

Characterization of Individuals Taking Part in Low Dose Computed Tomography (LDCT) Screening Program

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Abstract In the past years the participation rate in conventional voluntary x-ray lung screening has been around 22 % in Somogy County in Hungary. Due to the high morbidity and mortality rates of lung cancer, low participation rate of the high risk individuals on the screening is a primary question in Hungary. To obtain an effectively high level of participation in our ongoing low dose CT screening program, we had to emphasize the benefits of participation for the targeted individuals. As a first step, our aim was to gather information on the aspects affecting the individuals' will for participation. We used the most accessible source of information: individuals over the age of 50, who attended the conventional voluntary lung screening, were approached to fill a questionnaire on their habits relating to smoking, health issues and their prior participation of lung screening. 1080 adults anonymously completed the questionnaire. Analyzing the results, beside other findings, we found a unique variable factor, which altered negatively the compliance for the screening: older individuals, who started participating in the screening in obligation to the health regulations, took part in the voluntary screening programs at a significantly lower rate. Our findings led us to better understanding the complexity of decision making affecting the individual's participation and attitudes toward health issues. Trial registration: IG/03833/2012.

Keywords Lung cancer · Lung screening · Participation rate · Hungary

Introduction

Morbidity and Mortality of Lung Cancer

Pulmonary carcinoma is associated with the highest mortality among neoplastic diseases in the developed countries and in Hungary as well [1, 2]. Mortality due to lung cancer in Hungary has significantly exceeded the averages of the European Union member states. Lung cancer mortality statistics in the EU has been led by Hungary since 2004 [3, 4]. In Hungary most patients with lung cancer have been diagnosed within the 60- to 70-year-old group in both sexes [5].

The Hungarian Lung Screening Program

The Hungarian methodology of mass screening of the lung has been unique among the European countries since 1946: as regulated by the national law for the population over 14 years of age, annual participation of adults in chest radiological examination—(X-ray and fluoroscopic mass screening of the lung)—was obligatory until 31 July 2004. The regulation served as screening for tuberculosis. The method was only partially suitable for detecting lung cancer, the detection of lung tumors was only “accidental finding”. In Hungary 45,000 patients suffered from tuberculosis and more than 7000 patients died of it in 1950. While the containing of tuberculosis in Hungary was one of the greatest successes of the 20th century medical history [6], the main role of screening examinations recently has shifted to the detection of patients with pulmonary carcinoma.

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In the time of survey, the population of 50-year-old individuals had participated in obligatory screening for 27 years, followed by voluntary participation in the last 9 years; while, the 70-year-old population took part in mandatory mass screening of the lung for 47 years.

Currently the participation in the annual mass screening of the lung is absolutely voluntary and free of charge for the population over the age of 40 due to the coverage of the expenses by the Hungarian National Health Insurance Fund.

The participation ratio in the voluntary population lung screening in Somogy County in the recent 5 years has been lagging considerably behind the national average (22.0–22.5 % vs. 33.6–34.0 %), only five of the 19 Hungarian counties are characterized by poorer participation in the mass screening of the lung. The participation ratio under 20 % means practically no population screening in the given area [5]. The ratio of pulmonary tumors detected by screening shows an even worse situation: with a value of 11 %, Somogy County occupies the 17th place from 19 Hungarian counties.

Mass Screening of the Lung, Introduction of Voluntary Low-Dose CT Screening for Lung Cancer in Hungary

Today, in lung cancer screening professionals more and more tend to vote for low-dose CT screening according to methodological aspects, however a number of parameters for LDCT screening do not have uniform criteria: the age of included people varies in different countries [7, 8], the interval of screening also varies: one or two [9] year intervals can be found [10]. In our previous study, patients who voluntarily attended the mass screening of the lung, were free of complaints, and underwent a digital thoracic radiography with a negative result, were offered to take part voluntarily in low-dose computed tomography (LDCT) examination [11]. In the age groups over 50, 60 and 70 years the ratio of voluntary participants on LDCT examination was 17.9, 12.3 and 5.1 % respectively.

Aims

The aim of the work presented in this paper was to launch a prospective study in order to characterize the population who attended the current, voluntary national lung disease mass screening program, and to find the most effective approach to attract the most probably affected individuals into the screening. To obtain a higher, effective level of participation in our ongoing low dose CT screening program, we decided to emphasize its benefits in a more convincing way for the targeted individuals.

Material and Methods

We started a public awareness campaign in order to increase the participation of the population over 50 years of age in the voluntary screening of the lung (Fig. 1), and introduced the use of LDCT screening as a technique considered currently the most up-to-date to detect early lung cancer [12, 13].

For characterization purposes, from May 2012 to November 2013, patients older than 50 years of age, who voluntarily took part in the mass screening of the lung for prevention in this period, anonymously completed a 28 questions questionnaire compiled by us.

After exploring the physical, economic and social background (gender, age, occupation, education level, job, and marital status) the participants were asked to answer questions revealing the subjective estimate of physical well being, knowledge and commitment to live a healthier life style. Ten questions asked about smoking habits (duration, intensity, level of commitment for termination). Nine questions explored the frequency, motivational basis, and expectations in taking part in lung screening program. We examined their factual knowledge on lung diseases and mass screening of the lung with six true/false statements. We edited a questionnaire partially including WHO validated open-ended and close-ended questions. The time of surveying was chosen in a random way in order to represent the whole period of the year.

Inclusion criteria: voluntary participation in the mass screening of the lung, lack of pulmonological complaints; voluntary completion of the questionnaire.

Exclusion criteria: incompletely answered questionnaire, presence of pulmonological complaints.

Data verification was continuous during the data input procedure and the processing phase.

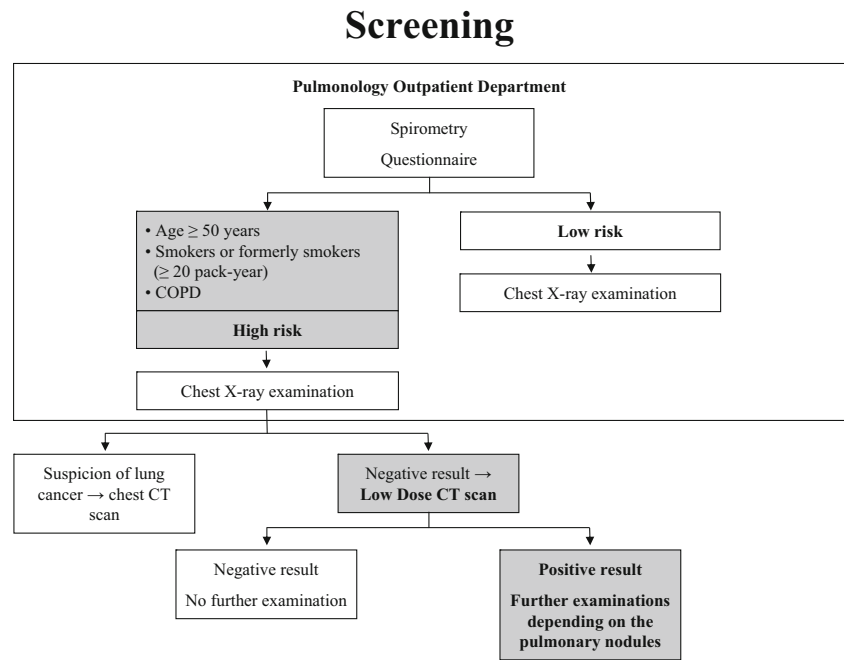
With the statistical analysis we calculated the average, the standard deviation and the frequency distribution for the different groups. The analysis of the results was based on 95 % confidence interval ($p < 0.05$) comparisons and two-sample t-tests. Parameters were examined concerning the entire population and the age-related subgroups as well. Age groups were studied in categories according to decades; in addition there were various sub-samples such as: current smokers; former smokers who quitted; never smokers; patients who attended mass screening of the lung annually, or less frequently.

Data were analyzed by using SPSS v20.0.0.

We applied the terminology of the US Centers for Disease Control and Prevention in the characterization of the participants by smoking habit.

Never smokers: adults who have never smoked a cigarette or who smoked fewer than 100 cigarettes in their entire lifetime.

Fig. 1 Screening algorithm



Former smokers: adults who have smoked at least 100 cigarettes in their lifetime, but say they currently do not smoke. *Current smokers:* adults who have smoked 100 cigarettes in their lifetime and currently smoke cigarettes every day (daily) or some days (nondaily) [14].

To define the high risk group we used the guidelines published in the contemporary Hungarian literature [11].

In Hungary, people of both genders with a high risk of lung cancer can be characterized as follows:

- age >50 years,
- current smokers or former smokers,
- chronic obstructive pulmonary disease (COPD),
- forced expiratory volume in the first second (FEV1) decrease >15 %,
- other neoplastic disease,
- lung cancer in the family,
- workplace exposition.

The definitions of risk groups were based on the National Comprehensive Cancer Network (NCCN) [1] and the Hungarian guidelines [11].

Screening participation was recommended individually based on risk survey:

1. High risk group, screening is recommended: 55–74 years of age, 30 pack-year or greater smoking index number. Further risk factor is chronic obstructive pulmonary disease (COPD).
2. High risk group, screening is also recommended: minimum 50 years old, 20 pack-year smoking index number with another additional risk factor.

Passive smoking is not stated as an individual risk factor in the NCCN guideline [1], unless there are other risk factors present.

Low dose CT-based screening has to be considered effective only for a well-defined risk group. Routine LDCT screening is not recommended for moderate or low risk groups.

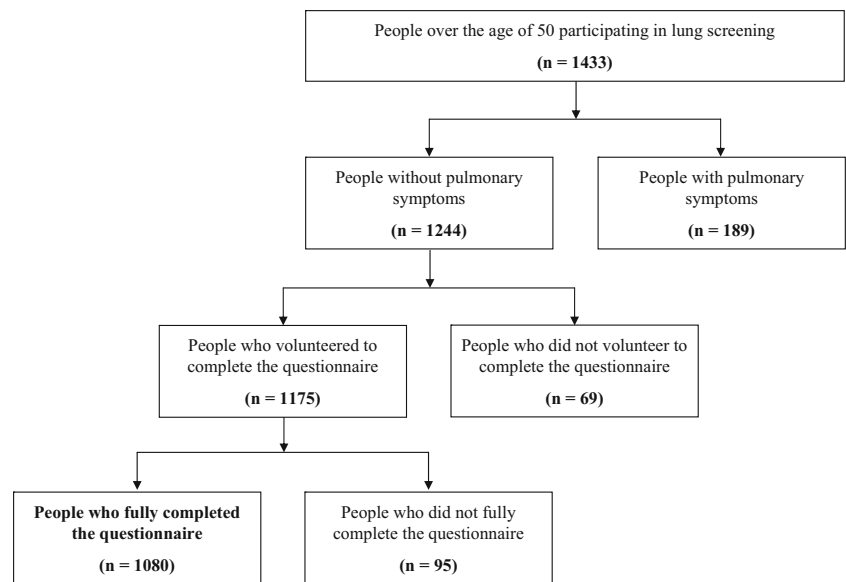
Furthermore we examined if there was a correlation between the number of the years of mandatory attendance in the mass screening of the lung and the frequency of the voluntary attendance, i.e., whether regular mandatory attendance for a longer period of time might result in increased participation as a developed habit.

Ethical approval was issued by “Kaposvári Egyetem Egészségügyi Centrum Etikai Bizottsága [In Hung.] = Ethical Committee of Kaposvár University Health Center” for this study corresponding to the current national and international ethical laws and guidelines. The reference numbers are: EC 611/2012.

Results

In accordance with the criteria, 1080 participants (402 males / 37.2 %/ mean age 60.0±7.0 years and 678 females /62.8 %/ mean age 58.6±6.2 years) were included in the survey (Fig. 2). Except for the oldest age group, there was a female majority in all decades.

There was no significant difference between man and women according to the mean age and age distribution (Fig. 3). 239 (22.1 %) of all participants completed elementary school and 383 (35.5 %) participants was educated in vocational school. 298 (27.6 %) participants possessed a general certificate of secondary education and 160 (14.8 %)

Fig. 2 Participants of the survey

participants had university qualification; 657 (61.2 %) of the participants lived in a town, and 416 (38.9 %) participants lived in a village.

Ratio of the Smokers; Smoking Habits

389 (36.0 %) of the questioned participants were current smokers, who had smoked during the week before the

questioning with no exception. In the age group over 70 years there were more never smokers (50 of 81 participants) than current smokers plus former smokers altogether (Fig. 4).

The current smokers at the time of the survey had been smoking for a mean (\pm SD) 37.3 (\pm 8.5) years, since a mean age of (\pm SD) 21.0 (\pm 6.6) years. More than half, 215 (55.4 %) of the current smokers smoked 10–19 cigarettes daily and 56 (14.4 %) of them smoked more than that. 2 (0.5 %) of the

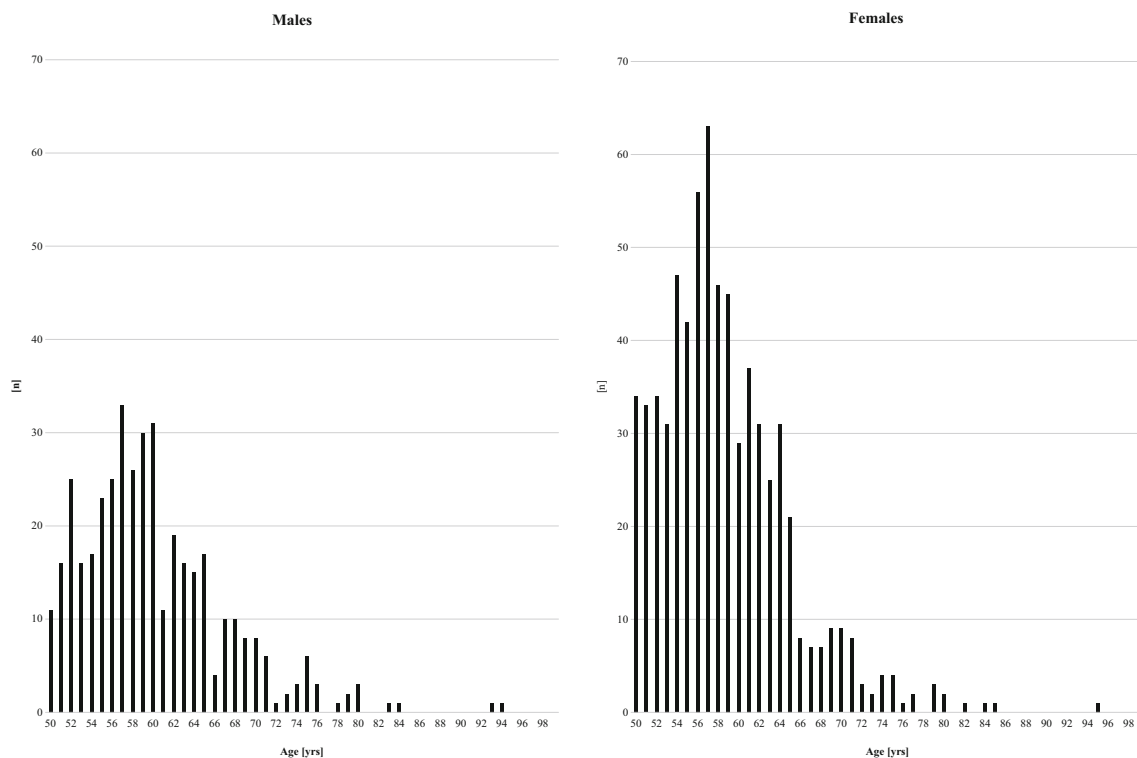
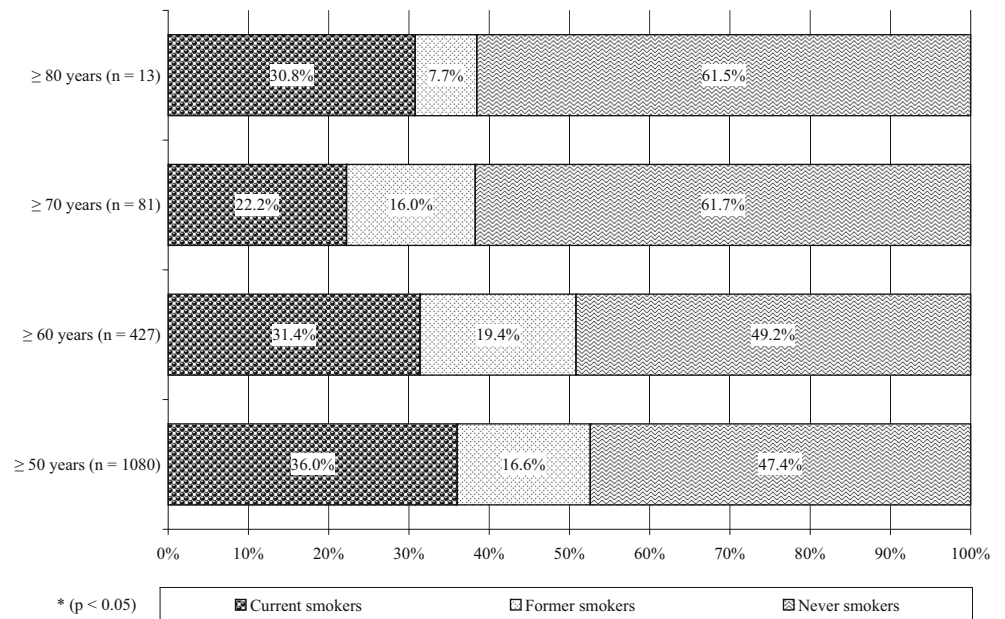


Fig. 3 Age distribution of patients attending mass screening of the lung ($n=1080$). The histogram emphasizes the female dominance in every age group among the voluntary lung screening attendants

Fig. 4 Ratio of smokers among persons who attended the mass screening of the lung ($n=1080$)



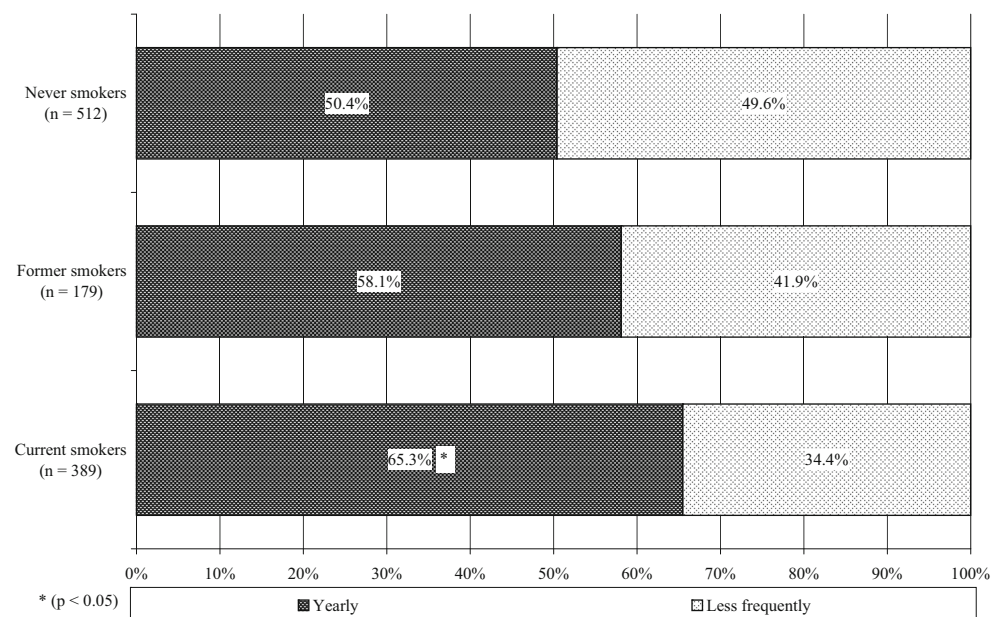
current smokers consumed more than two packs a day. Less than five cigarettes were lit daily by 31 (8.0%) of the current smokers.

179 (16.6%) of the questioned people were former smokers who stopped smoking approximately (\pm SD) 23.1 (\pm 16.9) years before. From the 568 people, who were former or current smokers in this study, 179 (31.5%) of them have lit a cigarette for the first time before the age of 18, and 389 (68.5%) of them started smoking at the age of 18 or later, this result was statistically equal in every age group.

Participation in the Mass Screening of the Lung; Attitudes

In the group of ≥ 50 years of age only annual attendance was considered as regular participation in the mass screening of the lung. 616 (57.0%) of the surveyed people attended mass screening of the lung every year, 244 (22.6%) in every other year, and 220 (20.4%) even less frequently. With the increase of age this rate of participation decreases to a non-significant extent; the rate of regular attendants in the annual mass screening of the lung is

Fig. 5 Attendance at the mass screening of the lung in the various subsamples ($n=1080$). Annual lung screening attendance is significantly higher among current smokers than in other subgroups



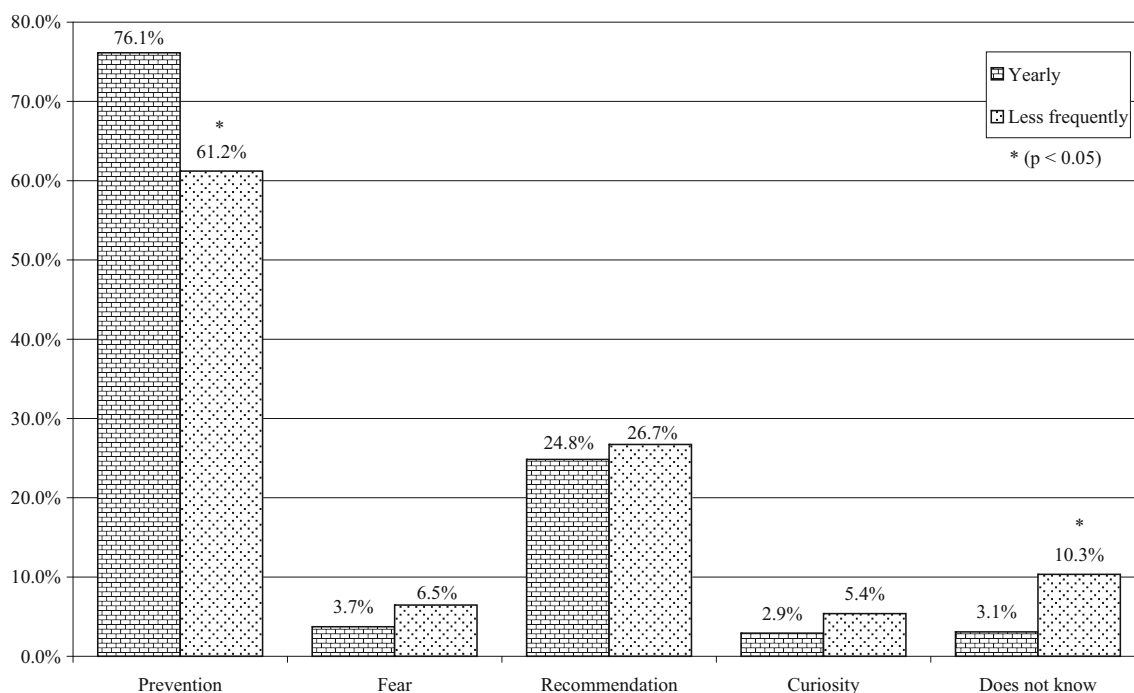


Fig. 6 Reasons for attendance in the mass screening of the lung among the regular yearly and among the less frequently attendants ($n=1080$). The figure shows the distribution of the underlying causes of the attendance in relation to the frequency of participation

217 of 427 participants (50.8 %) and 41 of 81 participants (50.6 %) among those of ≥ 60 and ≥ 70 years, respectively. The current smokers and the former smokers attended the mass screening of the lung annually at a significantly ($p < 0.05$) higher rate than the never smokers (Fig. 5).

Participants who attended annually the lung screening were more committed to prevention. Those who attended less frequently were rather driven by fear, curiosity or recommendation. Those who could not give a reason for their attendance in the mass screening of the lung were also at a higher rate among the less frequently attendants (Fig. 6).

Examining the correlation between the number of the years of mandatory attendance in the mass screening of the lung and the frequency of the voluntary attendance, we found a moderately strong significant negative correlation ($r=0.24$, $p < 0.01$), so regular mandatory attendance for a longer period of time resulted in decreasing participation in voluntary screening.

Discussion

Current smokers significantly more frequently took part in lung screening annually than never smokers. It is positive—in contrast to the data from the literature [15]—that the participation rate of former smokers is higher than never smokers, it is just a bit lower than the participation rate of current smokers—both in annual and biannual participation. So the

“protection” that they might assume to develop after they stop smoking is not substantial according to the results.

Based on the analysis of our data, mandatory participation may probably be regarded by the population with a negative attitude. The mean age of the less frequent attendants was non-significantly but higher than the mean age of people taking part in the prevention screening annually. Our results may further support the view that although a lifestyle chosen by the individual might be influenced “from outside”, e.g., with regulations, this would not be internalized into the health-related behavior of the personality, and it would not be “transformed” to a habit.

Our results demonstrate that prevention-consciousness is high among people who attend mass screening of the lung annually.

The screening of patients with a high risk for lung cancer is a crucial issue in Hungary, where the rates of morbidity and mortality of this disease are high particularly in the studied Somogy County. In Hungary, most of the lung cancer patients were singled out with conventional chest X-ray, until now. In countries with more developed technical facilities, this technique has not been recommended over the last several years. Presently LDCT examination is generally accepted as a screening method for lung cancer worldwide [16–18]. Our own results [11] correspond with the international literature which shows that low-dose CT-based screening has to be considered effective only for a well-defined risk group. Exact definition of high risk factors for selecting individuals to be screened highly contributes to the efficiency of the screening

[19, 20]. The finding of these criteria was our substantial purpose of investigation [11], and led us collaterally to the findings presented in this paper.

According to our knowledge, characterizing people by their habit in participating in voluntary lung screening is a novel initiative, as well the low dose CT screening for lung cancer in the Hungarian health care system.

Conclusion

There is unequivocal discrepancy between the incidence of lung cancer and the participation in lung screening. With our research screening associated attitudes, smoking habits and smoking related knowledge of the 1080 participants were mapped. One of the major experiences of our research was: to gain higher participation in screening programs for early detection of lung cancer, we have to individualize the way of proposing the participation based on the smoking habits.

International professional guidelines have to be dealt with reservation and critical approach. It is unavoidable to make estimations based on the available data of Hungarian risk groups for an actual domestic model. We are in the process of developing a new lung cancer screening model based on volumetric LDCT imaging in order to be inserted into the Hungarian health protection practice. Analyzing and characterizing the targeted Hungarian risk groups are required to accomplish the given task.

Conflict of Interest The authors declare that they have no competing interest.

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