

# Effectiveness of a telehealth patient education intervention for breast cancer awareness and screening uptake among Afghan refugee women: a cross-sectional survey and feasibility study



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## Summary

**Background** Refugee populations have low levels of cancer awareness, low cancer screening rates, and a high rate of advanced or metastatic cancer at diagnosis. Educational interventions to improve cancer awareness and screening have been successful in other nationality refugee populations but have never been implemented in Afghan refugee populations. We aimed to estimate the level of breast cancer awareness among Afghan refugee women and test the feasibility of a telehealth breast cancer educational intervention to increase breast cancer awareness in this population.

**Methods** A cross-sectional survey of Afghan refugee women residing in Istanbul, Türkiye who had no personal history of breast cancer and who presented to outpatient primary clinics for care between August 1, 2022, and February 10, 2023 was performed. Participant awareness of breast cancer (BC) was assessed using the validated BC awareness tool, Breast Cancer Awareness Measure (BCAM), during a telehealth encounter. After this baseline assessment, a BC educational intervention was administered to each participant during the telehealth encounter. Six months after the initial assessment and education, a follow-up BCAM was administered via telehealth in order to determine the effectiveness of the education intervention.

**Findings** One hundred participants were accrued to the study. Median age was 49 years (range: 40–64). All participants had no formal education, were married, and were not employed. Prior to the educational intervention, BC awareness was low; none of the participants were able to identify some common signs/symptoms and risk factors for BC. Prior to the educational intervention, zero participants had ever had a mammogram or seen a physician for a breast-related concern. Six months after the educational intervention, up to 99 percent of participants (99 of 100 participants) were able to correctly identify common signs or symptoms and risk factors for BC. Six months after the educational intervention, all one hundred participants had accepted the offer of a screening mammogram.

**Interpretation** A telehealth BC education intervention meaningfully increased BC awareness in Afghan refugee women. This increase in BC awareness was associated with a strong increase in completion of BC screening. Further implementation of educational interventions is warranted in order to increase participant awareness and improve screening rates.

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**Keywords:** Afghanistan; Türkiye; Refugee; Global health; Breast cancer; Cancer awareness; Screening

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**Research in context****Evidence before this study**

On February 2, 2023, we performed a PubMed search for all publications, with no date limitations, using the search queries “refugee cancer awareness” OR “Afghan refugee cancer awareness.” Only a single prior quantitative study, also authored by our group, of this topic was identified. A limited number of qualitative studies of cancer awareness in refugees, each involving fewer than 100 participants, were identified, but none of these included only Afghan refugees.

**Added value of this study**

This study is the first to implement a cancer education intervention in an Afghan refugee population. After

implementation of the intervention, cancer awareness was markedly increased in this population. Furthermore, screening behavior was drastically increased after implementation of the intervention.

**Implications of all the available evidence**

Cancer awareness among refugee populations is low but can be dramatically improved with patient education interventions. Education interventions can lead to large improvements in screening rates in the educated population. These findings warrant more widespread implementation of cancer education programs in refugee populations.

**Introduction**

Refugee populations often suffer from poor health outcomes in multiple categories of human disease, including cancer, and frequently have decreased access to medical care compared to non-refugee populations.<sup>1</sup> The disparity in healthcare access and outcomes in refugee populations is multifactorial; low health literacy, language barriers, financial barriers, and lack of knowledge regarding where care can be obtained are significant contributors.<sup>2,3</sup> Refugee health programs typically focus on the prevention and treatment of infectious diseases, with fewer resources available for refugee-focused public health initiatives focusing on cancer and other noncommunicable diseases.<sup>3</sup> These disparities have fatal consequences: Refugee populations have abysmally low rates of cancer screening and, when diagnosed with cancer, overwhelmingly present with advanced-stage disease.<sup>4–10</sup> Refugee populations have lower cancer-related knowledge compared to both citizen and non-refugee immigrant populations in their host countries, and there is a correlation between lower cancer awareness and lower use of screening in these populations.<sup>11–14</sup>

Afghan people have comprised one of the world’s largest refugee populations over the past five decades, and this population has increased even more dramatically since the fall of the Afghan government in August 2021. The United Nations High Commissioner for Refugees estimates that 2.7 million Afghan citizens were refugees outside of their home country, and an additional 260,000 were asylum-seekers, as of December 2021.<sup>15</sup> With a refugee and asylum-seeker population of over 4 million, or over 15% of the world’s refugee and asylum-seeker population, the country of Türkiye is the world’s largest harbor of refugees and asylum-seekers.<sup>16</sup> The population of Afghan refugees and asylum-seekers in Türkiye has grown rapidly since the Afghan political crisis: 129,323 Afghan refugees and asylum-seekers were residing in Türkiye in 2020, but as of July 2021, conservative estimates placed that number at over

200,000.<sup>16–19</sup> Therefore, Istanbul, a large Turkish metropolitan, offers the opportunity to study Afghan refugees residing in the country in an urban setting.

Despite the significant size of the world’s Afghan refugee population, the existing literature on cancer-related public health initiatives in refugees is notably lacking in any significant representation of Afghan refugees. We recently completed the first-ever quantitative evaluation of breast cancer (BC) awareness among Afghan refugee women.<sup>20</sup> This study identified dismally low rates of BC awareness among a cohort of over four hundred Afghan refugee women. For example, of 11 different warning signs of BC, such as a breast lump or pain in the breast, 80–90 percent of respondents were unaware that the finding was a warning sign of cancer. Use of BC screening was nonexistent: zero of 420 women reported ever seeing a physician in their lifetime for a breast-related concern. Awareness of BC risk factors was also low, with 60–95% of respondents unaware of various risk factors such as nulliparity and alcohol use. The country of Afghanistan has no national screening program for breast, colon, or cervix cancer; no national cancer management guidelines; and only 0.5 public cancer centres per 10,000 cancer patients.<sup>21</sup> In contrast, the country of Türkiye has formal national cancer management guidelines, a national breast cancer screening program, which recommends biennial screening mammography from the ages of 40–69 in average-risk women, and multiple interventions to increase access to screening, including government partnerships with primary care physicians and the Turkish Radiology Association and mobile mammography facilities.<sup>22</sup>

The combination of low access to education, underutilization of screening, a disproportionately high frequency of advanced disease at diagnosis, and a rapid increase in population represents an impending global health crisis. Previous studies of other ethnicity refugee populations have demonstrated that cancer awareness can be significantly increased with patient education

interventions, that increased awareness and cancer-related knowledge is maintained by participants over time, and that screening rates are also increased as a result of these educational interventions.<sup>5,9,12</sup> However, no study implementing patient education interventions in Afghan refugees presently exists. Interventions to increase cancer awareness, and in turn cancer screening, in the Afghan refugee population are critically needed. In the present study, we implemented a telehealth patient education intervention to increase BC awareness among Afghan refugee women with formal registered refugee status with the Turkish government residing in Türkiye, a country in which all individuals with registered refugee status with the Turkish government receive free health-care as part of the national universal healthcare system. We hypothesized that this patient education intervention would lead to durable improvement in BC awareness level among this patient population.

## Methods

### Study design and participants

This study consisted of an initial cross-sectional survey, an educational intervention, and a post-intervention survey, conducted between August 1, 2022 and February 10, 2023. The study was approved by the Institutional Review Board of Kanuni Sultan Süleyman Training and Research Hospital. Because the intervention was conducted via telephone, verbal informed consent was obtained from each participant.

A cross-sectional survey of Afghan refugee women residing in Türkiye was conducted as per our previously published protocol,<sup>20</sup> in which women presenting for care at outpatient public health clinics in Istanbul who were presenting for primary care encounters and who had refugee status were randomly selected and offered the intervention. The present study examined a second, separate cohort from our group's previous study.<sup>20</sup> During the initial study encounter, a pre-intervention survey was administered as detailed below, and then an educational intervention was administered as detailed below. A follow-up post-intervention survey was administered six months after the initial intervention. Participants were women aged 40 or older, of Afghan citizenship, who were residing in Türkiye with formal residency status designated as "refugee." The age of 40 was selected based on Türkiye's national cancer screening guidelines recommending commencement of breast cancer screening at age 40. Critically-ill patients and patients with a personal history of BC were excluded. During the consent process, participants were informed that the study would consist of a pre-intervention survey, an educational intervention, a six-month post-intervention survey, and an optional screening mammogram. Data reporting was per the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement.

### Procedures

BC awareness was assessed using the Breast Cancer Awareness Measure (BCAM).<sup>23</sup> As described previously, BCAM can be administered via telephone, has excellent validity and reliability, and has been validated in Muslim and Middle Eastern populations.<sup>20</sup> In the present study, BCAM was translated from English into Pashto or Dari by a certified translator. Participant responses were collected in Pashto or Dari and translated back into English. BCAM was administered verbally via telephone by a physician with the assistance of a female certified interpreter. After administration of BCAM, the physician, a citizen of Türkiye, conducted an interactive BC education session with education materials (see [Supplementary material](#)) written by the authors of the present study, also verbally via telephone, with each participant. The education session contained a comprehensive review of breast cancer etiology, risk factors, clinical manifestations, screening, diagnosis, treatment, and prevention. Similarly to the survey, the education intervention was administered with the assistance of a female certified interpreter, approximately 1 h in duration. Six months after the education session, each participant was contacted again via telephone, and BCAM was re-administered. The physician who administered the surveys and education session functioned solely as a researcher and was not involved in the medical care of the participants. At this time, each participant was offered a screening mammogram. Social work services, including assistance with appointment scheduling and transportation to the healthcare facility, were offered to each patient to assist with completion of screening mammography. The sample size was determined based on the available funding and logistical arrangements and based on prior studies of cancer awareness interventions in refugee populations.<sup>12</sup> Six months was chosen as the post-intervention follow-up time due to concern that shorter follow-up times might not fully reflect the durable nature of improved awareness levels, and longer follow-up times might result in a large number of participants being lost to follow-up given the increased frequency of moving domiciles and cities within the refugee population. Efforts to maximize the cultural responsiveness of the study included presentation of the educational intervention in participants' native language, use of female gender interpreters, and implementation of the intervention via telehealth, which enhances accessibility for this relatively disadvantaged population in comparison to in-person visits, which require time and funds for transportation.

### Statistical analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) statistical software version 25 (International Business Machines (IBM) Corporation, Armonk, New York, USA). Results

	n (%)
<b>Age</b>	
Median, years (range)	49 (40–64)
<b>Education</b>	
No formal primary or secondary education	100 (100)
Primary school	0 (0)
Secondary school	0 (0)
<b>Marital status</b>	
Single	0 (0)
Married	100 (100)
<b>Employment status</b>	
Formally employed	0 (0)
Informally employed (e.g. homemaker)	100 (100)

This table displays the median and range of ages, as well as the educational, marital, and employment statuses of participants (n = 100).

**Table 1: Demographic characteristics of participants.**

are presented as frequencies and percentages for categorical variables and median and range for continuous variables. Differences in response frequencies before and after the educational intervention were tested for significance via chi-squared test with a significance threshold of 0.05.

**Role of the funding source**

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. All authors contributed voluntarily to this work. MCK, SD, MFE, CB and MS had access to the dataset. The decision to submit for publication was made jointly by all of the authors.

**Results**

One hundred and twenty-two participants were invited to the study; 22 declined, for a total of 100 participants. All 100 participants were of female sex and self-identified as

female gender. The median participant age was 49 years (range: 40–64 years). All 100 patients had no formal education, were married, and described their employment status as “housewife.” Demographic characteristics of the participants are displayed in Table 1.

Awareness of 11 BC warning signs (lump/thickening in the breast, lump/thickening under the armpit, bleeding/discharge from the nipple, pulling in of nipple, change in nipple position, rash on/around nipple, redness of breast skin, change in size of breast/nipple, change in shape of breast/nipple, pain in a breast/armpit, dimpling of breast skin) was assessed at baseline and at six months after the BC education session. At baseline, 82–90 percent of participants responded “don’t know” regarding whether the above findings were warning signs of BC. Six months after administration of the educational module, awareness of BC warning signs was markedly increased: 77–90 percent of participants correctly identified warning signs of BC. BC awareness data are displayed in Table 2.

Participant confidence, skills, and behavior regarding BC were assessed at baseline and at six months after the BC education session. At baseline, the majority of patients rarely or never performed a breast self-exam (88%), were not confident or only fairly confident about noticing a change in the breasts (85%), had never visited a doctor due to a change noted in the breasts (100%), and were unable to identify BC risk based on age (82%). Six months after the BC education session, confidence, skills, and behavior were markedly increased: 91% of participants reported performing a breast self-exam monthly, 92% reported they were fairly or very confident about noticing a change in the breasts, and 69% of participants correctly identified BC risk based on age. 100% of participants again reported never having visited a doctor due to a change noted in the breasts. Participant confidence, skills, and behavior data are displayed in Table 3.

	Baseline (%)			Follow-up (%)			p-value
	Yes	No	Don't Know	Yes	No	Don't Know	
Lump or thickening in the breast	10	8	82	86	5	9	<0.0001
Lump or thickening under the armpit	10	8	82	86	5	9	<0.0001
Bleeding or discharge from the nipple	5	8	87	86	3	11	<0.0001
Pulling in of the nipple	7	7	86	81	5	14	<0.0001
Change in the position of the nipple	7	8	85	77	7	14	<0.0001
Rash on or around the nipple	10	6	84	83	7	10	<0.0001
Redness of the breast skin	12	6	82	81	6	13	<0.0001
Change in the size of the breast or nipple	10	7	83	86	6	8	<0.0001
Change in the shape of the breast or nipple	10	7	83	85	7	8	<0.0001
Pain in one of the breasts or armpit	11	0	89	90	3	7	<0.0001
Dimpling of the breast skin	0	10	90	86	7	7	<0.0001

This table displays the responses of participants regarding awareness of various signs of BC at baseline and at 6 months follow up (n = 100). BC, breast cancer.

**Table 2: Participant awareness of warning signs of BC.**

Participant awareness of nine BC risk factors (personal history of BC, use of hormone replacement therapy, drinking more than one unit of alcohol per day, being overweight, having a relative with BC, late child-bearing or nulliparity, early menarche, late menopause, or low physical activity) were assessed at baseline and at six months after the BC education session. At baseline, 61–86 percent of participants responded “not sure” regarding whether the above findings were risk factors for BC. Six months after the BC education session, awareness of BC risk factors was markedly increased: 60–99 percent of participants were able to correctly identify BC risk factors. Data regarding patient awareness of BC risk factors are displayed in Table 4.

At the completion of the six-month follow-up, each participant was offered a conventional two-dimensional mammogram of the bilateral breasts for screening. All 100 participants elected to undergo mammography, and no abnormalities were identified for any patient.

### Discussion

In this study, we present results of the first telehealth-based patient education intervention to improve BC awareness in Afghan refugee women. In the present study, administration of a BC education session resulted in drastically improved rates of BC awareness among Afghan refugee participants. As expected, among a population of 100 Afghan refugee women residing in Istanbul, Türkiye, BC awareness before the implementation of the intervention was critically low. In our prior study of BC awareness among Afghan refugee women, 70–83 percent of participants were unable to identify common warning signs of BC, such as a lump in the breast, and 60–96 percent of participants were unable to identify risk factors for BC, such as being overweight or having a personal history of BC. In the present study, 80–90 percent of women could not identify warning signs of BC; 88 percent never

	Baseline (%)	Follow-up (%)	p-value
<b>Breast self-exam</b>			
Rarely or never	88	5	<0.0001
At least once every 6 months	11	4	
At least once a month	1	91	
At least once a week	0	0	
<b>Confidence in noticing a change in the breasts</b>			
Not at all confident	3	1	0.0003
Not very confident	24	7	
Fairly confident	61	61	
Very confident	12	31	
<b>History of doctor visit about a change noticed in the breasts</b>			
Yes	0	0	NS
No	0	0	
Never noticed a change in one of my breasts	100	100	
<b>Who is most likely to develop breast cancer?</b>			
A 30-year-old woman	21	3	<0.0001
A 50-year-old woman	18	13	
A 70-year-old woman	18	69	
A woman of any age	43	15	

This table displays participant responses regarding breast self-exam behaviors, ability to notice a change in the breasts, and physician visits for breast-related issues at baseline and at 6 months follow up (n = 100). BC, breast cancer. NS, not significant.

**Table 3: Participant confidence, skills and behavior regarding BC.**

performed breast self-exam; and 60–99 percent were unable to identify risk factors for BC. Six months after implementation of a telehealth-based educational intervention administered by a physician, BC awareness was drastically improved. After the intervention, 77–90 percent of women correctly identified warning signs of BC; 91 percent performed breast self-exam monthly; and 60–99 percent were able to correctly identify risk factors for BC.

The present study is novel in its implementation of a BC patient education intervention among a population

	Baseline (%)					Follow-up (%)					p-value
	Strongly disagree	Disagree	Not sure	Agree	Strongly agree	Strongly disagree	Disagree	Not sure	Agree	Strongly agree	
Having a history of breast cancer	0	7	61	27	5	0	0	1	33	66	<0.0001
Using hormone replacement therapy	0	9	82	8	1	0	4	8	88	0	<0.0001
Drinking more than 1 unit of alcohol a day	0	8	70	20	2	0	2	10	88	0	<0.0001
Being overweight (BMI over 25)	7	5	76	8	4	2	1	8	56	33	<0.0001
Having a close relative with breast cancer	0	11	83	4	2	0	4	13	73	10	<0.0001
Having children later in life or not at all	8	10	79	3	0	4	4	24	68	0	<0.0001
Starting your periods at an early age	1	11	81	6	1	0	7	33	60	0	<0.0001
Having a late menopause	0	7	83	5	5	0	4	15	75	6	<0.0001
Doing less than 30 min of moderate physical activity 5 times a week	0	8	86	4	2	0	7	23	68	2	<0.0001

This table displays participant awareness of various risk factors for BC at baseline and at 6 months follow up (n = 100). BC, breast cancer. BMI, body mass index.

**Table 4: Participant awareness of BC risk factors.**

of Afghan refugees. We found that the intervention was highly effective at improving participant BC awareness, and that this improvement was maintained a full six months after completion of the intervention. Moreover, whereas zero of 100 participants had ever undergone screening mammography, clinical breast exam, or breast self-exam prior to the intervention, most participants were performing monthly breast self-exam, and all participants elected to undergo screening mammography, six months after the intervention. These findings are concordant with previous studies of health education interventions in other populations that have yielded meaningful increases in knowledge and adherence to screening. For example, a study of Syrian refugee women residing in Türkiye administered a breast and cervical cancer patient education intervention in participants' native language and found a significant increase in post-intervention knowledge at eight weeks after the intervention compared to the pre-intervention baseline.<sup>12</sup> A study of refugee women of all nationalities residing in Massachusetts, USA implemented a BC patient navigation/education program and found a significant increase in screening mammography rates in the study population after implementation of the intervention.<sup>9</sup> A study of immigrant women of Arabic, Chinese, South Asian, and Vietnamese nationality residing in Canada implemented a BC peer health educator program and identified strong themes of increased awareness, knowledge, and self-responsibility among participants after implementation of the program.<sup>24</sup> These findings in conjunction with the findings of the present study suggest that patient education interventions are highly effective at improving cancer awareness in refugee populations, and that these increases in awareness translate to meaningful increases in cancer screening rates.

Previous qualitative studies of Afghan refugee perspectives on healthcare, health literacy, and access to care reveal recurring themes germane to the present study. For example, a study of attitudes toward breast and colorectal cancer screening in Afghan refugee women in the USA identified low knowledge of cancer and poor communication with healthcare providers as factors that were impedimentary to receiving cancer screening in this population.<sup>25</sup> Similarly, a study of Afghan refugee women's experiences seeking healthcare in the USA identified poor communication as a key factor leading to mistrust of healthcare providers.<sup>26</sup> Studies have also found a relationship between poor communication and worse utilization of healthcare: for example, a survey of antenatal Afghan women in Iran found that lower level of knowledge regarding antenatal care was associated with inadequate antenatal care.<sup>27</sup> These studies combined with the findings of the present study emphasize the critical importance of cultural sensitivity, good communication, and improvement of health awareness in this population.

Multiple previous studies have demonstrated low rates of cancer screening in refugee populations. A study of a multiethnic refugee population in Texas, USA found that the majority of participants were either never screened or not up to date with screening with regard to four common, screen-detectable malignancies; for example, 87 percent had never had colon cancer screening in their lifetime, 81 percent of female participants had not had a screening mammogram in the past year, and 82 percent of female participants had not had a pap smear in the past three years.<sup>8</sup> A study of Syrian refugee women in Canada revealed that only 12 percent of participants had had a clinical breast exam and 6.7% of participants had had a mammogram in their lifetime.<sup>13</sup> Given this known low utilization of screening in refugee populations, the findings of the present study of increased cancer screening after an education intervention emphasizes the critical need for more widespread implementation of cancer education initiatives in refugee populations.

One of the strengths of the present study is its implementation of the educational intervention via telehealth. Telehealth is a valuable tool in the health care of refugees and other populations with reduced access to medical care. Telehealth improves access to medical care for underserved populations and regions, and is associated with decreased cost and time of healthcare delivery.<sup>28</sup> The main obstacle to wider implementation of telehealth in refugee populations is language barriers; other barriers include access to telephone and internet service and digital literacy.<sup>28</sup> Despite these obstacles, prior studies of telehealth interventions in refugee populations have suggested that telehealth may improve access to care by decreasing the need for transportation and decreasing use of emergency services for non-emergency conditions.<sup>28,29</sup> In the present study, language barriers were overcome by use of an interpreter during the telehealth encounter. Utilization of interpreters, and in particular same-gender interpreters, may be one effective means for increasing uptake of telehealth in refugee populations.

In the present study, 100% participation in the follow-up survey was achieved. This was most likely due to several factors: the use of telehealth for the intervention, the use of a same-gender, native-language interpreter to increase accessibility and patient comfort, and meticulous collection of contact information to facilitate long-term follow-up. With regard to the 100% participation rate achieved for the screening intervention, this is likely attributable to the intervention being made available free of charge to participants as well as the provision of transportation for participants.

A critical finding of the present study is low rates of health literacy among this vulnerable refugee population. Improving health literacy in this population is a crucial target for intervention to improve cancer prevention and screening rates in this population. Previous

studies have suggested that in underserved communities, culturally responsive approaches are important in the implementation of educational initiatives. For example, a study of breast cancer education in Native Hawaiian women found that culturally informed factors such as talk story discussions, incorporation of important cultural principles such as holistic health and intergenerational family responsibility, and sensitivity regarding the verbiage of interventions (for example, suspicion associated with labeling screening offerings as “free”) were frequently mentioned in interviews with participants.<sup>30</sup> Similarly, a study that aimed to develop a culturally sensitive intervention to improve genetic counseling rates in African American women with high hereditary risk for breast cancer found that culturally informed principles including inclusion of lived experiences, inclusion of stakeholders in the development of the intervention, and incorporation of religion and spirituality were identified as highly influential to participants.<sup>31</sup>

The limitations of this study include that the administration of BCAM and the BC education intervention were focused educational tools. Therefore, only limited demographic and health history information were collected for each participant. Additional history for each participant would be helpful to elucidate how personal and family BC history, among other factors, influence BC education and screening behavior. Additionally, the survey instrument included some dichotomous “yes/no/don’t know” response items that precluded more nuanced, subjective responses from being gathered. As the study was performed via telehealth, participation was restricted to individuals who had access to and ability to use a telephone. The study was performed in Istanbul, an urban metropolis with relatively more readily available healthcare resources compared to more rural areas, and may not be generalizable to refugee individuals living in more rural areas. The length of time of residence in Türkiye was also unknown for each participant and may be an important influencing factor on health literacy and screening behavior. Future studies will investigate the effect of length of residency on outcomes including health literacy and education, health and cancer awareness, and participation in screening. The study team did not include an Afghan scholar, which would have added to the cultural robustness of the study.

Among a population of Afghan refugee women in Türkiye, BC awareness was critically low, but was drastically increased by an educational intervention administered by physicians via telehealth. The impact of the educational intervention was long-lasting: participants maintained increased BC awareness at six months after the intervention. After implementation of the educational intervention, screening behavior was also drastically increased in the participant population: 100 percent of participants underwent mammography after

completion of the educational intervention, compared to zero percent having undergone mammography at any prior point in their lifetime. Wider implementation of cancer education initiatives in refugee populations is critically needed; these initiatives can durably improve patient knowledge and translate to meaningfully improved screening rates in this high-risk population.

#### Contributors

MCK contributed to data collection, data analysis, manuscript review, and editing; SK contributed to data analysis, data interpretation, manuscript writing, and manuscript review and editing; SD contributed to data collection and manuscript review and editing; MFE contributed to data collection and manuscript review and editing; CB contributed to data collection and manuscript review and editing; NO contributed to data interpretation and manuscript review and editing; and MS contributed to conceptualization, study design, funding acquisition, data collection, data analysis, data interpretation, manuscript writing, and manuscript review and editing. MCK and MS have accessed and verified the underlying data.

#### Data sharing statement

The individual participant data for the present study, after de-identification, will be shared with interested parties upon reasonable request, who may inquire with MS.

#### Declaration of interests

MS declares funding from Dana-Farber Cancer Institute. All other authors declare no conflicts of interest.

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#### Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.eclinm.2023.102094>.

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