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Association of education & lifestyle factors with the perception of genetic knowledge on the development of lung cancer

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***Background & objectives*: The perception of genetic knowledge is useful for improving the heath behaviour change against developing cancers. However, no studies have investigated the perception of genetic knowledge on the development of lung cancer. The aim of this study was to examine demographic and lifestyle factors of the perception of genetic knowledge on the development of lung cancer.**

***Methods*: Data on 2,295 US adults (739 had the perception of genetic knowledge) were taken from the 2003 Health Information National Trends Survey. Multiple logistic regression models were used to evaluate potential factors of the perception of genetic knowledge of lung cancer.**

***Results*: Participants aged ≥65 yr were more likely to have the perception of genetic knowledge than those aged 18-44 yr (OR=1.77, 95% CI=1.27-2.46). Higher education was associated with a greater perception of genetic knowledge (OR=1.47, 95% CI=1.16-1.87). Subjects with correct smoking attitude were more than three times more likely to have the perception of genetic knowledge (OR=3.15, 95% CI=2.10-4.72). Subjects with exercise were at an increased likelihood of having the perception of genetic knowledge than those without exercise (OR=1.63, 95% CI=1.24-2.13).**

***Interpretation & conclusions*: Positive associations were observed between education and lifestyle factors and the perception of genetic knowledge on the development of lung cancer among US adults. Strategies developed to improve the perception of genetic knowledge of lung cancer may target on individuals who are young, less educated, and lack correct smoking attitude or exercise.**

Key words Age - education - exercise - genetic knowledge - lung cancer - perception - smoking attitude

Interactions between genes or gene and environment play an important role in the aetiology of complex human diseases. Genetic testing has been used to examine whether individuals are at an increased risk for genetic susceptibility to various diseases[1], and to allow the susceptible individuals to be less likely to have detrimental exposures and more likely to have surveillance for early disease or to accept preventive treatment[2]. Compared to low predictive values for chronic diseases obtained from most non-genetic risk factors for these diseases[3], high predictive values of disease risk factors was expected via the use of genetic testing[4]. However, individuals who lack genetic knowledge feel difficult to formulate

an opinion for genetic testing[5]. A greater perception of genetic knowledge is associated with more positive attitudes towards the benefits of genetic testing for chronic diseases[6] and cancer risk[7].

The value of genetic test for lung cancer is controversial due to the complexity and uncertainty of the role of the perception of genetic knowledge in health behaviour[1]. Lerman and colleagues[8] found that smokers at increased risk for lung cancer did not change their behaviours, by contrast, they might become more vulnerable and depressed and less likely to enhance quitting smoking behaviour. However, it was found in a follow up study that depressive symptoms were not maintained over time and genetic testing for susceptibility had the intended roles in motivations to quit smoking if more intensive smoking-cessation treatment was provided to heighten motivations for the behaviour change[9]. These results suggest that the perception of genetic knowledge and appropriate support such as genetic counselling and intensive education may be useful for improving the health behaviour change against developing lung cancer. Identification of factors for the perception of genetic knowledge may contribute to the greater understanding of risk for the diseases, which could lead to potential positive behaviour and lifestyle changes if given sufficient support. Candidate gene and genome-wide association studies have identified a number of genetic variants associated with lung cancer risk while identifying genetic biomarkers and patterns of genetic risk may be useful in the earlier detection and treatment of lung cancer patients[10,11]. To our knowledge, however, no studies have investigated factors of the perception of genetic knowledge on the development of lung cancer. The aim of this study was to examine the associations of demographic and lifestyle factors with the perception of genetic knowledge on the development of lung cancer using data from a national cross-sectional survey.

Material & Methods

Data were from the U.S. National Cancer Institute's Health Information National Trends Survey (HINTS 2003) (*hints.cancer.gov*), a national probability survey conducted in every two years covering a wide range of issues with regard to cancer-related knowledge, information, attitudes and behaviours among U.S. adults. This survey utilized a cross-sectional, complex sample survey design, data weighting and oversampled Hispanic and African American populations. For analytic purposes, variances of parameter estimators were obtained using a jackknife[12]. HINTS participants were reached by random-digit dialing and data collection which consisted of two phases including a screening phase and an extended interview phase. Details regarding the HINTS are available elsewhere[13,14]. The HINTS 2003 sample consisted of 6,369 individuals, of whom 2,919 respondents smoking at least 100 cigarettes in the lifetime were randomly assigned to answer questions with regard to lung cancer prevention and were thus eligible for this study. We excluded individuals who were American Indians or Alaska Natives, Asians, and Native Hawaiians or other Pacific Islanders due to the small sample size for each of this race, leaving a sample of 2,295 participants in our final analysis. This study was approved by the Institutional Review Board (IRB) of East Tennessee State University, USA.

Measures

Outcome: Perception of genetic knowledge: For respondents who have smoked at least 100 cigarettes in his/her lifetime, responses to the question "Whether a person gets lung cancer depends more on genes than anything else?" were dichotomized into yes or no. The perception of genetic knowledge was determined by an affirmative answer "yes" to the question.

Demographic and lifestyle factors: Demographic characteristics included gender (male, female), age (18-44, 45-64, ≥65 yr), race (White, African American), marital status (never married, married, and other), education, family history of cancer, and general health status. Education was determined by asking whether he/she had a high school's degree. Family history was asked whether "having a family history of cancer".

Having correct smoking attitude, exercise, and fruit and vegetable intake were dichotomized into yes or no. Smoking attitude was determined by answering the question whether "there is no risk if someone only smokes a few years?" Having correct smoking attitude was determined by responding "somewhat disagree or strongly disagree" to the question. Having exercise was determined by a positive response to the question "During the past month, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?" Fruit and vegetable intake was asked by the question "how many servings of fruits and vegetables do you think a person should eat each day for good health?" and determined as "yes" if consuming more than five servings per day.

Statistical analysis: Base weights were generated for each sampled identification number in the final data release using the sampling strategy for the survey. A set of 50 replicate weights was generated according to procedures for jackknife variance estimation. The final set of replicate weights included calibrations against comparable population data regarding gender, age, race, and education from the current population survey. To account for the multistage sampling complex design and its sampling weights, we used the SAS PROC SURVEYFREQ procedure (*https://support.sas.com/documentation/cdl/en/statugsurveyfreq/61835/PDF/default/statugsurveyfreq.pdf*) to estimate the proportions of demographic (gender, age, race, education, marital status, family history, general health) and lifestyle (smoking attitude, exercise, fruit and vegetable intake) characteristics in participants with the perception of genetic knowledge and those without the perception. SAS PROC SURVEYLOGISTIC procedure (*https://support.sas.com/documentation/cdl/en/statugsurveylogistic/61836/PDF/default/statugsurveylogistic.pdf*) was used to calculate population estimates and their 95 per cent confidence intervals. Bivariate analyses with logistic regressions were used to examine the relationship between each demographic/lifestyle factor and the perception of genetic knowledge of lung cancer. Then, multiple logistic regression was performed to adjust for all the factors simultaneously to examine the associations of these factors with the perception of genetic knowledge. All the analyses were performed using SAS 9.2 (SAS Institute, Cary, NC, USA).

Results

Table I describes demographic and lifestyle characteristics of participants with the perception of genetic knowledge (group 1) and those without the perception (group 2). For demographic factors, more than half of participants were males or married in both groups. The majority of participants were younger than 65 yr of age or Whites. The percentage was higher in group 1 than group 2 for participants who received education of high school or above (59 vs. 46%) and had family history of cancer (69 vs. 64%), but the percentage was lower in group 1 than group 2 for participants who were in excellent or very good health condition (37 vs. 40%). For lifestyle factors, the majority of individuals in both groups had correct smoking attitude (78 vs. 92%), and did not consume more than five servings of fruits and vegetables per

Table I. Sample characteristics of demographic and lifestyle factors, 2003 Health Information National Trends Survey (N=1,556)

Variables	Participants with the perception of genetic knowledge (n=739)	Participants without the perception of genetic knowledge (n=1,556)
	n (weighted %)	n (weighted %)
Demographic factors		
Gender		
Male	343 (54)	676 (53)
Female	396 (46)	880 (47)
Age (yr)		
18-44	325 (51)	850 (61)
45-64	224 (27)	441 (25)
≥65	187 (22)	263 (14)
Race		
White	651 (89)	1398 (91)
African American	88 (11)	158 (9)
Education		
No	371 (41)	948 (54)
Yes	367 (59)	606 (46)
Marital status		
Never married	88 (12)	245 (19)
Married	368 (63)	814 (63)
Divorced	260 (24)	437 (19)
Family history		
No	229 (31)	508 (34)
Yes	500 (69)	1036 (64)
General health		
No	454 (63)	898 (60)
Yes	285 (37)	658 (40)
Lifestyle factors		
Smoking attitude		
No	546 (78)	1380 (92)
Yes	123 (22)	121 (8)
Exercise		
No	329 (50)	951 (62)
Yes	307 (50)	486 (38)
Fruit and vegetable intake		
No	524 (81)	1024 (72)
Yes	153 (19)	468 (28)

day (81 vs. 72%). More participants in group 1 were engaged in exercise than group 2 (50 vs. 38%).

Associations of factors with the perception of genetic knowledge: The associations of demographic and lifestyle factors with the perception of genetic knowledge are shown in Table II. The univariate results showed that demographic (old age, higher education, divorced marital status) and lifestyle factors (correct smoking attitude, exercise, lack of fruit and vegetable intake) were positively associated with the perception of genetic knowledge. Multiple logistic regression model showed that participants aged 65 yr or older were more likely to have the perception of genetic knowledge than those aged 18-44 yr (OR=1.77, 95% CI=1.27-2.46). Higher education was associated with a greater perception of genetic knowledge (OR=1.47, 95% CI=1.16-1.87). Participants with correct smoking attitude had more than three times odds of having the perception of genetic knowledge than those without correct smoking attitude (OR=3.15, 95% CI=2.10-4.72). Participants with exercise were at an increased likelihood of having the perception of genetic knowledge (OR=1.63, 95% CI=1.24-2.13).

Discussion

Our study suggested that old age, higher education, and several lifestyle factors including smoking attitude and exercise were positively associated with the perception of genetic knowledge on the development of lung cancer.

A constant decline in age-adjusted cancer deaths has been shown via primary prevention efforts in tobacco and diet and secondary prevention efforts for breast, cervical, and colorectal cancers[15]. For lung cancer, however, secondary prevention strategies such as early detection, screening, or treatment may not be available to individuals at high risk identified by genetic testing. For example, the *CYP2D6* gene is associated with lung cancer, however, the genotyping of *CYP2D6* may not be always feasible due to laboratory quality issues and cost[1]. In contrast, those individuals who obtained the information from genetic testing may ultimately have adverse health behaviours regardless of results. For example, individuals may continue their risk behaviours due to falsely low perceived risk if they were told to have a reduced risk for developing lung cancer[1]. In our study, it was found that incorrect smoking attitude was associated with a lack of the perception of genetic knowledge of lung cancer. Individuals would continue the unhealthy behaviour if they had a low perception of genetic knowledge. In contrast, individuals with such perception may be more likely to have intensive smoking cessation treatment that can be used to motivate smokers who understand lung cancer risk to quit smoking[9].

Our study aimed to examine the factors of the perception of genetic knowledge. Higher levels of the perception of genetic knowledge have been shown to be associated with higher likelihood of individuals endorsing behavioural factors[16], and it also shows that low levels of health literacy is associated with less likelihood of developing health behaviours and poorer health outcomes[17,18]. Thus, it is imperative to assess roles of factors on individuals' perception of genetic knowledge. Our finding was consistent with other studies that higher education was associated with a higher level of the perception of genetic knowledge[6]. For age, previous studies found that younger age was associated with a higher level of the perception of genetic knowledge in the US[16], Netherlands[6,19,] and Finland[20], which was different from our finding. This is because our study focuses on the lung cancer and the definition of perception of genetic knowledge may vary across these studies. For lifestyle factors, because of the unique research outcome of interest, smoking attitude and exercise were proposed to be associated with the perception of genetic knowledge of lung cancer.

This study had several strengths. First, the instrument was well developed via three phases. Second, the average length of interviews was ensured to be within half an hour, which reduced the likelihood of participants' dropping during the interview. Third, the HINTS data were weighted to represent the national population.

Our study also had limitations. First, the HINTS used a probability sample of US telephone numbers which can only identify the non-institutionalized US civilian population. Thus, individuals who were homeless, did not have a telephone, or were not available to answer the telephone were excluded. This may cause a potential selection bias. Second, data were collected by using computer-assisted telephone interview (CATI) system in English or Spanish. It is more likely to exclude the adults who did not have patience to complete the CATI or those who did not understand these two languages. Although the data were weighted, the representation of the entire national population should be interpreted with caution.

Table II. Univariate and multiple logistic regression analyses of the associations between demographic and lifestyle factors and the perception of genetic knowledge, the 2003 Health Information National Trends Survey (N=2,295)

Variables	Crude OR	95% CI	*P* value	Adjusted OR [a]	95% CI	*P* value
Demographic factors						
Gender						
Male	1			1		
Female	0.96	0.74-1.24	0.736	1.17	0.87-1.59	0.301
Age (yr)						
18-44	1			1		
45-64	1.30	1.04-1.62	0.613	1.30	1.01-1.68	0.887
≥65	1.91	1.52-2.42	<0.001	1.77	1.27-2.46	0.011
Race						
White	1			1		
African American	0.73	0.50-1.06	0.095	0.72	0.44-1.19	0.199
Education						
No	1			1		
Yes	1.64	1.34-2.03	<0.001	1.47	1.16-1.87	0.002
Marital status						
Never married	1			1		
Married	1.54	1.07-2.21	0.393	1.64	1.08-2.49	0.084
Divorced	1.93	1.31-2.84	0.001	1.63	1.02-2.60	0.157
Family history						
No	1			1		
Yes	1.17	0.91-1.50	0.212	1.29	0.96-1.74	0.095
General health						
No	1			1		
Yes	0.88	0.71-1.09	0.249	0.92	0.72-1.19	0.525
Lifestyle factors						
Smoking attitude						
No	1			1		
Yes	3.22	2.23-4.65	<0.001	3.15	2.10-4.72	<0.001
Exercise						
No	1			1		
Yes	1.66	1.32-2.09	<0.001	1.63	1.24-2.13	0.001
Fruit and vegetable intake						
No	1			1		
Yes	0.62	0.48-0.81	0.001	0.73	0.52-1.01	0.058

OR, odds ratio; CI, confidence interval.
[a]Adjusted for all demographic factors and lifestyle factors

Third, data were collected based on self-reported and retrospective recall within a limited time, which may compromise the accuracy. Fourth, although a followup telephone call was arranged if the household reporter was not available, the response rate was still lower than expected, only 62.8 per cent. Fifth, family history of cancer has been given in general, which would be more accurate to have information of family history of lung cancer. Sixth, lifestyle factors such as exercise and fruit and vegetable intake were dichotomized as yes or no without taking into consideration the dose and duration effect due to lack of information. Finally, the increase

of genetic knowledge may likely increase people's beliefs about genetic testing, but the nature of cross-sectional design could not draw inferences concerning the direction of this relationship or determine the causality because of its "snap shot" characteristic that only measures exposure and outcome variables at one point in time. Longitudinal studies are needed to determine the effect of the factors on the perception of genetic knowledge.

In conclusion, positive associations were found between education and lifestyle factors and the perception of genetic knowledge on the development of lung cancer among US adults. Strategies developed to improve the perception of genetic knowledge of lung cancer may target on individuals who are young, have lower education, and lack correct smoking attitude or exercise.

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Conflicts of Interest **:** None.

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