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Recruitment preferences for lung cancer screening among 4-IN-THE-LUNG-RUN participants

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Abstract

Background Implementing a tailored approach that addresses both socioeconomic status (SES)-specific and sex-specific needs may enhance the effectiveness of information delivery, thereby potentially increasing lung cancer screening uptake. However, to date, there is a gap in knowledge regarding how recruitment strategies can be best adapted to these factors. This study investigates recruitment preferences among participants of the 4-IN-THE-LUNG-RUN study, the European implementation trial for lung cancer screening.

Methods An online questionnaire regarding reasons for participating (or not) in lung cancer screening and recruitment preferences was sent to 848 Dutch individuals, aged 60–79 years. All participants were randomized previously within the 4-IN-THE-LUNG-RUN study. Hereafter, two focus groups were conducted with a subsample of these participants ($n = 14$) to gain deeper insights into their responses. Data were analyzed using SPSS software.

Results Of 479 respondents (56.5%) with fully completed questionnaires, 377 (78.7%) preferred to be informed about lung cancer screening via email. This preference is significantly higher among the high and middle SES compared to those with lower SES (84.3% and 83.2%, versus 68.2%, $p < .001$). Only 9.8% ($n = 47$) expressed a desire to be contacted exclusively through a paper-based communication. The latter preference was primarily observed among individuals with a low SES, in comparison to those with middle or high SES (53.2% versus 23.4% and 23.4%). A total of 43.4% indicated that they would appreciate the integration of lifestyle advice within screening. Men were more open to this option than women ($p = 0.018$). In terms of sex-related differences, recruitment preferences were comparable between men and women. The focus groups revealed that participants preferred to receive the results by email rather than by post, to reduce waiting time and thereby alleviate anxiety. No added value was seen in recruitment being conducted through their general practitioner. Both of these statements were supported by the vast majority of participants.

Conclusions Recruitment for (lung) cancer screening should focus primarily on providing clear and concise information – independent of sex. A majority of participants prefer digital information delivery. Nevertheless, maintaining the option of paper-based information for lower SES groups may be essential to ensure inclusive and equitable access.

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Keywords Lung cancer, Cancer screening, Recruitment, Health communication, Health literacy, Information needs

Introduction

About 1 out of 5 cancer patients die from lung cancer, ranking lung cancer as one of the leading causes of death worldwide [1]. Lung cancer is characterized by its fast growing nodules, in approximately 75% of the diagnoses the cancer has already reached an advanced stage, resulting in a five-year survival rate of only 20% [2, 3]. Lung cancer screening programs using low-dose computed tomography (LDCT) for early detection and treatment have already demonstrated the potential to significantly decrease mortality rates in a high risk population [4, 5]. The risk of developing lung cancer is mainly determined by history of long-term smoking, but other factors as personal history of cancer, family history of lung cancer and the presence or absence of chronic obstructive pulmonary disease (COPD) further increase the risk. Given that screening is voluntary, the success of screening programs heavily depends on effective recruitment strategies to achieve adequate participation among the high-risk population.

One of the main challenges before implementation of lung cancer screening is to reach the target population. In contrast to existing population-based screening programs, where the target population is typically defined solely by age and sex, lung cancer screening introduces risk-based selection. It is essential to invite only the high-risk population to participate in screening, for whom the benefits are considered to outweigh the harms. Completing a pre-screening risk-assessment becomes a necessary step in the screening workflow, which adds complexity to the recruitment process. Furthermore, in the high-risk population, individuals with a lower socioeconomic status (SES) tend to be overrepresented in the target population as a consequence of differences in smoking patterns among SES groups [6–10]. However, individuals from this lower SES group face more barriers to participation in preventive programs, including reduced health literacy, financial constraints, and logistical reasons (e.g. travel) [6]. As a result, this group is less likely to participate in (lung) cancer screening [6–11].

Multiple barriers and facilitators may influence an individuals' participation in lung cancer screening. A personal history of smoking and a family history of lung cancer were found to increase screening uptake [12]. Additionally, the presence of symptoms served as a facilitator for participation, as well as, awareness of the perceived benefits of screening. Conversely, a lack of knowledge about lung cancer, lung cancer screening, and associated risks acted as significant barriers [12]. Psychological factors, particularly fear – such as fear of lung

cancer, the screening procedure, or potential treatment – negatively impacted screening uptake [12]. Moreover, travel distance to the screening facility was identified as a deterrent to participation [12]. Cavers et al. conducted a focus group study and found that fear and worry were the most pronounced psychological and emotional concerns among individuals, both men and women, eligible for lung cancer screening, acting as barriers to participation. Furthermore, having a family history of cancer could function both as a facilitator and as a barrier to participation, depending on the individual's personal experiences and perceptions [13]. Moreover, these studies on barriers and facilitators have not accounted for SES or sex [12, 13], and findings regarding sex differences in lung cancer screening participation rates remain inconsistent. Participation rates vary significantly across studies, with odds ratios ranging from 0.91 to 1.39 for men [14, 15] and from 0.83 to 1.40 for women [16, 17].

The focus group study among lung cancer screening participants found that participants generally had a poor understanding of the potential harms. Participants were particularly concerned about false-positive and false-negative results. In contrast, overdiagnosis and radiation exposure, although recognized as potential harms, did not deter participants from taking part in screening [18]. As part of the Lung Health Check program, the intervention group received a targeted, low-burden, and stepped leaflet that addressed psychological barriers (fear, fatalism, and stigma) and presented screening as a routine activity (annual vehicle test). The intervention leaflet was more effective in reaching individuals living in the most deprived areas, thereby improving equitable access to screening. However, no difference in uptake compared to the control group, which received a facts booklet about lung cancer screening was found [11].

A focus group study among women eligible for lung cancer screening revealed that preferences regarding both the type and delivery of information vary between individuals [19]. While some participants favored printed materials, such as brochures, others preferred video formats. However, there was consensus that the information should be concise, direct, and engaging. Participants preferred that information is summarized using bullet points for clarity. Additionally, the access of information through General Practitioners (GPs) was a strong demand. The tone of communication should be hopeful rather than fear-inducing to encourage participants to participate without causing unnecessary anxiety [19]. Since a significant proportion of the target population also consists of women, these findings may be relevant;

however, it remains unclear to what extent these preferences can be generalized to men. All Participants, independently of sex, in the focus group study conducted by Cavers et al. perceived the independent nature of the screening process as a positive aspect. Specifically, it was appreciated that the responsibility for screening did not rest with their GP, as some participants expressed concerns about being treated adequately and fairly due to their smoking history [13].

Currently, individuals in the Netherlands are only informed and invited to participate in population-based screening by post. However, digital technologies have the potential to improve the communication of information, thereby influencing participants' decision-making. In colorectal cancer screening, the implementation of digital interventions has been shown to significantly increase screening uptake [20].

The use of video as a recruitment strategy was effective in cervical cancer screening [21]. However, studies on colorectal cancer screening have yielded inconclusive results regarding the effectiveness [21]. For breast cancer screening, the use of video-based recruitment was five times more effective in adherence for mammography screening among women with lower incomes compared to usual care, whereas no significant difference was observed in higher income groups compared to usual care [22].

Currently, little is known regarding SES-specific and sex-specific recruitment preferences in (lung) cancer screening programs. Implementing a tailored approach that addresses both SES- and sex-specific needs may enhance the effectiveness of information delivery to the target population, thereby potentially increasing screening uptake. Ensuring the adequate inclusion of high-risk individuals could increase the overall effectiveness of screening programs, reducing lung cancer mortality, and contribute to mitigating socio-economic health disparities.

4-IN-THE-LUNG-RUN (4-ITLR) is the first large-scale, multi-centered implementation trial on lung cancer screening across five European countries to develop and implement the optimal CT lung cancer screening program for high-risk populations. This embedded sub-study aims to investigate the participation reasons and recruitment preferences regarding lung cancer screening participants. Potential sex and SES related differences were explored.

Methods

Study design and population

Based on population registries, 336,860 Dutch men and women, aged 60 to 79 years, residing in 3 regions close to the screening sites, were randomized by socioeconomic group (low, middle, and high) and zip code numbers to one of the three recruitment methods: the standard

paper group, the standard online group, or the tailored online group. Socioeconomic group data were obtained from Statistics Netherlands (SN) national databases, and zip code numbers were retrieved from national population registries. Randomization was performed using R Statistical Software.

Invitations for participation in the randomized controlled trial (RCT) 4-ITLR were sent out at the end of 2022 and the beginning of 2023. The standard paper group received their invitation letter, baseline questionnaire and information leaflet by mail, all materials were on paper. People in the standard online group received an invitation letter by mail along with a reference to a website (website and QR code). On the website, they could download the information leaflet and fill out the baseline questionnaire digitally. Lastly, participants of the tailored online group received a letter by mail with a reference to an interactive website. Besides all standard information, this website included a self-test, decision aid, animation video, and infographic. Participants in this last group were also asked to fill out the baseline questionnaire digitally if they were willing to participate in the study. Individuals living outside the targeted regions were able to self-register for participation, exclusively facilitated through the website. All participants gave written informed consent. 4-ITLR is approved by the Dutch Minister of Health after a positive advice of the Dutch Health Council according to the Population Screening Act. The English translation of the baseline questionnaire and a summary of the RCT protocol are available in Supplementary Materials 1 and 2, respectively.

Questionnaire

A subsample of 848 eligible 4-ITLR participants (men and women, 60 to 79 years of age), recruited at the beginning of July 2024, have been invited to complete an additional online questionnaire, followed by a reminder at the end of July 2024 for participants who had not yet completed it. Participants were able to complete the questionnaire until the end of August 2024. All participants were recruited from the four recruitment groups (standard paper, standard online, tailored online, and self-registration), and meet the 4-ITLR inclusion criteria of at least a 6-year lung cancer risk ($PLCO_{m2012}NoRace$) of 2.6% and/or the pack-year criteria (≥ 35 pack-years and quit smoking < 10 years). Part of these participants already had at least one computed tomography (CT) scan ($n = 600$; 200 participants from each Dutch screening site), while others were still waiting for their first scan at the time of invitation ($n = 248$; 100 participants from both Amsterdam and Bilthoven, and 48 from Drachten, as no additional participants in this region were pending their initial scan). Only participants with a registered email address (74.3%) were included.

The questionnaire was specifically developed for this study to collect relevant supplementary data and consisted of multiple sections. After completing identifiable and demographical self-reported variables (studyID, date of birth, sex, current smoking status, and number of GP visits), the questionnaire continued with 5 multiple-choice questions about the digital skills. Hereafter, 15 multiple-choice questions, 4 questions with a 5-point Likert scale (ranging from 'very important' to 'not important at all'), and 1 open question were presented, each allowing respondents to provide their own answer in addition to the predefined options. The survey explored reasons (not) to participate in lung cancer screening, as well as preferences related to: (1) the preferred method of receiving information about lung cancer screening, (2) topics to be informed about, (3) the use of figures, tables and videos, (4) the amount of text, numerical data, and visual representations used (5) practical issues (e.g. distance to screening location, costs, participation in other population-based cancer screening programs), and (6) lifestyle counselling. Each of those was designed to target a specific unresolved issue that needs to be resolved before implementation of lung cancer screening can proceed. The questionnaire was administered in Dutch. An English translation, intended for reference purposes, is included in Supplementary Material 3. Level of education and smoking behavior were derived from the baseline questionnaire completed upon enrolment in the study.

Focus group

Two focus groups were organized in August 2024 in two of the Dutch screening sites with a subsample of participants who completed the questionnaire. During completion of the additional questionnaire, participants were asked whether they were willing to participate in a focus group. Based on these responses, groups were formed. Both men and women across all SES groups were represented. Participants were contacted approximately two weeks prior to the scheduled sessions via email invitation. The two groups consisted of 5 and 9 participants from the trial, all have had at least one CT-scan. Each focus group lasted 60 min and was facilitated by two researchers (J. H. and C. A. – public health researchers). All sessions were audio-recorded with participants' consent. In addition, one of the moderators took detailed notes during the discussions to capture non-verbal interactions and group dynamics. During the focus groups, each participant was provided with a brochure containing various images, which were discussed throughout the session. All participants received financial compensation for their participation in the focus group (a voucher worth €25,-). Only key quotations were translated from Dutch into English.

The aim of the focus groups was to further explore the recruitment preferences of participants regarding

how they would like to be informed about a lung cancer screening program, what information is relevant, what are potential facilitators and barriers for participating in a lung cancer screening program with additional and in depth questions.

The integration of the additional questionnaire about recruitment preferences and focus groups within the primary RCT is depicted in Fig. 1.

Statistical data analysis questionnaire

For statistical analysis in this sub-study, a three-level classification of SES has been established based on self-reported level of education responses in the baseline questionnaire, using the Dutch Standard Educational Classification 2021 [8]: the low, middle, and high category. Low educational level: primary education, lower secondary general education, or lower vocational education; middle educational level: intermediate vocational education or higher secondary education; high educational level: higher vocational education or university. Baseline characteristics were summarized, and differences in distribution of nominal or categorical variables (non-normal distribution) (e.g., sex, SES, smoking status, recruitment method, and screening status) were analyzed using Pearson's chi-square test. Differences in distribution of ordinal or continuous variables (non-normal distribution) (e.g., age, pack-years, and $PLCO_{m2012}$ NoRace risk) were conducted using the Mann–Whitney U-test. SPSS software, version 28, was used to perform the analyses.

Qualitative data analysis focus group

The qualitative data obtained from the focus groups were analyzed using a thematic analysis approach [23]. Recordings were transcribed and cross-checked against the notes to ensure accuracy and completeness. Patterns and recurring topics were systematically explored to develop preliminary themes both within and across focus groups. To enhance the trustworthiness of the qualitative analysis, two researchers independently coded the focus group data and compared the coding frameworks to ensure consistency. Any differences in interpretation were discussed until consensus was reached. Finally, the findings were organized and reported with attention to both the collective dynamics of the group discussions and the individual perspectives shared by participants.

Results

Questionnaire

Baseline characteristics are presented in Table 1. A total of 479 (56.5%) out of 848 selected participants completed the questionnaire of whom 60.5% were men and the median age at completing the questionnaire was 69.0 years (IQR:7.0), with a median $PLCO_{m2012}$ NoRace

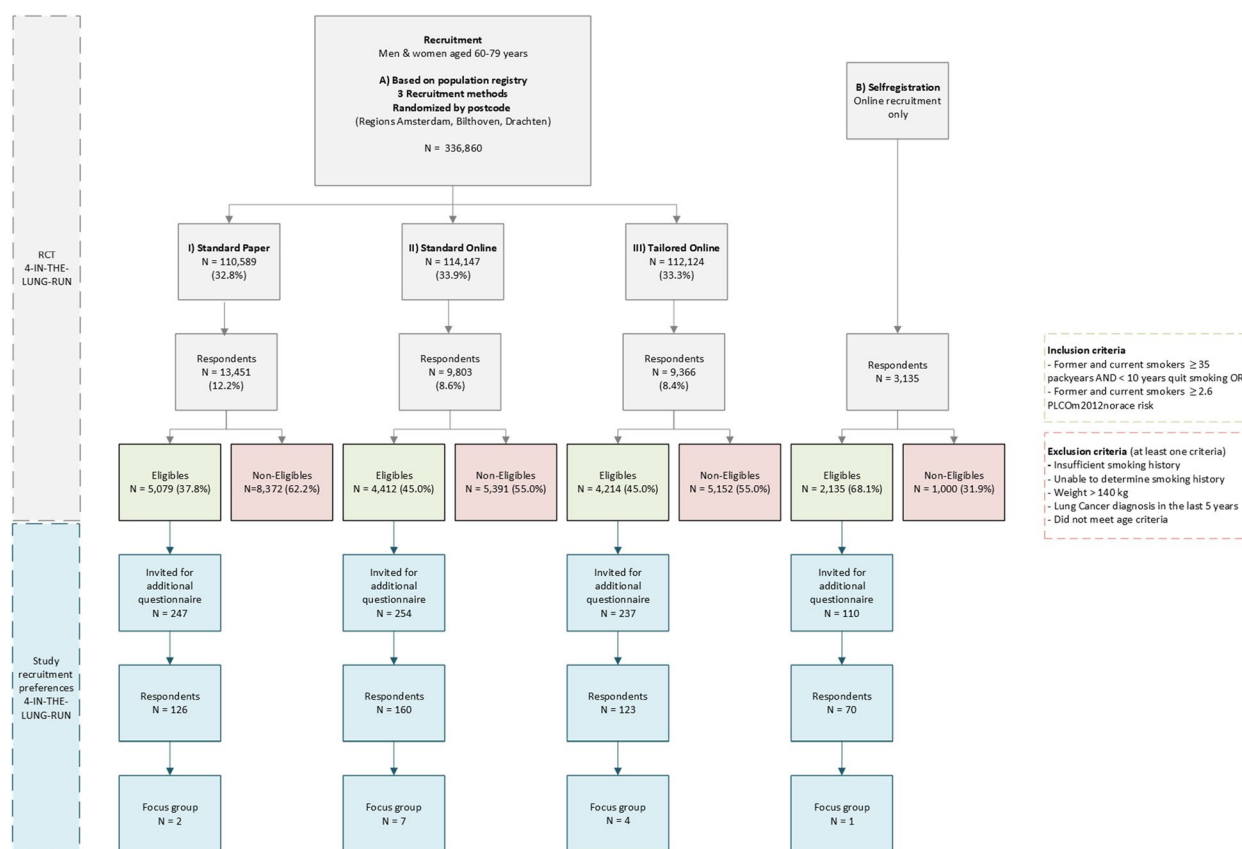


Fig. 1 Relationship between the RCT 4-ITLR and the sub-study of recruitment preferences. This figure illustrates how the assessment of recruitment and communication preferences was embedded within the larger randomized trial. Grey boxes represent the general flow of the primary RCT, while blue boxes indicate the components related specifically to the assessment of communication preferences

risk of 4.4% (IQR:3.4) and a median smoking history of 45.0 (IQR:20.0) pack-years. Overall, almost two thirds (64.5%) of the respondents are individuals who formerly smoked cigarettes. Most of the respondents (82.7%) reported that they visit their GP at least once a year, while almost a quarter (24.0%) visited their GP at least every 3 months or more often. Women tend to visit their GP more often than men (86.8% versus 80.0%, respectively, $p=0.071$). Almost all respondents (97.1%) stated that they are using digital technologies at least every week, 91.2% even use it on a daily basis, what might be related to the fact that the questionnaire was an online questionnaire. No differences in SES and sex were found in the use of digital technologies. 81.2% of respondents consistently participate in colorectal cancer screening. Among women, 86.3% participate in breast cancer screening, and 55.3% in cervical cancer screening.

Participation reasons for participation in lung cancer screening

The primary reasons for participants to participate in lung cancer screening include early detection of lung cancer (82.7%), a history of smoking (71.8%), contributing to

science (61.1%), contributing to society (31.1%), and for reassurance (26.3%). The presence of a smoking history is reported significantly more often as a participation reason among individuals with middle and high SES (74.8% and 80.1%, respectively) compared to those with low SES (59.2%) ($p<0.001$), without any differences by smoking status. Additionally, individuals with lower SES report significantly more often that the occurrence of lung cancer within their social network is a reason of participation compared to those with higher SES ($p=0.039$).

Furthermore, women significantly more often state fear of developing lung cancer as a reason for participation compared to men (20.6% versus 10.0%, $p=0.001$). Despite the small numbers, men reported that reassuring family members about their own health significantly more often as a reason for participation compared to women (4.1% versus 1.1%, $p=0.05$). No other sex-related differences were identified. Only 6.1% of participants state that the absence of lung symptoms is a reason for not participating.

Perceived importance of harms and benefits

The benefits of screening are substantially more important in the consideration to participate in lung cancer

Table 1 Baseline Characteristics of all Questionnaire Respondents by Sex (N = 479)

	Men (N = 290)	Women (N = 189)	Total (N = 479)	p-value [#]
Age				0.214
Median (IQR)—yr	70.0 (8.0)	69.0 (8.0)	69.0 (7.0)	
Distribution n/N(%)				
< 60 yr	0/290 (0.0)	0/189 (0.0)	0/479 (0.0)	
60–69 yr	142/290 (49.0)	100/189 (52.9)	242/479 (50.5)	
70–79 yr	139/290 (47.9)	87/189 (46.0)	226/479 (47.2)	
≥ 80 yr	9/290 (3.1)	2/189 (1.1)	11/479 (2.3)	
SES – Distribution n/N (%)				0.338
Low SES	90/290 (31.0)	67/189 (35.4)	157/479 (32.8)	
Middle SES	86/290 (29.7)	45/189 (23.8)	131/479 (27.3)	
High SES	114/290 (39.3)	77/189 (40.7)	191/479 (39.9)	
Smoking status n/N (%)				0.857
Current	102/290 (35.2)	68/189 (36.0)	170/479 (35.5)	
Former	188/290 (64.8)	121/189 (64.0)	309/479 (64.5)	
Pack-yr of smoking				< 0.001*
Median (IQR)	48.2 (22.6)	43.0 (18.3)	45.0 (20.0)	
PLCO _{m2012} NoRace risk				0.566
Median (IQR)	4.4 (3.7)	4.3 (3.2)	4.4 (3.4)	
Recruitment method n/N (%)				0.174
Standard paper	79/290 (27.2)	47/189 (24.9)	126/479 (26.3)	
Standard online	101/290 (34.8)	59/189 (31.2)	160/479 (33.4)	
Tailored	76/290 (26.2)	47/189 (24.9)	123/479 (25.7)	
Self-registration	34/290 (11.7)	36/189 (19.0)	70/479 (14.6)	
Screening Status [^]				0.164
Finalized	250/290 (86.2)	154/189 (81.5)	404/479 (84.3)	
In Transit	40/290 (13.8)	35/189 (18.5)	75/479 (15.7)	

[^]Finalized: participants who have already been screened. In Transit: participants who are ready to be screened

[†]Percentages may not total 100 because of rounding. IQR denotes interquartile range

[#]Group differences in SES, smoking status, recruitment method, and screening status were tested with Pearson Chi-Square, group differences in age, pack-yr, PLCO_{m2012}NoRace were evaluated with Mann–Whitney U

*Indicates statistically significant difference $p < 0.05$

screening relative to the harms (Fig. 2). Among 98.3% of participants, the primary benefit of participation is that early detection may lead to better treatment options. Furthermore, respondents indicate the reduced risk of dying from lung cancer (94.1%) and the less invasive treatment when detected early (92.4%) as highly important.

The likelihood of receiving a false positive result is perceived as a significantly more important harm by individuals with lower SES (88.5%) compared to those with middle and high SES (80.7% and 78.9%, $p = 0.032$). Additionally, women (78.3%) perceive the possibility of detecting untreatable lung cancer as significantly more concerning than men (63.9%, $p = 0.005$). A similar trend is observed among individuals with lower SES (74.4%) compared to those with middle and high SES (67.8% and 67.3%, $p = 0.005$). Women (46.7%) experiencing substantial more anxiety while awaiting screening results compared to men (3.1%, $p = 0.005$). Similarly, individuals with lower SES (49.6%) report higher levels of anxiety compared to those with middle and high SES

(36.4% and 28.5%, $p < 0.001$). Radiation exposure from the CT scan is perceived by participants as the least important harm, with only 31.0% of respondents indicating it as a concern.

Recruitment method preferences

Participants were allowed to select multiple options to the question regarding their preferred method of obtaining information. More than three-quarters of respondents (78.7%) prefer to be informed about the availability of lung cancer screening via email. This preference is significantly higher among individuals with middle and high SES compared to those with lower SES (83.2% and 84.3%, versus 68.2%, $p < 0.001$). 36.3% of the respondents indicated a preference for communication via paper. Of these 73% also considered digital communication to be an appropriate option. Only 9.8% ($n = 47$) expressed a desire to be contacted exclusively through a paper-based communication. This preference was primarily observed among individuals with a low SES, in

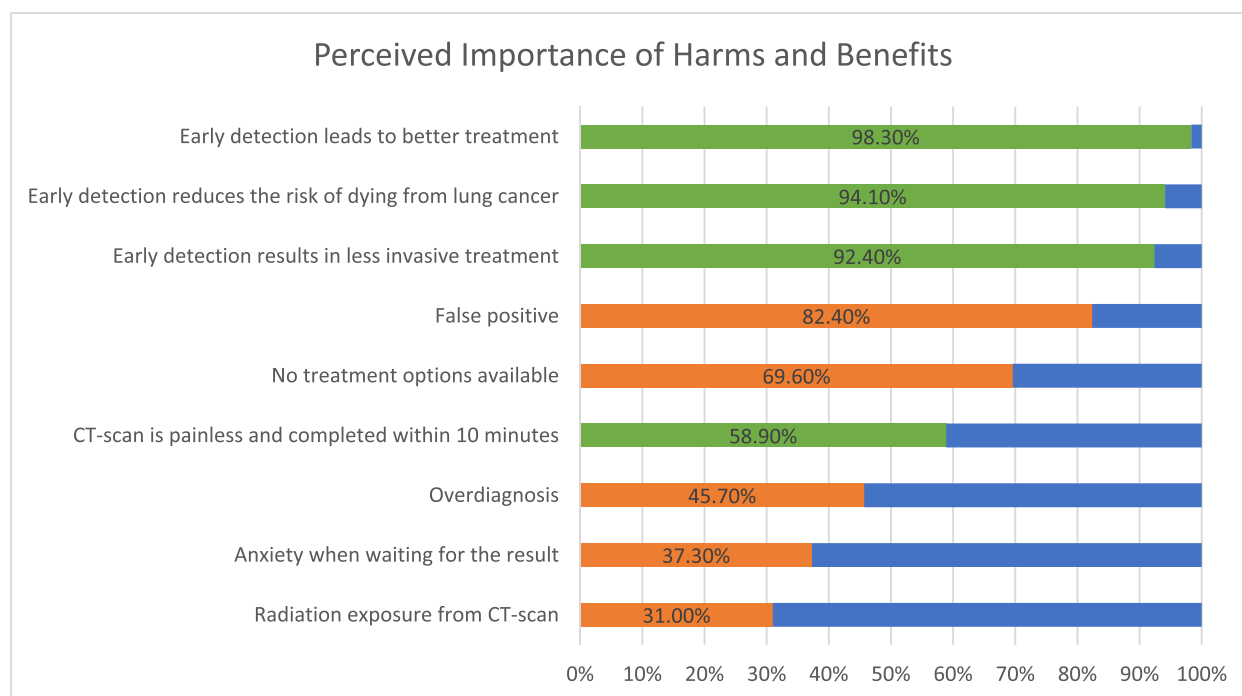


Fig. 2 The perceived importance of the harms and benefits of lung cancer screening. The green bars represent the importance of benefits for individuals, while the orange bars indicate the importance of harms. The blue bars indicate the proportion of participants who did not assign importance to the respective harm or benefit

comparison to those with middle or high SES (53.2% versus 23.4% and 23.4%). Results were comparable between sexes with 48.9% of men and 51.1% of women indicating this preference. Furthermore, a subsample of the participants expressed a preference for receiving information through their GP, with men showing a slightly stronger trend toward this method than women (22.1% versus 15.3%, $p=0.069$). Only two participants (0.4%) expressed a preference to receive information exclusively through their GP.

Visual representations

Most of the participants indicated that they do not prefer recruitment materials containing copious amounts of text. Women expressed this preference more strongly, whereas men were more likely to respond neutrally ($p=0.005$). No differences were found between SES groups in this regard. However, the low SES group (39.8%) report a preference for the inclusion of images slightly more often compared to the middle and high SES groups (27.4% and 31.2%), although not statistically significant ($p=0.180$).

Participants preferred numerical data to be presented in tables (46.3%) or graphs (48.0%) rather than through text (38.8%) or images (31.9%). While men were more likely to prefer numerical data presented in graphs compared to women (51.0% versus 43.4%, $p=0.004$), graphical presentation was the most preferred format among

both sexes. A similar pattern was observed for numerical data presented in tables, with men showing a higher preference (49.8% versus 41.0%, $p=0.003$), while the use of tables was indicated as second most preferred option by both sexes. A significantly higher proportion of the high SES group expressed a preference for numerical data presented in tables compared to middle and low SES groups (54.7%, versus 43.2% and 38.0%, $p=0.035$).

Men were significantly more likely to prefer the inclusion of an informational video compared to women (51.0% versus 43.4%, $p=0.004$). When a video is used, participants tended to prefer a video featuring real people rather than an animation video (72.6% versus 27.4%). No statistically significant SES differences were found for either of these aspects. The high and middle SES groups reported a higher preference for the inclusion of an infographic compared to the low SES (74.7% and 76.7%, versus 61.5%, $p=0.019$).

Participants were shown four different images depicting the location of lung cancer in the body (Fig. 3). A strong preference was indicated for image 4 (53.4%) followed by image 3 (19.7%), 2 (15.8%), and 1 (11.1%). The preference for image 4 was significantly more prominent among individuals with higher SES (58.2%) compared to those with middle (54.3%) and low SES (46.4%; $p=0.045$). However, image 4 was the most preferred across all SES groups. No differences were found between men and women. Furthermore, all participants expressed a

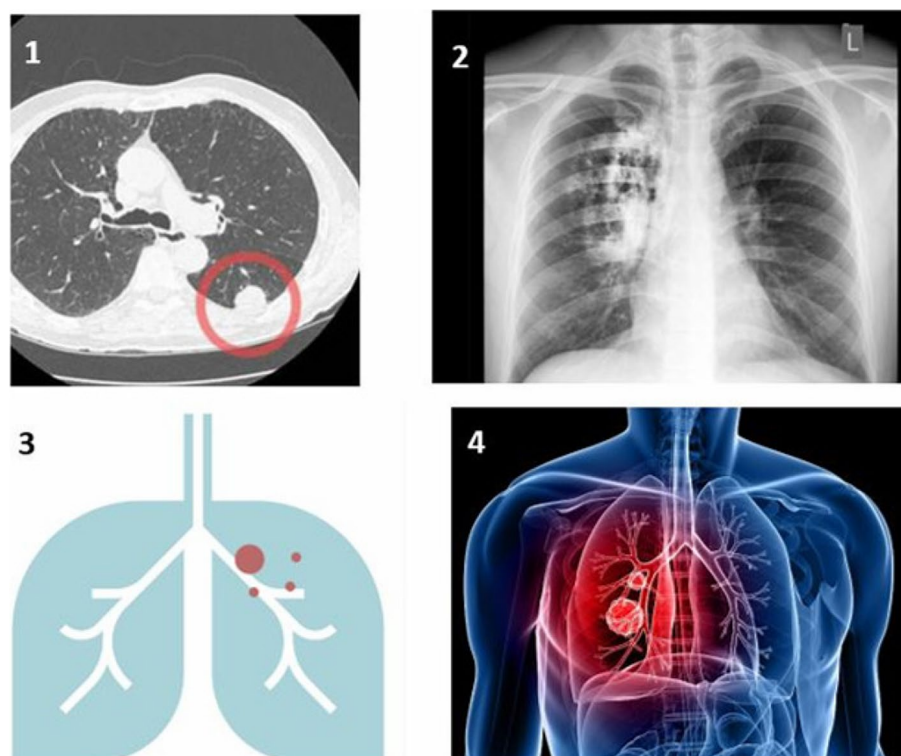


Fig. 3 Four different visual representations of lung cancer: including (1) CT-scan image with cross-sectional imaging, (2) frontal X-ray image, (3) simple schematic illustration, and (4) computer-generated animation. These representations highlight differences in depiction style and potential to use in participant education

preference for images featuring real people over animated figures, on the condition that such visuals do not contain stigmatizing elements such as depictions of cigarettes or smoking individuals.

Lifestyle advice

A total of 43.4% of participants indicated that they would appreciate the integration of lifestyle advice with screening, while 20% were uncertain, and 36.6% expressed no need for it. Men were more open to this option than women ($p=0.018$). The highest demand was for advice on alcohol consumption (30.1%), followed by healthy nutrition (26.5%), physical activity (26.5%), and mental health/relaxation (26.1%). 30.6% of the individuals who currently smoke cigarettes expressed a desire for smoking cessation advice. Despite the small numbers, men were more likely than women to seek advice on alcohol consumption (10.7% versus 5.3%, $p=0.039$). The need for mental health counselling was significantly higher among the low and middle SES groups compared to the high SES (32.5% and 29.8% versus 18.3%, $p=0.006$).

Screening location

87.2% reported that traveling up to 30 min to a screening location would not be an issue, with 31.9% even willing to travel up to one hour. Only 6.8% of the participants

indicated that a travel time exceeding 15 min would deter them from participating in screening. Additionally, 98.0% stated that travel costs would not prevent them from attending the screening. No significant differences in travel time or travel costs were found between both sexes and across SES groups.

Focus groups

Among 14 participants, 57.1% were men and the median age during the focus group was 71.5 years (IQR:6.0), with a median $PLCO_{m2012}$ NoRace risk of 4.12% (IQR:3.0) and a median smoking history of 43.0 (IQR:37.7) pack-years. Most focus group participants were individuals who formerly smoked cigarettes, some quit smoking years ago, while others quit smoking (very) recently. The characteristics of the focus group participants are shown in Table 2.

The majority of participants reported no issues with digital recruitment, particularly because it simplifies the process of returning the questionnaire compared to physically delivering a paper version to a mailbox in the neighborhood. One participant expressed these views:

'[I have a] preference for digital [recruitment], returning the questionnaire is easier that way.'
'It is a hassle that the informed consent form still had to be returned on paper.'

Table 2 Characteristics of the focus group participants

	Participants focus groups (N = 14)
Sex	
Men	8
Women	6
Age	
60–69	4
> = 70	10
Smoking status	
Current	2
Former	12
SES group	
Low SES	3
Middle SES	5
High SES	6

In contrast, some participants also noted advantages of the paper version. For instance, they appreciated that a paper invitation could be set aside, allowing them to take time to consider participation. Several participants mentioned that they were more likely to forget about the invitation if it was received digital solely. One participant stated:

'Paper versions can be set aside and picked up later. That way you're less likely to forget.'

Ultimately, one participant from the first focus group proposed the following suggestion, which was widely supported by the rest of the group. This proposal was subsequently presented to the second focus group, where the majority agreed.

'I would like to receive an invitation with a short leaflet and read the full information on a website.'

One participant further added that she primarily focuses on the key points, appreciating the availability of comprehensive information, but not considering it essential for her decision-making process:

'I only look at the main points.'

The researchers proposed an alternative approach in which relevant information would be provided step by step throughout the screening process. However, participants did not find this preferable. They expressed concern that if the information was not fully disclosed from the outset, it might discourage individuals from participating. As one participant articulated:

'Getting all information at once – there's a risk that people will not participate if the information is too brief.'

For most participants, potential harms associated with screening played little to no role in their decision to participate. While a few participants acknowledged being aware of radiation exposure, they indicated that this did not influence their choice. Two participants expressed this as follows:

'No harms that would keep me from participating, glad I could take part.'

'Radiation was considered, but in daily life there are also things you do without knowing everything about them.'

Nonetheless, participants reported experiencing anxiety during the three-week waiting period for the CT-scan results. One of the participants described this feeling as follows:

'The tension while waiting for the results remains; it is still uncertain.'

Regarding the information available at the time of study enrolment, participants unanimously agreed that all necessary details were provided. In particular, they highlighted that visual representations were valuable. Two participants expressed these views:

'A graphical display (infographic) is pleasant, better than a stack of paper.'

'The use of graphs is quite convenient.'

Finally, none of the focus group participants indicated that if lung cancer screening would be facilitated through their GP, this would influence their informed decision-making process. Several reasons were given, as illustrated by the following three participants:

'What is the benefit of the GP? I can fill it out myself.'

'Receiving information through the GP would not be an extra reason for me to participate.'

'So, you have to visit the GP; otherwise, you will not get the information.'

Discussion

Providing information tailored to individual preferences is essential to support informed decision-making regarding participation in lung cancer screening programs. The key challenge is to present comprehensive information that is both understandable and concise, ensuring accessibility for the target population. Individuals at high-risk for developing lung cancer are overrepresented in the lower SES group. However, this group is less likely to participate in screening, even though they might benefit the

most from early detection [6–8]. This study investigated the participation reasons and recruitment preferences regarding lung cancer screening, while taking SES and sex into account. Results showed that individuals from the high and middle SES groups express a clear preference for digital recruitment methods relative to the low SES group (84.3% and 83.2%, versus 68.2%). Whereas those in lower SES group still show a stronger need for at least some printed materials. Only 9.8% expressed a desire to be contacted exclusively through a paper-based communication. Preferences regarding the recruitment method were comparable between both sexes. Individuals are receptive to multiple methods of communication. Preferences for the kind of information, manner it is presented, and visual representations appear to be consistent across gender and SES, indicating a general uniformity in how materials should be designed. Notably, participants expressed a stronger desire for information highlighting the benefits of lung cancer screening. The current emphasis on potential harms was perceived as disproportionate relative to the actual impact these harms may have on participants.

A smoking history emerged as one of the primary personal motivators for participation. This aligns with findings by Lin et al. (2022), who demonstrated a personal history of smoking as a major facilitating factor associated with increased uptake in lung cancer screening [12]. Participants from middle and high SES groups cited their history of smoking more frequently as a reason for participation than those from a lower SES background, potentially due to higher awareness of smoking-related health risks among more educated individuals. Conversely, participants from lower SES group were more likely to report participation due to experiences with cancer within their social network. Given the higher prevalence of lung cancer in low SES populations, coupled with increased social interaction within similar SES groups in their environment, the likelihood of personal exposure to individuals diagnosed with lung cancer might be elevated. Previous studies have also indicated that having a family history of lung cancer can positively influence uptake, although in some cases it may act as a barrier [12, 13].

Perceived benefits of screening were consistently reported as a decisive factor for participation, both in questionnaire responses and during the focus group discussions – findings that are in line with earlier research [12]. These benefits were regarded as more important than potential harms by the majority of participants. Consistent with previous findings, participants considered overdiagnosis and radiation exposure to be less important potential harms of lung cancer screening, and these harms would not deter them from participation. On the other hand, false-negative results were perceived as the most important harm by participants [18]. These

converging findings highlight that the primary concern lies with the accuracy of the screening test.

Although previous studies have shown that psychological factors, such as fear of being diagnosed with lung cancer, can reduce screening uptake [12, 13], this study found that fear also could act as a motivator. Specifically, 20.6% of women and 10.0% of men indicated that fear prompted them to participate, rather than deter them. Only 4.2% of the responders cited fear as a reason for non-participation. Nevertheless, this does not imply the absence of fear. Participants, especially women (46.7%), reported heightened anxiety while waiting for their results. These findings suggest that this waiting period should be kept as short as possible. Acknowledging and mitigating fear-related concerns in recruitment material can increase screening uptake in more deprived areas [11]. Additionally, both questionnaire and focus group findings revealed a strong preference for receiving result by email rather than by postal mail. Accommodating this preference may abbreviate participant anxiety by eliminating postal delays and enabling faster delivery. In addition, this approach may also contribute substantially to reducing costs. Whereas Lin et al. identified the presence of respiratory symptoms as a facilitator for participation [12], in the present study, only 6.1% of participants indicated that the absence of such symptoms would be a reason not to participate. This suggests that the information provided effectively conveyed that screening is intended for individuals without respiratory complaints.

Previous focus group studies have produced mixed results regarding the role of the GP. One study found a strong desire among women to receive information via their GP [19], while another reported discomfort with GP involvement, citing concerns about unequal treatment [13]. Our findings from the focus group and questionnaire data align with the latter: only 19.4% of the participants in our study expressed a preference for receiving information through their GP, with only 0.4% indicating that they would want to receive information solely via this channel. The observed differences in preferences regarding GP involvement may be explained by variations in the general role and responsibilities of GPs across countries. However, GPs can significantly contribute in the risk-based selection of the target population [24].

The use of videos as a recruitment strategy has yielded inconclusive results [21, 22]. A potential explanation could be the type of video used during those studies. In our study, participants clearly preferred videos featuring real people (72.6%) over animated videos. In communications directed at participants, the use of medical imaging (e.g., CT scans or X-rays) should be avoided, as such visuals may be too complex for the target population. There is a clear preference among participants for simplified visual representations.

The findings from this study indicate that individuals from the low and middle SES group report a significantly greater need for lifestyle advice related to mental health. These groups often experience a higher burden of psychosocial stressors, such as financial insecurity, relationship stress, perceived inequality, and serious problems within the family, which compound the challenges associated with smoking cessation [25]. Introducing mental health support within lung cancer screening could help to alleviate some of these underlying stressors. This may enhance individuals' capacity to engage in and adhere to smoking cessation. This study also shows that participants are open to receiving such support in the context of screening, highlighting a valuable opportunity to integrate mental health interventions into existing preventive care, particularly in the more deprived areas.

However, several limitations warrant consideration. A significant difference in the number of pack-years was found between male and female respondents. This may be explained by historical differences in smoking behavior between men and women within the age group studied. This difference is not expected to affect the results, as both sexes still belong to the very high-risk population. Given that our questionnaire was sent out digitally, individuals with adequate digital skills may have responded more often. However, the overall recruitment data from the 4-ITLR trial suggested that individuals with lower SES were still successfully reached. 43% of the participants who self-registered belong to the low SES group. Furthermore, of the more than 130,000 participants, a total of 74.3% provided their email address for digital communication. Since this question was optional, the actual number is likely even higher. It is also important to consider potential response bias during focus group discussions, where participants may have agreed with each other to avoid confrontation. This study specifically examined individuals identified as being at very high risk for developing lung cancer. However, national programs are expected to adopt broader eligibility criteria, incorporating lower risk thresholds and younger age parameters than those used in the current study [26]. Therefore, it is recommended that future research investigates the preferences of individuals at slightly lower risk, who nonetheless present an elevated risk of developing lung cancer. Furthermore, investigating the perspectives of those who choose not to participate could provide valuable insights, as non-participation could be affected by the recruitment strategies employed. Alternative approaches may improve engagement and enhance participation among these individuals.

Additionally, recruitment preferences were assessed within a Dutch population, where screening uptake (81.2% for colorectal cancer screening and 86.3% for breast cancer screening) and level of digitalization in general are relatively high. This might influence the

generalizability of our findings to other countries. Although large RCTs provide the strongest evidence for predicting population-level effects, inevitable differences between trial settings and nationwide implementation highlight the need for real-world evaluation.

Despite these limitations, this study has several strengths. The relatively large sample size and strong response rate provide a solid foundation for the analyses. Moreover, it addresses important questions regarding the implementation of lung cancer screening, distinguishing between sex and SES differences in recruitment preferences among high-risk individuals. Such differentiation has rarely been explored in previous studies, adding valuable nuance to the understanding of participation behavior in lung cancer screening. Furthermore, 4-ITLR has been recognized by Nature Medicine as one of the key clinical trials expected to shape the future of medicine [27].

Digital technologies have been shown to enhance informed decision-making and increase uptake in other cancer screening programs [20]. Similarly, in the context of lung cancer screening, informed decision-making was significantly higher among participants in the tailored online group compared to those who received the standard paper-based materials [28].

To develop effective recruitment materials for lung cancer screening, it might be recommended to use an interactive website that allows individuals to find information according to their personal needs. Providing a variety of digital tools (e.g., infographics, video (featuring real people), charts, tables, and decision aids) ensures accessibility across the target population without necessitating differentiation based on sex or SES. However, for the more deprived areas, it is advisable to include a brief printed leaflet with the invitation, as a preference for paper-based materials remains. Since additional printed materials are only necessary for a specific subgroup rather than the entire population, this approach can lead to substantially reduced costs. Furthermore, it addresses the preferences of the majority of individuals, ensuring greater alignment with their needs. Moreover, the balance between benefits and harms should be reconsidered to retain information on harms while presenting benefits in a way that makes them more explicitly presented. This approach supports adequate inclusion of high-risk individuals, in line with their preferences, and is likely to improve screening uptake, reduce lung cancer mortality, and contribute to reduce socio-economic health inequality.

Conclusions

The results of this study contribute to a better understanding of recruitment preferences among eligible participants for lung cancer screening. While societal attention is currently given to differences in sex and SES in research, it is also important to question the ethical

implications of determining an individual's preferred information based solely on sex. Such an approach risks reinforcing gender stereotypes, overlooking individual variation, and ignoring other influential factors such as education, health literacy, health performance status, and cultural background. Our findings indicate that recruitment for (lung) cancer screening should focus primarily on providing clear and concise information – independent of sex. A majority of participants prefer digital information delivery, and an interactive website represents an optimal solution that accommodates individual preferences. Nevertheless, maintaining the option of paper-based information for lower SES groups may be essential to ensure inclusive and equitable access.

Abbreviations

COPD	Chronic obstructive pulmonary disease
CT	Computed tomography
GP	General Practitioner
LDCT	Low-dose computed tomography
RCT	Randomized controlled trial
SES	Socioeconomic status
SN	Statistics Netherlands
4-ITLR	4-IN-THE-LUNG-RUN

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

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Authors' contributions

CA and HK contributed to project administration and funding acquisition. CA contributed to supervision and methodology. DM contributed to methodology and investigation. JH performed investigation, methodology, visualization and writing of the original draft. All authors contributed to conceptualization, had access to all data, interpreted the data, contributed to critical revisions, and read and approved the final version of the manuscript.

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Data availability

The data are not publicly available. The 4-IN-THE-LUNG-RUN trial only provides data access to qualified researchers with legitimate requests, based on a formal application and research proposal.

Declarations

Ethics approval and consent to participate

The 4-IN-THE-LUNG-RUN study protocol was reviewed and approved by the Dutch Minister of Health after a positive advice of the Dutch Health Council according to the Population Screening Act. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki, as well as all applicable guidelines and regulations. Written informed consent to participate in this study was provided by all participants.

Consent for publication

Written informed consent for publication was provided by all participants.

Competing interests

The authors declare no competing interests.

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