 years).
†NELSON inclusion criteria refer to current or former smokers (those who quit less than or equal to 10 years ago) aged between 50 and 74 years who had smoked more than 15 cigarettes per day for at least 25 years or who had smoked more than 15 cigarettes per day for at least 30 years.
‡Ever-smokers are individuals aged 50 years or older who have smoked more than 5 packs of cigarettes during their lifetime.
NELSON, Dutch-Belgian Randomized Lung Cancer Screening Trial; NLST, National Lung Screening Trial.

in lung cancer screening and individual time preferences. Individual time preferences were significantly associated with the intention to participate in lung cancer screening at a 5% significance level across all specifications of lung cancer screening eligibility. Among NLST-eligible individuals, those with lower time preferences (more patient) were about 4.5 times (OR 4.51, 95% CI 1.66 to 12.27) more likely to report the intention to participate in lung cancer screening than were individuals with higher time preferences (less patient). Among NELSON-eligible individuals, those with lower time preferences were about 3.9 times (OR 3.86, 95% CI 1.89 to 7.90) more likely to report an intention to participate than were individuals with higher time preferences. Further, ever-smokers with lower time preferences were about 2.8 times (OR 2.75, 95% CI 1.60 to 4.75) more likely to report an intention to participate in lung cancer screening than were ever-smokers with higher time preferences. No other demographic variables were consistently associated with an individual's intention to participate in lung cancer screening. Finally, the coefficient on the time preferences for non-smokers was still statistically significant (OR 1.59, 95% CI 1.29 to 1.96) but was smaller in magnitude than in screening eligible individuals or ever-smokers (NLST vs non-smokers, p=0.045; NELSON vs non-smokers, p=0.019).

Table 3 shows the results of regression analysis examining the association between the intention to participate in lung cancer screening and individual present bias controlling for demographics. Present bias was negatively associated with screening participation, although the association was not statistically significant for NLST-eligible individuals. Among NELSON-eligible individuals, a present-biassed individual was about four times less likely to report an intention to participate in lung cancer screening than were individuals with no present bias (OR 0.26, 95% CI 0.12 to 0.57). Present bias coefficients were statistically significant regardless of smoking status. Ever-smokers with present bias were about three times less likely to report an intention to participate in screening than were ever-smokers with no present bias (OR 0.32, 95% CI 0.17 to 0.62). Likewise, non-smokers with present bias were about three times less likely to report an intention to participate in lung cancer screening than were non-smokers with no present bias (OR 0.34, 95% CI 0.26 to 0.43). Although statistically insignificant, the direction of association was consistent in NLST-eligible individuals (OR 0.43, 95% CI 0.13 to 1.47).

DISCUSSION

Following the recent promising evidence from the NLST and from Europe, many countries are now planning to implement lung cancer screening programmes with low-dose CT. Whether a country could replicate the same effectiveness shown in previous RCTs remains unknown. One major challenge that policymakers are facing is the expectedly low participation rates, as the target population for lung cancer screening is less likely to be interested in health and thus participating in screening.[6 7]

In deciding whether to participate in lung cancer screening or not, an individual trades off immediate rewards for delayed but generally larger future benefits,

Table 3 Effect of individual present bias on intention to participate in lung cancer screening by screening eligibility

	NLST* (N=205)	NELSON† (N=421)	Ever-smokers‡ (N=734)	Non-smokers (N=3360)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Older (age ≥65 years)	0.94 (0.35 to 2.57)	1.66 (0.63 to 4.38)	0.98 (0.51 to 1.88)	0.94 (0.69 to 1.29)
Male	2.16 (0.10 to 49.01)	1.05 (0.06 to 19.15)	1.12 (0.37 to 3.41)	1.32*** (1.07 to 1.62)
Living in rural area	1.20 (0.36 to 4.01)	0.62 (0.27 to 1.42)	0.60 (0.33 to 1.12)	0.85 (0.67 to 1.07)
Lower income	0.50 (0.20 to 1.25)	0.59* (0.29 to 1.22)	0.92 (0.54 to 1.58)	1.01 (0.81 to 1.26)
Lower educational attainment	1.54 (0.51 to 4.69)	0.62 (0.27 to 1.42)	0.96 (0.50 to 1.86)	0.85 (0.63 to 1.15)
Present bias	0.43 (0.13 to 1.47)	0.26*** (0.12 to 0.57)	0.32*** (0.17 to 0.62)	0.34*** (0.26 to 0.43)

The table reports the relationship between self-reported measures of present bias and cancer screening participation controlling for demographics. Logistic regression was used for the analysis. The dependent variable is the binary variable that takes on a value of 1 if the individual intends to participate in lung cancer screening.
*NLST criteria refer to an individual aged between 55 and 74 years with at least a 30 pack-year smoking history (who quit within 15 years).
†NELSON inclusion criteria refer to current or former smokers (those who quit less than or equal to 10 years ago) aged between 50 and 74 years who had smoked more than 15 cigarettes per day for at least 25 years or who had smoked more than 15 cigarettes per day for at least 30 years.
‡Ever-smokers are individuals aged 50 years or older who have smoked more than 5 packs of cigarettes during their lifetime.
NELSON, Dutch-Belgian Randomized Lung Cancer Screening Trial; NLST, National Lung Screening Trial.

such as the early detection of cancer. The early detection of cancer can result in early treatment of the disease that can consequently reduce lung cancer mortality. According to the decision theory, such intertemporal decisions are determined by underlying individual time preferences. An individual who discounts the future more heavily would be less likely to participate in cancer screening. The present study is the first to report the association between underlying individual preferences for present over future and the decision to participate in lung cancer screening, on the basis of an individual's intention to participate in lung cancer screening.

This study showed that an individual who discounts the future more heavily is up to four times less likely to report an intention to participate in lung cancer screening than an individual who places a greater value on the future (for NLST criteria-eligible individuals). Interestingly, the magnitudes of coefficients on time preferences for screening eligible individuals and non-smokers were relatively different. It may be the case that time preference is indeed a more significant factor in an individual's intention to participate in lung cancer screening. This could also be attributed to the difference in the sample size between the two groups. Also, the exact measurement of time preferences was limited. Even within the same categorical measurement of time preferences, the degree of patience may differ. Future studies could test differences in the impact of time preferences using a continuous measurement.

An individual with a present bias was also less likely to report an intention to participate in screening. A present-biassed individual was about four times less likely to report an intention to participate in screening than was an individual with no present bias. The impact of individual time preferences on lung cancer screening participation was greater than that in other cancer screening programmes including gastric, colorectal, breast and cervical cancer screening programmes (online supplementary tables S1–S3). Our results imply that only extremely patient individuals would be willing to participate in lung cancer screening.

These findings are concerning for policymakers who are planning to implement a national lung cancer screening programme, as lung cancer screening generally targets heavy smokers who are more likely to have higher discount rates than in the general population.[30] Indeed, most NLST-eligible individuals were men with lower income and lower educational attainment, a population that has been previously shown to be associated with higher time preferences.[31 32] The participation rates of these targeted high-risk groups are potentially worrying; in consequence, policymakers may require incentives to encourage participation and thus maximise the effectiveness of lung cancer screening when implemented.

Theoretically, an incentive that could compensate for immediate costs from participating in screening may work well for individuals who prioritise the present, whereas promoting the long-term benefits of lung cancer screening may be less effective for individuals who place less value in the future.

For example, a recent community-based lung cancer screening trial in Manchester with a CT-equipped lorry minimised the immediate costs of travelling to screening units and was highly successful.[23] Empirical evidence also suggests that contractual precommitment (eg, conditional deposits) of future decisions could effectively mitigate the impact of present bias on smoking cessation[33] or physical activity participation.[34] Financial incentives have also been previously shown to be effective in enhancing healthy behaviours,[35 36] but were found to be less effective in promoting colorectal cancer screening participation.[37] Future studies should focus on developing strategies that

could encourage cancer screening participation among individuals with high time preferences and present bias.

This study has several limitations. First, it should be acknowledged that the intention to participate in lung cancer screening is different from actual participation. Thus, our analysis is limited to the prediction of behaviour. Future studies should validate the effect of time preferences on actual lung cancer screening participation. Second, individual preferences with regard to financial management and plans were used as a proxy for time preferences and present bias. We acknowledge that there are a number of external factors that affect an individual's decision over finances such as family income, family structures, location of residence or even any event that has recently occurred. For example, it is possible that individuals with budget constraints, especially from low-income families, may wish to save more but simply cannot do so. A more accurate approach in measuring time preferences such as incentivised experiments used in recent experimental economics could be more informative.[38] Third, the 95% CIs were wide, especially in the analysis for NLST-eligible individuals. This can be attributed to small sample size, and the precision of estimates could be improved with a larger sample size in the future. Fourth, hypothetical and indirect measures of underlying individual preferences were used in this study. Individuals may not reveal their true preferences in hypothetical surveys. However, it remains unclear whether incentive compatibility and the direct elicitation of individual preference are superior to hypothetical and indirect elicitation.[12 39] Incentivised direct measures of individual preference are also costly and time-consuming, which is inappropriate in a large-scale survey.[40 41] Finally, it remains unclear whether individual time preference measured in the monetary domain is compatible with time preference measured in the health domain; however, although debatable, studies have shown a high correlation between the two domains.[42] The external validity of our results in the health domain should be examined in future studies.

CONCLUSIONS

The provision of incentives may be necessary to encourage heavy smokers to participate in lung cancer screening.

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Competing interests None declared.

Patient consent for publication Obtained.

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