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Oncology

IMPACT OF A LARGE - SCALE MOBILE CANCER SCREENING PROGRAM IN INDIA: AN ANALYSIS OF COMMUNITY-BASED SCREENINGS

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ABSTRACT Cancer is a leading cause of death worldwide, second only to heart disease in the United States. Cancer screening is essential for early detection and prevention. Cancer screening is the process of searching for cancer in asymptomatic patients. Cancer remains a significant challenge to global health. Cancer screening guidelines permit evidence-based cancer prevention. Screening for cancer involves surveillance of populations towards the identification of cancer that was unknown to the patient. Therapeutic cancer treatments generally are more effective when applied earlier in the condition's development; as such, screening for cancer has the potential to improve the standard of patient care and improve mortality and morbidity associated with the disease. Cancer screening aims to detect treatable precancerous lesions or early-stage disease to enable actions aimed at decreasing morbidity and mortality. Cancer mortality can be prevented through cancer screening programs, which have a considerable impact on reducing cancer-specific mortality by selecting pre-symptomatic cases and driving more extensive diagnostic procedures, and finally prompt treatment. The dream of universal cancer screening remains elusive at the moment.

KEYWORDS : Universal Cancer Screening, International Agency for Research on Cancer (IARC), Multi-cancer early detection; Biomarker;

Background:
Access to cancer screening remains very minimal in rural parts of India. Mobile screening units reduce these geographical barriers. These units go directly to rural villages and assess them with early detection cancer screening tests.

Methods:
An observational analysis of anonymized data from the Grace Cancer Foundation mobile screening program in India was done to illustrate the impact of early screening. Screeding data was taken from January 2021 to August 2025. Results discussed the variable number of screening camps and individually screened participants as well as positive tests.

Results:
Between 2021 to 2025, GCF conducted 454 screening camps with over 90,000 individuals screened. 15,259 mammograms down with 537 screening positive. Over 13,000 pap smears were done and 2,410 positive for cervical cancer. As well as, 175 oral exams were done.

Conclusion:
This multi-year observational analysis demonstrates the power and impact of the work that NGOs such as GCF are doing with the screening units. Further standardized data and referral follow-ups would continue to strengthen the impact of mobile units and support more implementation across rural India.

INTRODUCTION

Current screening methods have increased survival rates, but they also have some drawbacks, including the risk of overdiagnosis, false-positive results, exposure to radiation, invasiveness leading to a decrease in patient compliance, and lack of support from the general public to undergo these investigations (1,2)

One recent study illustrated the profound impact of disproportional cancer mortality in women: an estimated one million children became maternal orphans in 2020 because their mother died from cancer in that year, with close to one half of these orphans the result of maternal deaths from either female breast or cervical cancer (3)

A meta-analysis of randomized clinical trials conducted by Bretthauer et al. to evaluate the advantage of cancer screening, recently published by the Journal of the American Medical Association Internal Medicine, concluded that "common cancer screenings do not save lives with the possible exception of sigmoidoscopy screening" (4)

According to the Centers for Disease Control and Prevention (CDC), there were 606,520 cancer deaths, and new cancer cases in 2020 were expected to exceed 1.8 million. Globally, nearly 20 million new cancer cases and almost 10 million deaths are reported annually. Fortunately, early screening for cancers such as colon, lung, cervical, breast, and prostate can delay or halt disease progression, increase cure rates, and reduce morbidity and mortality (5)

Cancer screening is a form of secondary prevention that reduces mortality without altering disease incidence. Given the lengthy process of malignant transformation, screening allows for the detection of premalignant lesions and early intervention, slowing disease progression and enabling early curative treatment when appropriate (6)

Most cancer risk factors are preventable. Measures such as eliminating tobacco products and secondhand smoke exposure, getting vaccinated (eg, against human papillomavirus or HPV), avoiding tanning beds, maintaining a healthy weight, staying physically active, abstaining from processed or red meat, and consuming high amounts of fruits and vegetables can substantially decrease a person's lifetime risk of developing cancer or dying from the condition (7)

Healthy People Initiative (HPI) is a US program that develops health objectives and tracks the achievement of these objectives. The National Health Interview Survey (NHIS) is a chosen data source for setting and assessing several HPI cancer targets (8)

The 2015 NHIS findings showed that the utilization of cancer screening tests for cervical, breast, and colorectal cancer (CRC) was below the Healthy People 2020 targets. In 2015, the rates of Pap tests, mammography, and CRC screening were 80%, 70%, and just above 60%, respectively. In contrast, the Healthy People 2020 targets are 93% for Pap tests, 81% for mammography, and 70.5 % for CRC screening (9)

An interesting technological approach involving Attenuated Total Reflection-Fourier Transform Infrared spectroscopy with multifractals was utilized for studying a cell line's metastatic potential. A tailed primer isothermal amplification study was also performed, which involved translating assays to achieve multiplexed detection of

three hrHPV genotypes in a disposable cartridge, providing rapid, low-cost, and decentralized cervical cancer screening (10)

An analysis of cryptogenic hepatocellular carcinoma (HPC) was performed, and a complementary analysis focusing on DNA methylation markers in HPC was also conducted. Additionally, CXCL5 and CXCL14 were proposed as potential biomarkers of colorectal cancer (11)

The use of advanced computational techniques has become ubiquitous in cancer screening. Due to the large accumulation of data on a per-patient basis, AI and machine learning approaches have become extremely popular. An AI decision support tool that uses an object detection algorithm to locate and isolate skin lesions in a patient's total body images was developed, with a clinical validation study demonstrating an average sensitivity of 95% for the top-10 AI-identified suspicious skin lesions selected by experts (12)

An AI model that included age, neutrophil-to-lymphocyte ratio, and red blood cell count was developed, and a risk stratification model was proposed towards risk-based screening strategies for breast cancer (13)

Detecting cancer at earlier stages can potentially reduce cancer-related morbidity and mortality (14)

Over time, an individual undergoing recommended periodic screening has a high cumulative probability of having an invasive diagnostic workup, ultimately because of a false-positive screening result (15)

About Cancer Screening

Cancer is a large group of diseases that can start in almost any organ or part of the human body (WHO). This disease is created when cells abnormally grow uncontrollably and go beyond their boundaries, metastasizing into other organs and parts of the body, which is the cause of death in many cancer patients. WHO states that cancer is the leading cause of death globally, estimating to about 1 in 6 people a year or 10 million alone in 2020. Cancer is caused by three main types of carcinogens, physical, chemical, biological, as well as genetic factors. One of the largest most prevalent ways to reduce the burden and effects of cancer, especially when the causes are so prevalent, is early screening and detection.

Cervical cancer stems from 2 subtypes, squamous cell carcinoma and adenocarcinoma. Specific risk factors for cervical cancer include pregnancy, smoking, extensive use of oral contraceptives, and a weak immune system. Breast cancer is divided into 3 common subtypes, invasive ductal carcinoma, invasive lobular carcinoma, and inflammatory breast cancer. IDC and ILC affect the milk ducts and glands in the breasts and can spread to both breasts. Risk factors of breast cancer include age, dense breasts, family history, radiation therapy, obesity, and alcohol. Lastly, oral cancer is primarily squamous cell carcinoma that starts by lining the cells on the tongue, lips, and inner cheek/gums. Common risk factors include, smoking or chewing tobacco, betel quid, gutka, HPV, obesity, UV light, and poor nutrition.

Furthermore, cancer markers are used to diagnose the specific type of cancer and the prognosis for the patient. For example, oral cancer markers are substances that come from the tumor itself or the body's response to the tumor, whether it is benign or cancerous. These substances can be attained through blood or urine and are often cheaper than a procedure. An example of tumor growth markers are cyclin, nuclear cell proliferation antigens, and telomerase (Rajguru). Breast cancer markers are also taken through blood, but a high level of markers may not always indicate a cancer related problem. Some examples of tumor markers are CA 15-3, CA 27.29, and CA 125. In cervical cancer, common markers are CA 125 and CA 19-9.

Cancer remains as a major public health challenge faced globally with a disproportionate burden coming from low to middle class income countries. However in India, the top three most prevalent forms of cancer in male and females are breast, cervical, and oral cancer leading to record number morbidity rates. This is largely due to the low access of screening, early detection services, and late stage diagnosis. WHO (World Health Organization) recognizes that 30-50% of cancers can be prevented just with early detection services.

Though India may have an availability of screening mechanisms they are suboptimal. Many hospital based screening services, which make up a majority of screening mechanisms, fail to reach rural and socioeconomically disadvantaged populations due to barriers. These barriers can include geographic inaccessibility, shortages of trained healthcare professionals, and limited education on cancer treatment. These barriers highlight the need for other alternatives to screenings and more accessible services since so many patients that are the most at risk of cancer come from areas where these barriers are overwhelmingly present.

In order to provide more care and accessibility, mobile cancer screening units have been successful in reaching areas that are not typically screened. Many NGOs have started to use these mobile clinics in underserved countries and The Grace Cancer Foundation has the largest mobile screening unit of any NGO. GCF has conducted over one million screenings across many rural cities in India. This program provides screenings for those in areas that were never possible before. This study will evaluate the impact of GCF's data on the prevalence of breast, cervical and oral cancers, also determining the prevalence of trends in these types of cancers and new recommendations in scaling across India.

METHODS:

Study Design And Setting

This study is an 4 year observational analysis of anonymized data collected through the Grace Cancer Foundation (GCF) mobile cancer screening buses that traveled to rural cities in states across India such as Telangana, Andhra Pradesh, and Karnataka. The buses offered mammograms, pap smears, HPV screenings, and vaccinations to patients that are the most at risk for cervical, oral, and breast cancer. The analysis was designed to evaluate the outcomes from the screening and patterns across a large community based population.

Study Population:

The study population includes all individuals who practice in GCFs mobile screening camps, with approximately 26,074 individuals screened from January to August 2025. All records are anonymized to protect participant confidentiality. Screenings are done by healthcare professionals and licensed physicians trained in specific screening protocols.

Data Collection:

Screening data was recorded during each session using standardized formatting. Variables included, date, location, state, total number of participation, sex, and results of each test during the screening.

Screening Procedures:

Participating individuals were screened for cancer, NCD indicators as apart of the GCF screening model

●Oral Cancer: oral examination of Leukoplakia in the mouth especially when white and red patches begin to mix are a large indication of oral cancer. Examination of non healing ulcers and oral submucous fibrosis.

● Breast Cancer: Clinical breast examination includes assessment for breast lumps, nipple discharge, nipple fissures, gynecomastia and other breast abnormalities.
- Mammograms were performed and recorded as a positive test.

● Cervical Cancer: Pap smear testing, if positive it was indicated
- Human papillomavirus screening (HPV) with documented positives.
- Other Gynecologic findings such as leucorrhoea, uterine prolapse, ovarian masses, uterine fibroids PCOD, and cervical swelling.

● Non-Communicable Disease and General Health Screening
- Blood pressure measurement
- Oxygen saturation
- ECG
- Patient history of hypertension, diabetes, and cardiac disease.
- Blood Test

Outcome Definitions:

A screen positive outcome was defined as documenting a potential cancer suspicion and warranting further tests to determine breast, cervical, or oral cancer.

RESULTS -

Section 1

Table 1. Program Reach By Year

Year	Screening camps (n)	Individuals screened (n)
2021–22	79	15,988
2022–23	141	24, 223
2023–24	89	21,775
2025 (Jan–Aug)	145	28,241
Total	454	90,227

Across the four-year study period, the screening program held multiple cancer and NCD markers tests, delivering most of the time more than one test per participant. Between 2021 and 2025 the Grace Cancer Foundation has conducted mobile screening camps in multiple areas in India. Over the 4 year study period, tens of thousands of people were screened with an increase in screenings per year.

RESULTS –
Section 2
Table 2. Screen-Positive Findings By Cancer Type (2021–2025)

Cancer type	Screening modality	Screened	Positive Findings
Breast	Mammograms	15,259	537
Cervical	Pap smear	13,172	2,410
Cervical	HPV test	402	43
Oral	Oral Pathology	-	177

Screen positive tests were identified across all cancer screening mechanisms over the time of the study with oral, breast, and cervical screenings. Breast cancer screenings include 15,259 mammograms with 537 positive results (Percent) . Cervical screening included 13,172 pap smears with 2,410 positive results(percent). Oral screening was not consistently recorded, however 177 oral pathology findings were recorded which is about 1.96 per 1,000 participants. (16)

RESULTS –
Section 3
Table 3. Alignment With WHO Screening Priorities

Cancer Type	WHO priority	GCF screening modality	Implementation evidence from program data
Cervical	>70% screened with Pap/HPV	Pap smear + HPV	Multi-year delivery of HPV tests and Pap smears
Breast	Early diagnosis and screening	Mammography + CBE	Mammograms and breast examinations are offered across many mobile camps.
Oral	Oral screenings regularly and reducing Environmental carcinogens	Visual oral exam	Identification of oral lesions and markers of oral cancer.

Over the four years of implementation the Grace Cancer Foundation demonstrated alignment with the World Health Organization recommendation for cancer detection. While the population targets cannot be directly assessed using the camp data, the consistent use of WHO screening mechanisms over the multiple years highlight the potential role in advancing the screening goals.

DISCUSSION
The multi year study summarizes the outcomes from the Grace Cancer Foundation mobile screening units across India. From 2021 to 2025 over 90,000 individuals have been screened for multiple cancer tests. During these four years the NGO screened 15,000+ individuals for breast cancer by way of mammograms, 13,000 for cervical cancer through pap smears, and 175 visual oral exams.

Impact Of Breast Cancer Screening
GCF mobile cancer screening units carried out breast cancer screening tests at scale and performed 15,988 mammograms in the four year study period (17)

The screen positive findings conveyed that the mobile units are essential to early detection by identifying individuals that are at risk or will have breast cancer in the future . In rural areas where hospitals are already under limited resources, the work of NGOs is essential to making sure that health care accessibility is reached no matter where individuals live, especially when rural people are the most at risk in India.

Impact of Oral Cancer Screening
Oral screenings results were primarily recorded as oral pathology findings in which a visual exam was done to see whether individuals had mouth lesions or masses. The data set did not consistently capture the total number of individuals undergoing an oral exam; the findings were measured as screen-detected abnormal findings with 177 participants . The exams provided early intervention in an environment where tobacco exposure and other oral cancer risk factors are common.

Impact Of Cervical Cancer Screening
Cervical cancer tests were implemented through pap smears and HPV screenings . Across 2021-2025, 13,172 pap smears were performed and 2,410 positive findings (18%). 402 HPV tests were done and 43 individuals were positive indicating 10% of those screened had HPV .

Over the study period the most screening positive cancer was cervical cancer (18).

Though the number of HPV tests were lower compared to other tests 99% of cervical cancer is caused through HPV. GCF targeted many testing modalities in order to reduce the barriers for women who are less likely to receive care and increase their chance with early detection.

WHO alignment
Through the anonymized data and the overall trend from the past four years, GCF's program is strongly aligned with WHO's early detection priorities . Breast, cervical, and oral cancer screening services via the mobile units show that the NGOs can make a meaningful impact on the national screen targets.

Recommendations for scaling across India
1) Standardize data across all camps and years
To make sure that there is consistent evaluation, GCF as well as other NGOs should adopt a national reporting system that tracks the number of individual screens and the screen positives. Particularly for oral screening, positive findings can be recorded by the lesion or tumor found.

2) Strengthen referral pathways and follow up tracking
Many screen positives are recorded for breast, oral, and cervical cancer, but there is not any concrete follow up data that seem to be provided. Scaling in the future should include a referral tracking system and or frequent checks with nearby hospitals to ensure that the individuals that are screen positive receive the proper care.

3) Use risk - based targets
To increase GCF efficiency, prioritizing screening for high at risk groups but still minting broad access to rural communities. Potentially focusing on communities with high tobacco use, women at cervical screening and mammogram age can provide more focused mobile units. This strategy can increase the screen positives per camp and continue to serve underserved populations.

CONCLUSION
The multi year study demonstrates that the Grace Cancer Foundation's mobile screening program has delivered community screenings for rural India on a large scale. Between 2021 and August 2025, the program conducted 454 screening camps with over 90,000 individuals screened for many types of cancer. The programs screening modalities align with WHO and the national screening priorities for early detection in rural and resource limited communities. GCF's screening units are the largest camps by any NGO, indicating that the work being done is very impactful to the many rural Indian communities.

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