Effect of invitation letter in language of origin on screening attendance: randomised controlled trial in BreastScreen Norway

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ABSTRACT

OBJECTIVE
To explore attendance at organised mammographic screening among immigrant groups that received an invitation letter and information leaflet (invitation) in their language of origin and Norwegian compared with Norwegian only.

DESIGN
Randomised controlled trial.

SETTING
Population based screening programme for breast cancer in Norway (BreastScreen Norway), which invites women aged 50-69 to two-view mammographic screening biennially.

PARTICIPANTS
All women invited to BreastScreen Norway in the study period April 2021 to June 2022 whose language of origin was Arabic (women born in Algeria, Egypt, Lebanon, Iraq, Palestine, Sudan, Syria, Tunisia, or Morocco), English (women born in the Philippines), Polish (women born in Poland), Somali (women born in Somalia), or Urdu (women born in Pakistan) (n=11 347).

INTERVENTION
The study group received an invitation to screening in their language of origin and in Norwegian, whereas the control group received an invitation in Norwegian only during the study period.

MAIN OUTCOME MEASURE
Attendance at BreastScreen Norway during the study period.

RESULTS
Overall attendance was 46.5% (2642/5683) in the study group and 47.4% (2682/5664) in the control group. No statistical differences in attendance were observed after stratification by language of invitation, age at invitation, or years since immigration.

CONCLUSIONS
No difference in attendance was observed between immigrant women invited to BreastScreen Norway in their language of origin and in Norwegian compared with Norwegian only. Several barriers to cancer screening may exist among immigrants, and translating the invitation is probably only a part of a complex explanation.

TRIAL REGISTRATION
ClinicalTrials.gov NCT04672265.

WHAT IS ALREADY KNOWN ON THIS TOPIC

International health authorities recommend mammographic screening as secondary prevention to reduce mortality from breast cancer

Several studies have shown substantially lower attendance rates among immigrants compared with non-immigrants

Language has been suggested as a barrier to attendance, but the evidence for the effect of translated invitations and information is limited

WHAT THIS STUDY ADDS

This randomised controlled trial did not show any difference in attendance among immigrant women invited to BreastScreen Norway in their language of origin and Norwegian versus in Norwegian only

The invitation included an invitation and an information leaflet

Introduction

Breast cancer is the most common cause of death from cancer among women worldwide,[1] and international health authorities recommend mammographic screening as secondary prevention to reduce mortality from the disease.[2 3] However, screening is associated with both benefits and harms, and provision of information to women is recommended to enable them to make an informed decision about attendance.[4 5] Several studies have shown substantially lower attendance rates for mammographic screening among immigrants compared with non-immigrants.[6-11] A recent publication from Norway showed a rate of 56% among immigrants versus 78% among non-immigrants, with rates below 40% in some immigrant groups.[12] Similar differences in rates have been shown in other cancer screening programmes.[13 14] Furthermore, the rate of screen detected cancers has been shown to be lower and histopathological tumour characteristics less prognostically favourable among immigrants compared with non-immigrants, and even less favourable for immigrants from countries with low versus high incidence of breast cancer.[15] The reason for this might be related to early detection, emphasising the need for actions aimed at increasing attendance at screening among immigrants. This is relevant and important for patients because such actions signal that immigrant groups are seen and included and that their health is of value for the authorities. It is also relevant and important for carers as they try to overcome the challenges they regularly face when communicating across languages and cultures.

Studies from different countries have identified language as a barrier to screening attendance and to healthcare in general among immigrants.[16-19] Making information about screening available in different languages is thus proposed as a simple and cost effective action to increase knowledge about screening and attendance at screening among immigrants.[17-20] In most countries, including Norway, the information material and invitation letter to mammographic

screening are written in the official language of the country, regardless of the invited women's language of origin. As far as we are aware, only one study using translated information in mammographic screening has been published.[21] No effect on attendance was observed. However, this was a small study including 1032 participants. The effect of inviting women to mammographic screening by using immigrants' language of origin has not yet been investigated in a large scale randomised controlled trial.

To fill some of the knowledge gaps related to the effect of translated information on attendance at mammographic screening, we did a randomised controlled trial in which the primary aim was to compare attendance at BreastScreen Norway among immigrant groups who received an invitation letter and information leaflet in their language of origin and in Norwegian versus in Norwegian only. Our secondary aim was to study whether the potential effect differed across languages (Arabic, English, Polish, Somali, and Urdu). We hypothesised that translated invitations and information would increase attendance.

Methods

BreastScreen Norway started in 1996 and is a population based screening programme administered by the Cancer Registry of Norway. The programme invites all women in birth cohorts corresponding to the age range between 50 and 69 years at the start of the screening round with a Norwegian personal identification number to biennial two-view mammographic screening.[22] A personal identification number is given to all Norwegian inhabitants at birth or immigration. The Cancer Registry is responsible for tasks related to information, invitations, data collection, monitoring, quality assurance, quality improvement, and research. The annual attendance rate is 75%, and 84% of invited women have attended at least once since the programme started in 1996.[22] The recall rate for further assessment is about 3.5%, and 15-20% of the women recalled are given a diagnosis of breast cancer. The screening takes place at 26 stationary units and four mobile units. These units cover different geographical areas and are linked to 17 breast centres where interpretation of the screening mammograms and eventual further assessment, treatment, and follow-up take place.

Women targeted by the screening programme are identified through the National Population Register. The women are offered screening by a personal letter in Norwegian, which includes a scheduled time and place for examination. An information leaflet describing the benefits and harms of mammographic screening is enclosed with the invitation letter. One reminder is sent to non-attending women four to six weeks after the regular appointment, offering them an opportunity to schedule a new appointment by contacting the local breast centre. Immediately below the heading of the invitation letter are instructions in English about how to get further information in other languages.[23] The invitation letter and leaflet have been available in Arabic, English, Polish, Somali, and Urdu on the Cancer Registry of Norway's website since January 2021.[22]

Data on immigration to Norway were available from the National Population Register, which uses data

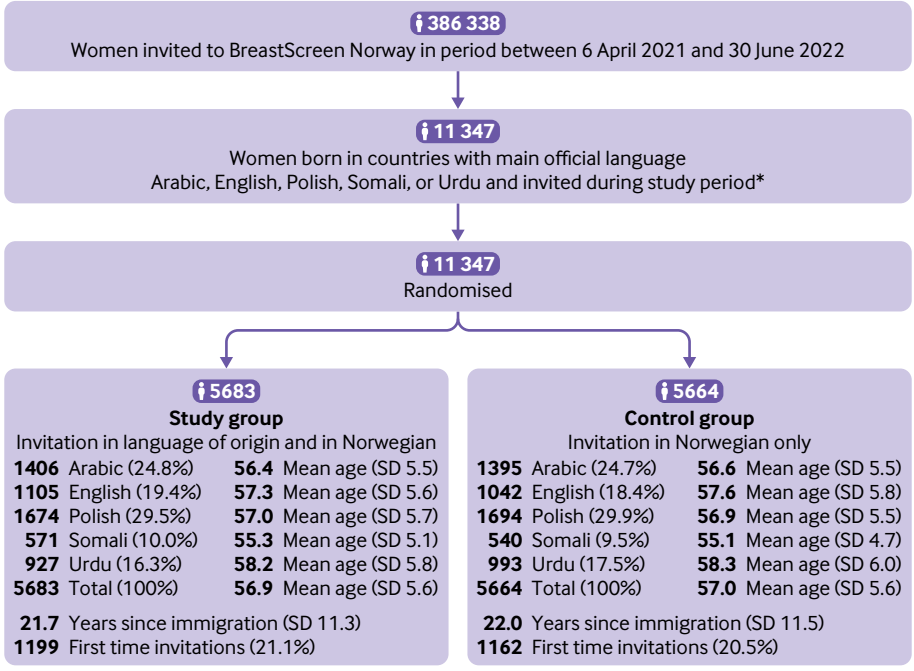

Fig 1 | Characteristics of study population in randomised controlled trial comparing attendance among immigrants receiving invitations to BreastScreen Norway in language of origin of their country of birth and in Norwegian versus control group receiving invitations in Norwegian only. *Language of origin and country of birth: Arabic—Algeria, Egypt, Iraq, Lebanon, Morocco, Palestine, Sudan, Syria, and Tunisia; English—Philippines; Somali—Somalia; Polish—Poland; Urdu—Pakistan. SD=standard deviation

from Statistics Norway. These data are included in the Cancer Registry database and updated every month. On the basis of this information, we defined immigrants as women with a registered date of immigration to Norway before 31 October 2020 and a registered country of birth outside Norway.

Study design

We conducted a large scale, two armed, superiority, randomised controlled trial with a one-to-one allocation ratio within BreastScreen Norway. We identified country of birth for all women with registered immigration before 31 October 2020. We established five language groups and randomised women within each group to receive a postal invitation letter, leaflet, reminder, and screening result letter in their language of origin and in Norwegian (study group) or in Norwegian only (control group). Women not included in the trial were invited according to normal procedures. The envelope was the same for the study and control groups—white, in A5 format, with a window showing the woman's name and address and the logo of BreastScreen Norway. The women's personal identification numbers were de-identified before randomisation and pseudonymised to the researchers throughout the study period.

A professional agency translated the invitation letter, leaflet, result letter, and reminder from Norwegian into different languages before the translations were quality assured by health professionals and women in the target group. We did a pilot of the trial, including the technical part of the randomisation process and sending of the invitation letters, in the first quarter of 2021. To ensure that women received the correct letters, the Cancer Registry contacted 10 randomly selected women by phone. The pilot did not include results on attendance. The pilot did not reveal any errors.

Study population

We used results from a study conducted with data from BreastScreen Norway, showing lower attendance rates for all immigrant groups compared with non-immigrants,[12] to choose the study population for this randomised controlled trial. We selected five non-Scandinavian languages used by populous immigrant groups with low attendance rates in BreastScreen Norway: Arabic for women born in Algeria, Egypt, Iraq, Lebanon, Morocco, Palestine, Sudan, Syria, and Tunisia; English for women born in the Philippines; Polish for women born in Poland; Somali for women born in Somalia; and Urdu for women born in Pakistan (fig 1). For convenience, we chose for women from the Philippines to receive invitations in English, as English and Filipino are equally used as official languages in the Philippines.[24] We assigned the women to a language with the assumption that they read and understand the major official languages of their country of birth. The inclusion period was set to nine to 12 months. However, owing to the covid-19 pandemic, which led to cessation and delay in invitations, we extended the study period and included women invited to BreastScreen Norway between 6 April 2021 and 30 June 2022 in the study population. We followed the women for attendance six months after their regular scheduled appointment. Figure 1 describes study and control populations in terms of numbers, age at invitation, years since

Table 1 | Attendance at BreastScreen Norway among immigrants born in countries with Arabic, English, Polish, Somali, or Urdu as language of origin, stratified by type of invitation to screening programme

	Study group*			Control group†		
		Attended			Attended	
	No invited	No	% (95% CI)	No invited	No	% (95% CI)
All invitations						
Arabic	1406	677	48.2 (45.9 to 50.8)	1395	657	47.1 (44.5 to 49.8)
English	1105	671	60.7 (57.8 to 63.6)	1042	634	60.8 (57.8 to 63.8)
Polish	1674	785	46.9 (44.5 to 49.3)	1694	811	47.9 (45.5 to 50.3)
Somali	571	139	24.3 (20.9 to 28.1)	540	135	25.0 (21.4 to 28.9)
Urdu	927	370	39.9 (36.7 to 43.1)	993	445	44.8 (41.7 to 48.0)
Total	5683	2642	46.5 (45.2 to 47.8)	5664	2682	47.4 (46.0 to 48.7)
Ordinary invitations						
Arabic	1406	581	41.3 (38.7 to 43.9)	1395	566	40.6 (38.0 to 43.2)
English	1105	614	55.6 (52.6 to 58.5)	1042	571	54.8 (51.7 to 57.9)
Polish	1674	706	42.2 (39.8 to 44.6)	1694	739	43.6 (41.2 to 46.0)
Somali	571	112	19.6 (16.4 to 23.1)	540	116	21.5 (18.1 to 25.2)
Urdu	927	301	32.5 (29.5 to 35.6)	993	372	37.5 (34.4 to 40.6)
Total	5683	2314	40.7 (39.4 to 42.0)	5664	2364	41.7 (40.4 to 43.0)
Reminders						
Arabic	825	96	11.6 (9.5 to 14.0)	829	91	11.0 (8.9 to 13.3)
English	491	57	11.6 (8.9 to 14.8)	471	63	13.4 (10.4 to 16.8)
Polish	968	79	8.2 (6.5 to 10.1)	955	72	7.5 (5.9 to 9.4)
Somali	459	27	5.9 (3.9 to 8.4)	424	19	4.5 (2.7 to 6.9)
Urdu	626	69	11.0 (8.7 to 13.7)	621	73	11.8 (9.3 to 14.6)
Total	3369	328	9.7 (8.8 to 10.8)	3300	318	9.6 (8.7 to 10.7)

CI=confidence interval.
*Invitations in language of origin and in Norwegian.
†Invitations in Norwegian only.

Table 2 | Attendance at BreastScreen Norway among immigrants born in countries with Arabic, English, Polish, Somali, or Urdu as language of origin, stratified by first time (prevalent) and subsequent invitations to screening programme

	Study group*			Control group†		
		Attended			Attended	
Type of invitation	No invited	No	% (95% CI)	No invited	No	% (95% CI)
Prevalent invitations	1199	570	47.5 (44.7 to 50.4)	1162	561	48.3 (45.4 to 51.2)
Subsequent invitations	4484	2072	46.2 (44.7 to 47.7)	4502	2121	47.1 (45.6 to 48.6)
Total	5683	2642	46.5 (45.2 to 47.8)	5664	2682	47.4 (46.0 to 48.7)

CI=confidence interval.
*Invitations in language of origin and in Norwegian.
†Invitations in Norwegian only.

immigration, and the proportion of women invited for the first time.

We did power calculations for two independent sample proportions with a statistical power of 0.8 and significance level of 0.05. The effect size was 3% for all five groups and 10% for each immigrant group. See supplementary methods and supplementary table A, which also describe the lowest statistically significant increase achievable in attendance in the study group versus the control group.

Variables of interest

In addition to country of birth and the intervention variable—invitation letter, information leaflet, result letter, and reminder in different languages—hereafter referred as the invitation, we extracted information about age at invitation, county of residence, date of screening invitation, and invitation type (regular/reminder) from the Cancer Registry of Norway. The outcome variable was attendance at BreastScreen Norway. We extracted the date of invitation and attendance (yes/no) from the Cancer Registry database. On the basis of these data, we created variables on first time (prevalent) invitations and subsequent invitations and history of attendance in BreastScreen Norway.

Statistical methods

All data used in statistical analyses were pseudonymised. We presented attendance as frequencies and proportions among the invited women. We used a test of proportion to calculate 95% confidence intervals and a t test to estimate the P value to compare the means of the study and control groups, considering a value <0.05 to be statistically significant. We considered age at invitation and years since immigration as continuous variables and presented them as means with standard deviations. We used a binomial test to calculate odds ratios and 95% confidence interval for attendance, using the control group as reference. We used Stata version 17.0 for Windows for randomisation and all statistical analyses.

Patient and public involvement

Laywomen and women from non-governmental organisations representing various immigrant groups in Norway and healthcare personnel originating from the countries included in the trial were involved in the process of quality assuring the translations of the information. The Norwegian Cancer Society supported the study with a grant but was not involved in the planning, performance, data collection, or interpretation of the results.

Results

Attendance at BreastScreen Norway before, during, and after the study period, which also covered the covid-19 pandemic period, for the five immigrant groups and non-immigrants is shown in supplementary table B. The overall attendance during the study period was 46.5% (2642/5683) in the study group and 47.4% (2682/5664) in the control group (table 1). Regular invitations resulted in 40.7% (2314/5683) attendance in the study group and 41.7% (2364/5664) in the control group. The attendance after reminders was 9.7% (328/3369) in the study group and 9.6% (318/3300) in the control group. No differences were statistically significant.

Women born in Somalia had the lowest attendance: 24.3% (139/571) in the study group and 25.0% (135/540) in the control group. Women born in the Philippines had the highest attendance: 60.7% (671/1105) in the study group and 60.8% (634/1042) in the control group (table 1).

Women in the study group with first time invitations to BreastScreen Norway had an attendance of 47.5% (570/1199), compared with 48.3% (561/1162) in the control group (table 2). When we stratified by language groups, we found 35% (53/152) attendance in the study group and 51% (90/177) in the control group among women born in Pakistan with first time invitations (supplementary table C).

We observed no differences in attendance for the study versus the control group when we stratified by age groups (fig 2). Furthermore, we observed no difference in attendance between the study and control groups after stratification by residential time in Norway.

We found no statistical difference in attendance between the breast centres (supplementary table D). The attendance was 41.1% (690/1678) for women in the study group residing in Oslo, the capital, compared with 42.7% (733/1717) in the control group. For women residing outside Oslo, 48.7% (1952/4007) of the women in the study group and 49.4% (1949/3947) in the control group attended.

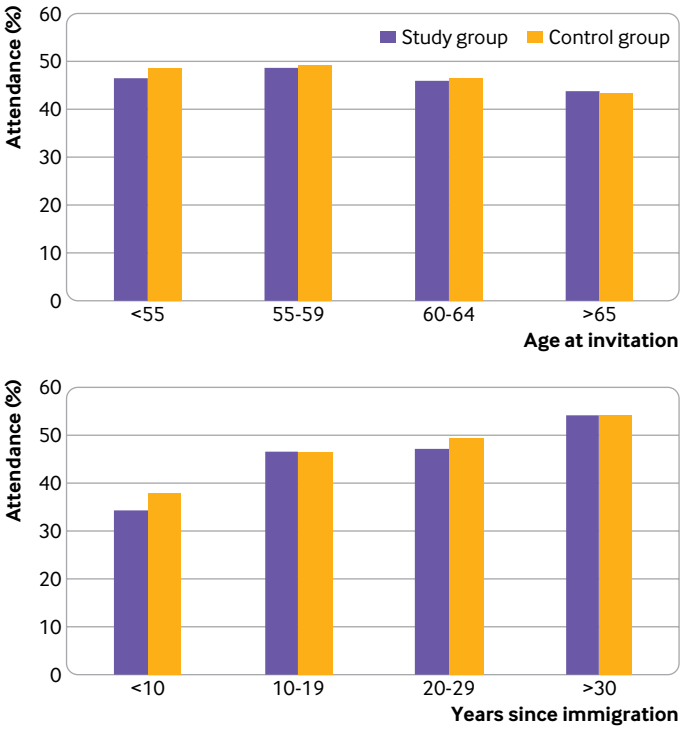

Fig 2 | Attendance at BreastScreen Norway among immigrants born in countries with Arabic, English, Polish, Somali, or Urdu as language of origin; percentage of participating women in intervention group receiving invitations in their language of origin and Norwegian and percentage in control group receiving invitations in Norwegian only, stratified by age at invitation, and by years since immigration

Discussion

In this large scale randomised controlled trial, we observed no difference in attendance between the study group, in which immigrants received an invitation in their language of origin and in Norwegian, and the control group, in which the women received an invitation in Norwegian only; therefore, the null hypothesis was not rejected. The results remained stable after stratification by country of birth, age at invitation, and years since immigration.

Strengths of study

Provision of translated information has been suggested to be a key factor to increase attendance at cancer screening among immigrants,[17-20 25 26] and we did our study as a result of a qualitative study in BreastScreen Norway that concluded that translated information might be a cheap and simple solution to reach these women and increase uptake.[27] That our intervention did not increase attendance is therefore disappointing. Limited high quality studies have shown an effect of translated information on participation in cancer screening programmes.[18 21] Our study represents a large population based randomised controlled trial with high quality data. Five large immigrant groups in Norway, including women with different residential time in the country, participated in the study. The personal identification number given to all people in Norway at birth or immigration made reaching the entire target population possible.

Limitations of study

Inclusion in the trial was based on information about women's countries of birth. We stratified the analyses by residential time in Norway. However, the study sample was not powered to show statistical differences in subgroup analyses (see supplementary methods and supplementary table A). Another limitation of the study was the lack of information about sociodemographic and other factors that might influence attendance.[28 29] Sociodemographic factors are known to influence attendance at mammographic screening. A study from BreastScreen Norway has shown that being an immigrant, and an immigrant from certain countries, having a low educational level, having a low income or being unemployed, not being married or being a widow, and residing in the capital of Norway were associated with low attendance rates.[28] We believe that sociodemographic factors did not differ between the study and control groups in our randomised controlled trial.

We assumed that all women participating in the study group and the control group opened the invitation letter. We did not measure the number of women who opened the envelope but did not attend. The envelope with the invitation was identical for the study and control groups. Hence, women in the study group did not get an indication that the information inside was translated. They had to open an envelope with a Norwegian logo to access translated information. A printed text or logo in the language of origin might have inclined more women to open the envelope. However, translated information was publicly available online from January 2021, three months before the study period started. We considered postponing making the translated information available online but decided to make the information available online for all and thus run this trial in a real screening setting.

We had no information about the women's actual mother tongue or level of literacy, and we were not able to consider dialects or other variations of the languages for the individual woman. This may be a limitation for some of the language groups—for example, the group defined as "Arabic," as ethnic minority groups may not speak or understand Arabic, and others might be unfamiliar with the written classic Arabic that we used. However, as our results were the same across all languages included, we do not consider this to have critically altered the outcome. We consider the generalisability of the study to be high for the immigrant groups residing in western countries, as the culture and healthcare systems differ substantially from what most of the women are used to.

We conducted the study during and after the covid-19 period, when the screening programme was closed for some weeks. However, we assume that the pandemic did not influence attendance differently among women in the study group and the control

group. This assumption is supported by the fact that we were not able to show any clinically relevant difference in attendance at the screening programme in that period (supplementary table B).

Possible reasons for results

Attendance at screening is dependent on skills determining motivation and capability to understand and use information that promotes and maintains good health, which is related to health literacy.[17 19 30] An increased level of health literacy might be achieved by translated and adjusted information, bilingual health professionals, collaboration with governmental and non-governmental organisations, and outreach activities.

Being able to read and understand written information is only a part of health literacy and does not necessarily imply that readers have resources, possibilities, or values and beliefs that enable them to make an informed decision about participation or act in accordance with the intention of the sender. Parts of the immigrant society face public health challenges as a result lower health literacy compared with the general population.[17 19 31] This is reported to have been reinforced during the covid-19 pandemic.[32 33] Experiences from the Nordic countries have shown that translating information into languages of the target groups was not effective as the only measure.[33] Direct translation presents challenges as language indirectly communicates culture and rules and implies an understanding of these codes. Wording, colours, illustrations, and graphic design should thus be carefully considered.[34] Furthermore, communication channels seem to be essential, and one-to-one or oral communication might be preferred in some groups. However, the costs of such efforts are high. The desire for the participants to make an informed choice might be a high demand, especially for immigrants and those with low health literacy.

We expected higher attendance in the study group than in the control group, but this hypothesis was rejected. The study was powered to show a 10% or greater increase in attendance for each language group. The recruitment period continued for a longer period and included more women than planned, to get the numbers needed to show even smaller differences between the two groups, without success. We found great variation in time since immigration between and within the groups, but no information about individual reasons for immigration was available. We assume that these factors might contribute to the complexity of reasons for our findings.

Findings in different language groups

Women born in the Philippines had the highest attendance among the groups in the study. Most Filipina women living in Norway who enter into marriage get married to Norwegian men.[35] Their Norwegian husbands and family members might help them to navigate the system and influence their trust in the healthcare system. We question whether this explains why an intervention with translated information did not have any additional effect on this group.

In our study, Pakistani women formed the group with the longest residential time in Norway. However, they were also among the groups with the lowest attendance. In a qualitative study, Pakistani women stated several reasons for not attending mammographic screening and that receiving information in Norwegian, despite them not understanding the language, did not alone prevent their attendance. This was also the case for some of them who were illiterate and used their family and friends for translation.[27] Our trial confirmed that language problems were not likely to be the primary obstacle to attendance among Pakistani immigrants living in Norway. Pakistani women in Norway have many descendants and a high number of health professionals from their community.[35] This may suggest access to family and friends for assistance with translation and navigating the Norwegian healthcare system, which might be one reason for why translated information in Urdu did not increase attendance. Some Pakistani women reaching a certain age might alternate between living in Norway and Pakistan for longer periods and thus do not attend the screening programme.[36] To our surprise, we found higher attendance in the control group than in the study group among prevalent invited women born in Pakistan. The number of women invited was small—152 in the study group and 177 in the control group. We have no explanation for this finding and consider it random.

Polish people make up the largest non-Scandinavian immigrant group in Norway. Most are migrant workers, and in 2017 about half of them had lived in Norway for less than five years[35]; they may thus be less familiar with healthcare services in Norway than in Poland. Studies have shown that immigrants from Poland living in Norway want information about cancer and screening and that they request information translated into Polish.[37 38] Some Polish immigrants have their colonoscopy, as a screening tool for colorectal cancer, performed in Poland. This is, among other reasons, due to higher trust in and familiarity with the Polish compared with the Norwegian healthcare system and being able to communicate in their language of origin.[37] These explanations may also be relevant for breast cancer screening. Trust in the Polish healthcare system, the convenience of speaking a known language, and the short and easy travel between Norway and Poland might outweigh the potentially positive effect of receiving translated information. We thus wonder whether receiving information in Polish about BreastScreen Norway prompted them to seek mammography screening in Poland.

A large proportion of the Arabic and Somali communities in Norway have arrived as refugees after 1990.[35] Cancer prevention might not be a priority given limited resources in their country of origin and less developed health services than in Norway and Scandinavia.[39] Also, Somali immigrants have faced some difficulties regarding discrimination and

integration in Norway, which may have reduced their trust in the authorities.[40]

Possible policy implications

On the basis of the results of this trial, no reason exists to expect that translated information alone will increase attendance at BreastScreen Norway for immigrant women in the future. Several aspects of the screening programme should be considered to facilitate a higher attendance among immigrant women, such as guaranteed access to female radiographers and the use of an interpreter service.[41] A guarantee of a female radiographer is difficult to give in Norway, and the interpreter service is challenging in a screening setting. However, the screening programme strives to adapt arrangements for the individual participant.

Studies have reported that knowledge about cancer screening is associated with increased screening attendance.[10 20] Various cultural beliefs, including views on women, women's health, and cancer prevention and screening, and immigrants' trust in the healthcare system in a foreign country, could differ between the immigrant groups and between immigrants and non-immigrants.[26 27 42 43] Lack of trust and awareness of cancer screening might also be linked to low or no education.[28]

Preventive health services, including breast cancer screening, are less common in low and middle income countries where many of the women were born and raised.[2] These factors can be obstacles to establishing the trust and knowledge needed to make an informed choice about attendance. However, some women might have understood the invitation letter and leaflet, in their language of origin as well as in Norwegian, but chose not to attend because of cultural or religious beliefs.[27 43] The fact that the incidence of breast cancer is lower among immigrants from low income countries may also undermine the importance of participation in screening.

Access to a health service implies more than availability of translated information or awareness of the service's existence. Accessibility has several dimensions including acceptability. The list of potential barriers includes, in addition to health literacy, sociodemographic, cultural, psychological, and migration related factors, travel distance, and healthcare system barriers.[2 26 41 44 45] The results of this study indicate that efforts other than translated information are needed to increase attendance. Future intervention studies should emphasise these aspects.

We involved lay people in parts of this study. In future studies, we will consider involving patients and people with different relations to the women, backgrounds, and positions in several parts of the studies with an aim of influencing decision making authorities and patient empowerment. Collaboration with public health services and initiatives might be beneficial for faster and more successful progress and implementation.[46-48]

Conclusions

Our randomised controlled trial did not show any effect on attendance at BreastScreen Norway among immigrants invited in their language of origin and in Norwegian, compared with in Norwegian only. The results were consistent across language groups, age, number of previous attendances at mammography screening, and years of residence in Norway. The results can provide a basis for future work aimed at increasing the availability of and attendance at breast cancer screening among immigrants, but also for authorities, healthcare systems, policy makers, users' organisations, and others involved in communicating health related information to immigrants. Our results indicate that among several barriers to attending breast cancer screening among immigrants, written language in the invitation is probably only part of a complex causal relationship.

Data from the Cancer Registry of Norway (CRN) have been used in this publication. The interpretation and reporting of these data are the sole responsibility of the authors, and no endorsement by CRN is intended nor should be inferred.

Contributors: All the authors took part in the study concepts/study design and data acquisition or data interpretation, manuscript editing, and approved of final version of the submitted manuscript. SH, NI, JET, and GM did the literature research. SH, NI, and JT did the statistical analyses, manuscript drafting, and manuscript revision for important intellectual content. SH is the guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Competing interests: All authors have completed the ICMJE uniform disclosure form at https://www.icmje.org/disclosure-of-interest/ and declare: support from the Cancer Society in Norway; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval: The study was approved by the Norwegian Directorate of Health for exemption from the duty of confidentiality according to § 29 b of the Health Personnel Act (# 20/33385-2). This study has a legal basis in accordance with Articles 6 (1) (e) and 9 (2) (g) and (i) of the GDPR. The data was disclosed with legal bases in the Cancer Registry Regulations section 3-1 and the Personal Health Data Filing System Act section 19 a to 19 h.

Data sharing: Research data used in the analyses can be made available on request, given legal basis according to the GDPR, Article 6 and 9, and that the processing is in accordance with Article 5, with additional national legal basis as per the regulations on population based health surveys.

The lead author (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Dissemination to participants and related patient and public communities: We will submit abstracts to national and international conferences and congresses and make summaries of the project and results of the study available for the women in the target group of the screening programme, the public, the professionals involved, health policy makers, and stakeholders. We will contact the media for attention and use Mammonett, an internal web page for professionals working in BreastScreen Norway, the website of the Cancer Registry of Norway, and the collaborators' official web pages, to inform women targeted by the screening programme, professionals working with screening, and the general population about the project. All results will be presented at an aggregate level, making identification of any individuals impossible.

Provenance and peer review: Not commissioned; externally peer reviewed.

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Web appendix: Supplementary materials