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Exploring the link between cervical cancer screening and COVID-19 vaccination adherence. Evidence from a pilot study in Rome, Italy (2021-2022)

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Abstract

Introduction. Oncological screenings and vaccinations are essential preventive strategies, yet participation in both remains suboptimal and variable.

Methods. This pilot study examines the association between cervical cancer screening adherence and COVID-19 vaccination uptake among women aged 25-64 years in a large Local Health Authority in Rome, Italy, during 2021-2022. Analyzing data from 101,302 women, we identified a strong positive association between COVID-19 vaccination status and cervical screening participation, suggesting that common determinants influence both behaviors.

Results. Age and area of residence also emerged as predictors of screening adherence, with lower participation observed among younger women and those living in central districts.

Conclusions. Our findings highlight the need to foster a broader culture of prevention by integrating vaccination and screening efforts to improve public health outcomes. Enhancing health literacy and addressing shared barriers may increase participation in both programs. However, further research is needed to validate these findings, explore the underlying determinants of preventive behaviors, and develop targeted interventions to boost adherence to prevention programs.

Key words

- prevention
- oncological screening
- COVID-19 vaccination
- screening adherence
- cervical cancer screening

INTRODUCTION

Cervical cancer is a significant global health concern. The highest incidence and mortality are observed in low- and middle-income countries, particularly in sub-Saharan Africa, South America, and South-East Asia [1] where limited access to screening and preventive measures significantly reduces survival rates. To accelerate its elimination, in 2020 the World Health Organization (WHO) launched a global strategy that focuses on three initiatives: (i) vaccination of 90% of girls with the human papillomavirus (HPV) vaccine by the age of 15; (ii) screening of 70% of women by the age of 35, and again by the age of 45; and (iii) treatment of 90% of precancerous and invasive tumours [2]. Unfortunately, significant progress is still required to meet these targets, as cervical screening coverage remains highly variable across the globe and is particularly low in Africa, reaching just 14% among women aged 30-49 as of 2020 [3]. Even within the WHO European Region, screening rates exhibit substantial variation, from 78.5% in Sweden to just 3.9% in Romania in 2021 [4]. Italy falls among the countries with intermediate adherence rates, with cervical screening participation among women aged 25 to 64 years decreasing from slightly more than 40% in the pre-pandemic years to approximately 34% in 2020, with an increase to around 39% in 2021 and 40% in 2022 [4].

However, achieving the WHO's targets for cervical cancer elimination requires not only expanding global screening coverage but also integrating these efforts with robust vaccination strategies. Even though they are different health promotion interventions, with vaccination being part of primary prevention and cancer screening falling under secondary prevention, they both embody and promote the fundamental principles of prevention: maintaining health and ensuring access to early diagnosis. In Italy, these efforts are made possible through the universalistic framework of the National

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Health Service (NHS), which is a public system primarily funded through general taxation and guarantees access to essential and uniform healthcare services for all citizens across the country. Both vaccines and organized oncological screenings are included in the essential levels of assistance (livelli essenziali di assistenza, LEA) [5], which represent the services and treatments that the NHS is obligated to provide to all citizens, either free of charge or for a modest fee (ticket). All regional health systems in Italy guarantee population screening programs for cervical, breast, and colorectal cancer. These organized programs include the active invitation of target populations, free testing and treatment, and quality control throughout the entire process, supported by continuous monitoring by the National Screening Monitoring Centre [6]. As for vaccinations, the provision of free vaccinations is guided by the National Vaccine Prevention Plan. Regional health authorities are responsible for implementing vaccination programs, ensuring accessibility and adherence to national guidelines [6].

Despite the extensive literature investigating adherence to either vaccination or cancer screening programs uptake, little evidence is available on their potential association. Indeed, while these two preventive interventions have distinct characteristics that can serve as barriers or facilitators to access, identifying and addressing shared factors influencing participation in both campaigns could significantly improve overall health outcomes. A few studies have begun to explore this connection: for example, Kuitto *et al*. have found that attitudinal factors were the strongest determinants of participation in both cervical screening and HPV vaccination [7], but the evidence remains limited and usually refers to a common disease (i.e., vaccination and screening for cervical cancer). Therefore, in line with the need to adopt a comprehensive approach when it comes to population health [6], we conducted a pilot study to investigate the association between adherence to cervical cancer screening uptake and vaccination, using data on COVID-19 vaccine administration during 2021 and 2022 in one of Italy's largest Local Health Authorities (LHA; in Italian ASL, Azienda Sanitaria Locale), LHA Rome 1. The aim of this study was twofold: to (i) explore potential correlations between participation in cervical cancer screening and COVID-19 vaccination programs, testing the hypothesis that these activities are interconnected and reflect the adoption of general health promotion behaviors, and (ii) identify demographic predictors of cervical cancer screening uptake at local level to guide the design of future campaigns.

METHODS

Setting

In Italy, cervical screening programs for cervical cancer are offered through the NHS. NHS is organized at three levels: national, regional, and local. At the central level, the Ministry of Health defines the fundamental principles and LEA; at the regional level, Regional Health Systems plan, organize, and manage healthcare services independently; at the local level, the actual provision of services and healthcare services is entrusted to LHA, which directly manage hospital and territorial care.

The study in question involved the LHA Rome 1, which covers Municipalities I, II, III, XIII, XIV, and XV in the city of Rome, with an approximate resident population of one million people accounting for 36% of the entire municipality's population, of whom about 53% are women [8]. The area is heterogeneous, including both the historic center and peripheral areas, with diverse social and economic characteristics, requiring accessible, integrated, and sensitive healthcare services.

Cervical cancer screening strategies for early detection are offered to all residents between 25-64 years. Specifically, women aged between 25 and 29 years are invited to undergo a cervical smear test every three years, whereas women aged between 30 and 64 years are screened with an HPV test every five years. Women who test positive in the initial screening are either invited for close follow-up or referred for a second-level examination with colposcopy. Exclusion criteria from the screening program include a prior history of cervical cancer, documented total hysterectomy, or serious medical conditions (e.g., terminal illness). Eligible individuals are invited to participate through personal letters sent directly to their home address.

As for the SARS-CoV-2 vaccine campaign, in Italy it began on December 27, 2020, and the National COVID-19 Vaccination Strategic Plan was officially adopted by decree on March 12, 2021 [9]. Initially, the vaccination campaign in Italy followed a prioritization order based on the risk of infection and severe illness from COVID-19 across different population groups. It began with healthcare workers, elderly residents, and individuals aged 80 and above, before expanding to include those with comorbidities, school staff, and law enforcement. Eventually, it became available to the entire population based on descending age groups.

Data collection

This study retrospectively analyzed women invited by LHA Rome 1 to undergo cervical screening from January 2021 to December 2022. Invitations are usually sent during two periods each year: from January to July and from September to November, while appointments are scheduled within one month of the invitation.

The outcome, adherence to cervical screening in 2021 or 2022, was defined as undergoing the first level of screening tests, either the Papanicolaou (Pap) smear or HPV test, according to the screening protocol. Vaccine status was determined by whether women had received the COVID-19 vaccination and, if applicable, the number of doses administered. Data were retrieved from the routinely collected records of the LHA Rome 1 cancer-screening platform, which provides aggregated participation data by age group and by residence district. The following baseline data were considered: age, district of residence, cervical screening uptake in 2021 or 2022, cervical cancer screening uptake in the previous round, COVID-19 vaccination status, and number of vaccine doses received.

Statistical analysis

Descriptive statistics were obtained using median and interquartile range (IQR) for continuous variables and proportions for dichotomous and categorical variables. For the purposes of this analysis, women were classified into five groups according to their ages (≤30 years, 31-40 years, 41-50 years, 51-60 years, and >60 years). Participation in the previous round of cancer screening was coded as not applicable (for newly invited women), yes, or no, while COVID-19 vaccination was categorized into four classes: none, one dose, primary cycle (according to vaccine type: two doses for Comirnaty, Spikevax and Vaxzevria, one dose for Jcovden), and booster dose. Living area was collapsed into two groups based on the district location: central (Districts I and II) and suburbs (Districts III, XIII, XIV, XV).

For the univariable analysis, the Wilcoxon rank-sum test was used to compare continuous variables with the outcome (i.e., cervical cancer screening uptake), whereas Pearson's chi-squared test was used for dichotomous and categorical variables. A multivariable log-binomial regression model was built to identify predictors of adherence to cervical cancer screening. Variables were included in the model based on expert opinion. Multicollinearity was checked using a variance inflation factor of 5 as the threshold. Given the large amount of available data, a calibration plot was used to visually evaluate the goodness of fit of the model, showing a good calibration [10]. As a result, the final model consisted of the following variables: COVID-19 vaccination (categorical), age (categorical), and living area (dichotomous). Adjusted prevalence ratios (aPRs) and 95% confidence intervals (CIs) were calculated. To further investigate the role of living area as a potential effect modifier of the association between COVID-19 vaccination and cervical cancer screening adherence, we conducted a stratified analysis and built two separate models for women residing in the central area and in the suburbs, respectively, using the same covariates as the main analysis. All statistical analyses were performed using R Statistical Software (version 4.2.3; R Core Team 2023, R Foundation for Statistical Computing, Vienna, Austria). A two-sided p-value <0.05 was considered statistically significant.

RESULTS

A total of 101,302 women were invited by LHA Rome 1 to participate in cervical cancer screening in 2021 and 2022, had available data on COVID-19 vaccinations, and were therefore included in this pilot study, representing 82.4% of the total number of women eligible for cervical cancer screening over the study period. Vaccination data were unavailable for the remaining women due to partially incomplete or inaccurate registry records (likely resulting from changes of residence causing delays or inconsistencies in population registry data). The median age of participants was 44.8 years (IQR: 34.1-56.0, range: 25-64) (*Table 1*). Almost two thirds of women (65.4%) had not participated in previ-

Table 1
Characteristics of LHA Rome 1 women invited to cervical cancer screening program in 2021 and 2022, by screening adherence

	Total (N=101,302)	Non-adherent women (N=92,690)	Adherent women (N=8,612)	p-value*
Age in years	44.8 (34.1-56.0)	44.7 (33.8-55.8)	46.0 (36.5-56.9)	<0.001
Age				
≤30 years	17,182 (16.8)	15,990 (17.3)	1,044 (12.1)	<0.001
31-40 years	25,116 (24.6)	22,585 (24.4)	2,227 (25.9)	
41-50 years	22,005 (21.5)	19,846 (21.4)	1,937 (22.5)	
51-60 years	28,682 (28.0)	25,999 (28.0)	2,456 (28.5)	
>60 years	9,285 (9.1)	8,270 (8.9)	948 (11.0)	
Previous participation in cancer screening program				
Not applicable	9,723 (9.6)	9,331 (10.1)	392 (4.6)	<0.001
Yes	25,303 (25.0)	21,315 (23.0)	3,988 (46.3)	
No	66,276 (65.4)	62,044 (66.9)	4,232 (49.1)	
COVID-19 vaccination				
None	27,644 (27.3)	27,153 (29.3)	491 (5.7)	<0.001
One dose	1,672 (1.7)	1,534 (1.7)	138 (1.6)	
Primary cycle	14,617 (14.4)	13,365 (14.4)	1,252 (14.5)	
Booster dose	57,369 (56.6)	50,638 (54.6)	6,731 (78.2)	
Living area				
Suburbs (Districts III, XIII, XIV and XV)	62,951 (62.1)	56,819 (61.3)	6,132 (71.2)	<0.001
Central (Districts I and II)	38,351 (37.9)	35,871 (38.7)	2,480 (28.8)	

Results are expressed as median (interquartile range), or frequency (percentage); LHA: Local Health Authority; *Wilcoxon rank-sum test for continuous variables and Pearson's chi-squared test for categorical variables.

ous round of cancer screening. The majority (72.8%) had received at least one dose of the COVID-19 vaccine, and more than half (56.6%) had also received the booster dose. Additionally, slightly less than two out of three participants were living in the LHA Rome 1 suburbs (i.e., Districts III, XIII, XIV and XV).

Adherence to the cervical cancer screening program varied by district. Specifically, Districts III (9.2%), XIII (10.5%), XIV (9.7%), and XV (9.9%) showed the highest adherence rates, while central districts (i.e., Districts I and II), reported lower rates of 7.1% and 5.9%, respectively *(Figure 1)*.

Univariable analysis showed that women who adhered to cervical cancer screening in 2021 or 2022 were older (median age: 46.0 *vs* 44.7 years; p<0.001), were more likely to have already participated in the cancer screening program (46.3% *vs* 23.0%, p<0.001), had a greater uptake of COVID-19 vaccination (booster dose: 78.2% *vs* 54.6%; no dose: 5.7% *vs* 29.3%; p<0.001), and were more likely to live in suburban districts (71.2% *vs* 61.3%; p<0.001) (*Table 1*).

In the multivariable analysis, the highest prevalence of adherence to cervical screening was found for women who had received a booster dose of COVID-19 vaccination compared to those who were not vaccinated (aPR: 6.34, 95% CI: 5.80-6.95; p<0.001) (*Table 2*). Similarly, having received either one dose or the primary vaccination cycle was positively associated with the outcome (aPR: 4.62, 95% CI: 3.83-5.52 and aPR: 4.72, 95% CI: 4.27-5.24; p<0.001). Additionally, being in a higher age range (31-40 years, 41-50 years, 51-60 years, and >60 years) was consistently associated with greater adherence to cervical cancer screening (aPR: 1.49, 95% CI: 1.39-1.60; aPR: 1.53, 95% CI: 1.43-1.65; aPR: 1.34, 95% CI: 1.25-1.44; and aPR: 1.53, 95% CI: 1.41-1.66, respectively). Conversely, living in a central district was negatively associated with cervical screening uptake compared to living in suburban districts (aPR: 0.77, 95% CI: 0.74-0.80; p<0.001). Finally, the stratified analysis by residential area showed estimates comparable to the main model, but participants living in the central area had higher aPRs for COVID-19 vaccination status (*Supplementary Table 1 available online*).

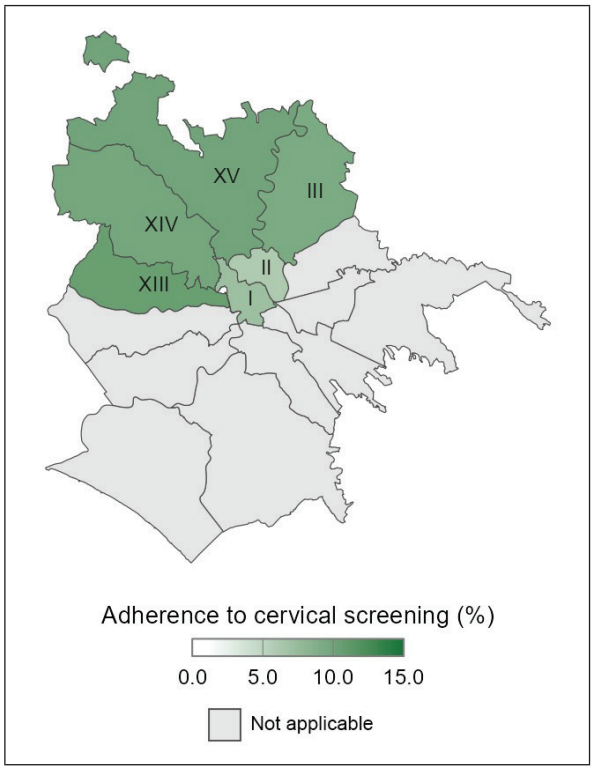

Figure 1
Percentage of study participants with residence in Local Health Authority (LHA) Rome 1 District (N=101,302) adhering to cervical cancer screening.

DISCUSSION

LHA Rome 1, like the rest of Italy, experienced a significant decline in cervical screening coverage during the COVID-19 pandemic. This reduction was unlikely due to service closures, as screenings were suspended only from March to May 2020 and resumed in June [6]. Instead, it was more likely driven by a decreased focus on prevention and heightened fear of accessing healthcare facilities, as documented by data from 2021-2022. However, our study clearly demonstrates a strong association between COVID-19 vaccination uptake and cervical screening participation, supporting the hypothesis that individuals engaging in both activities tend to adopt a broader preventive health approach. This aligns with the concept of a general prevention culture, in which shared factors-such as knowledge, attitudes, risk perception, and trust in health authorities-drive health-related behaviors. This perspective contributes to a comprehensive prevention framework, encapsulated

Table 2
Multivariable log-binomial regression model for adherence to cervical cancer screening among the LHA Rome 1 women invited in the years 2021 and 2022 (N=101,302)

	Adherence to cervical cancer screening	
	aPR (95% CI)	p-value
COVID-19 vaccination		
No dose	Ref.	
One dose	4.62 (3.83-5.52)	<0.001
Primary cycle	4.72 (4.27-5.24)	<0.001
Booster dose	6.34 (5.80-6.95)	<0.001
Age		
≤30 years	Ref.	
31-40 years	1.49 (1.39-1.60)	<0.001
41-50 years	1.53 (1.43-1.65)	<0.001
51-60 years	1.34 (1.25-1.44)	<0.001
>60 years	1.53 (1.41-1.66)	<0.001
Residential area		
Suburbs (Districts III, XIII, XIV and XV)	Ref.	
Central (Districts I and II)	0.77 (0.74-0.80)	<0.001

LHA: Local Health Authority; aPR: adjusted Prevalence Ratio; CI: Confidence Interval. Ref: reference.

in the concept of "one prevention", which integrates both preventive and health-promoting behaviors while fostering individual awareness. Scientific literature indicates that participation in both screening programs [11] it is important that those invited to screening participate. However, uptake rates are suboptimal in many populations and vary between screening programs, indicating a complex combination of patient factors that require elucidation to develop evidence-based strategies to increase participation. In this review, the authors summarize individual-level (sociodemographic and psychosocial and vaccination campaigns is influenced by complex decision-making processes involving multiple, sometimes overlapping, factors [12]. While facilitators and barriers may differ – reflecting variations in motivation, risk perception, and target populations [13] – identifying common determinants is essential for improving adherence to preventive health measures. Despite key differences – such as the fact that vaccinations protect against diseases not yet contracted, requiring the injection of a substance into a healthy body, while screenings enable the early detection of existing conditions with clear individual benefits – shared factors like health literacy and trust in health authorities significantly influence adherence to both practices. Recognizing this overlap underscores the potential of interventions aimed at enhancing participation in both vaccination and screening programs. Additionally, in resource-constrained settings, such as many healthcare systems, adopting an integrated framework that addresses these common determinants can optimize health spending while simultaneously strengthening multiple aspects of prevention.

Beyond COVID-19 vaccinations, our study has also identified other important predictors of adherence to cervical screening, i.e., age and district of residence, that can help define targeted strategies to increase screening coverage. The fact that older age was positively associated with cervical screening uptake could be explained both by greater awareness and knowledge about cancer and screening programs accumulated over a lifetime, and by the increased risk of developing cancer with age, which is generally acknowledged by the population. Indeed, from the age of 50 years, women in Italy are also invited to participate in breast and colorectal cancer screenings, which could further enhance their perception of oncological risk and be reinforced by the influence of family members and friends who have undergone screening tests. This is in the line with a recent systematic review [14] that found that cervical screening adherence was higher among women aged 30-59, while relatively lower among those aged 20-29. Furthermore, the fact that we found a negative association between living in the central districts of Rome and adherence to cervical screening may be because these areas are characterized by higher income levels [15] that have a population that can afford private healthcare services. Within this context, some women may opt for opportunistic screening rather than participating in public screening programs, but the effectiveness and cost-effectiveness of opportunistic screening are less established in the literature than those of organized screening. An organized program ensures quality and appropriateness through continuous monitoring, adherence to guidelines, and regular updates, while also reducing overdiagnosis, overtreatment [16], and health inequalities. However, this lower participation in the organized cervical cancer screening program by women living in central areas may also explained why the association with COVID-19 vaccination was particularly strong, as shown in the stratified analysis. In these districts, the women who chose to adhere to public prevention strategies adopt positive behaviors for both vaccination and screening, hereby reinforcing the general idea that the two practices share common determinants. Therefore, these findings further underscore the importance of designing targeted interventions to foster a health-promoting culture through a holistic approach. In addition, tailoring communication strategies to enhance awareness among younger age groups and advertising the benefits of organized screening over opportunistic approaches in higher-income areas could help bridge any gap in adherence. Furthermore, reinforcing the integration of multiple cancer screening programs within public health initiatives may further encourage participation, leveraging the cumulative impact of preventive behaviors over time.

This study has both strengths and limitations. Its primary strength is that, to the best of our knowledge, it is the first to explore the association between COVID-19 vaccination adherence and participation in cervical cancer screening programs. By highlighting the link between these two preventive behaviors, our findings suggest that addressing shared determinants could improve participation in both. Additionally, our study benefits from the use of anonymized healthcare data from one of Italy's largest LHAs, a large-scale real-world dataset that enabled the analysis of demographic predictors at the local level, offering valuable insights for designing tailored public health campaigns to enhance cancer screening adherence. However, some limitations should be acknowledged. Our analysis covered approximately 82% of females residing in LHA Rome 1, but the missing data are likely evenly distributed across its districts and age categories, minimizing the risk of selection bias. Another limitation is the cross-sectional design, which precludes causal inferences between vaccination and screening adherence. Furthermore, the reliance on routinely collected healthcare data restricted the variables included in the regression model, leaving room for potential residual confounding. A further limitation of our study is the lack of data on socio-cultural and economic characteristics of the women included, which are likely important determinants of adherence to cervical cancer screening programs. The absence of these variables in the dataset restricts our ability to fully understand the factors influencing participation. Nevertheless, the observed association is strong, with a clear gradient between cervical screening adherence and the number of COVID-19 vaccine doses received. While we consider it unlikely that additional variables would fully account for the observed relationship, further research is needed to expand this study, explore the vaccination-screening association in greater depth, and validate our findings.

CONCLUSIONS

In conclusion, our study (i) revealed a strong association between COVID-19 vaccination uptake and cervical cancer screening participation, suggesting that common determinants influence adherence to both preventive practices, and (ii) identified age and area of residence as demographic predictors of cervical cancer screening uptake. These results underscore the need to foster a culture of prevention through integrated strategies and targeted interventions that address shared barriers and enhance overall health literacy, ultimately strengthening public health efforts, while insights on the predictors of screening adherence at local level can inform the design of effective public health campaigns. Further research is needed to explore the underlying determinants of preventive behaviors and to evaluate strategies that can improve adherence.

Conflicts of interest statement

The Authors declare that there are no conflicts of interest.

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