Prevalence of High-risk Human Papillomavirus Infection Among Prisoners in the Nsawam Medium Security Prison, Ghana

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Abstract

Background: The Ghana Prisons Service has a Health Directorate that ensures delivery of healthcare to people in their custody under the Ghana Association of Quasi Health Institution (GAQHI) which is one of the agencies under the Ministry of Health. Across Ghana, females comprise 1.2% of the entire prison population (n=15,463). Cervical cancer screening services are however nonexistent and the prevalence of cervical precancer is undocumented. Our aim was to determine the prevalence of high-risk HPV infection and associated cervical abnormalities during a cervical cancer screening outreach.

Methods: After informed consent and counselling, women underwent a structured questionnaire-based interview. Responses were recorded directly into a Microsoft Excel spreadsheet. Inmates were co-tested for cervical pre-cancer by two trained nurses using dry brush cervical samples for 15 high risk HPV types using the AmpFire HPV test after which mobile colposcopy with the EVA system was performed. EVA images were reviewed by a gynecologist. Frequencies and percentages were used to describe categorical data while means and standard deviations or medians and interquartile ranges were used to describe continuous data.

Results: The majority (75%) of the inmates were convicts with a median sentence of 5 years. Their mean age was 41.1 years (range, 19–97). Out of the 14% that had ever been screened for cervical cancer, 75% had only been screened once. The self-reported prevalence rate of HIV among the inmates was 13.1%, all of who were receiving treatment. The high-risk HPV prevalence rate was 47.6% in the general population of inmates and 63.6% among HIV positive inmates. Using the EVA system, 5(6%) had lesions on the cervix of which 3(3.6%) were treated with thermal coagulation and 2(2.4%) were treated with LEEP. The average age of high-risk HPV positive inmates was 37.8 years. These inmates were also more likely to have been in prison for a shorter duration.

Conclusion: There is a high prevalence of high-risk HPV infection among women in custody. These women will benefit from structured cervical cancer prevention services, including treatment for abnormalities that are picked up during such screening.

Background

The health statuses of incarcerated persons are generally poorer than that of the general population, with a higher prevalence rate of chronic illnesses and infectious diseases in the former group [1]. This higher prevalence of infectious diseases has been linked with greater pre-incarceration vulnerability [2, 3], a greater number of risk factors (such as a history of multiple sexual partners, injection drug use, and HIV) [4], conduciveness of the prison environment for infectious disease transmission [3, 5], and lack of preventive measures, diagnosis, and treatment [3]. In addition, persistent sexually transmitted infections can arise upon reentry into the society due to the lack of diagnosis and treatment of diseases that occur during or prior to incarceration.

Globally, health challenges among incarcerated women remain an important topic and has gained wide attention, particularly as regards the prevention of sequelae of infectious diseases. In this respect, the human papillomavirus (HPV), the most important cause of cervical carcinoma, has been studied widely in numerous populations. Many of the risk factors for HPV infection (especially the high-risk type), such as cigarette use, immunosuppression, and low socioeconomic profiles are known to cluster in vulnerable populations, such as people incarcerated in prisons [6], and women in prison systems are likelier to have traded sexual favors for money or drugs [7]. This increases the risk of cervical intraepithelial neoplasia and cervical carcinoma among these women. A systematic review showed that 63–85% of incarcerated women used tobacco, which is very much higher than that of the general population [8]. The association between incarceration and poor oncologic outcomes is well established, and previous studies have reported that cervical carcinoma is the commonest cancer among women in prisons [1, 9–11]. The predictable nature of the evolution of invasive cervical carcinoma from cervical intraepithelial neoplasia affords its early detection via screening tests. Despite this, the evidence shows that incarcerated women and those undergoing rehabilitation are at increased risk of cervical carcinoma and are less likely to access screening for the cancer [12]. Few resource-limited countries have national cervical carcinoma prevention programs. Even where available, these are not specifically tailored to incarcerated women and other vulnerable populations.

The Ghana Prisons Service is a Security Agency under the Ministry of Interior mandated by the 1992 Constitution of Ghana to provide safe custody, welfare and when practicable reformation and rehabilitation. The Service is a key stakeholder in the overall public safety and also an important player in the Criminal Justice System. The Service has not only succeeded in establishing a Health Directorate but has registered the Prison Health System under the Ghana Association of Quasi Health Institution (GAQHI) and greater collaboration with Ghana Health Service which are all agencies under the Ministry of Health. According to recent estimates, as at September 2019, Ghana had a prison population rate of close to 50 per 100,000 population, with females comprising 1.2% of this number, a total of 15,463 [13]. With stagnation of infrastructure and an increasing prison population, Ghana ranks 56th in terms of prison overcrowding worldwide, with an occupancy level of 155.5% [13]. It is a conundrum that incarcerated persons generally have poor access to health care [14]. Studies conducted in similar resource limited settings have demonstrated a higher prevalence of infectious diseases such as HPV [15, 16], tuberculosis, hepatitis C [17], and HIV [18] among imprisoned persons. However, to our knowledge, no study has assessed the prevalence, distribution, and risk factors for HPV among incarcerated persons in Ghana. Although some prisons in Ghana have clinics, these facilities are often afflicted with shortage of essential medicaments, equipment, and tailored services to this minority group who are already faced with alarming levels of health inequality. This cannot be overlooked, as the weak surveillance systems existing in prison settings eclipses most cases of diseases such as HPV and enhance their transmission and infection among the population when these inmates are released [19]. Addressing the risk associated with HPV infection among incarcerated women would afford the opportunity to simultaneously accost pertinent health disparities and promote preventive health care to an otherwise neglected vulnerable group. In the same vein, the absence of public health programs aimed at preventing, diagnosing and

treating incarcerated women would contribute to the increasing incidence and prevalence of diseases in general, and especially those transmitted sexually.

Few studies have assessed the prevalence and distribution of HPV infection and cervical pre-cancerous lesions among women living in prisons in low resource settings, with most studies emanating from the United States of America and Europe. While awaiting a national program on cervical cancer prevention, there is the need, when the opportunity is presented, to ensure that women in prisons are provided with oncologic screening services, particularly regarding those of infectious causes.

After the training of three Prison Nurses and a Midwife in Cervical Pre-Cancer Screening, the Nsawam Medium Security Prison Clinic in collaboration with staff of the Cervical Cancer Prevention and Training Center (CCPTC), Battor, Ghana provided cervical screening services to female inmates at Nsawam Prisons, one of seven female prisons in the country and the most populated. The program was carried out to detect cervical precancer among the inmates and to provide treatment and arrest progression. Subsequent to this program, the present study aimed to estimate the prevalence and distribution of high-risk HPV infection with genotypic characterization and abnormal colposcopy findings among incarcerated women in Ghana, in anticipation that the results would influence policy on screening and preventing cervical cancer to bridge the gap in inequality, in accordance with the Ghana Prisons Service's ten-year Strategic Development Plan (2015–2025).

Methods

Study design and sample

We conducted a descriptive study involving the screening of all 90 incarcerated women at the Nsawam Medium Security Prison in Ghana on September 27-28, 2019 to assess the prevalence of high-risk HPV among them.

After obtaining written informed consent and psychological counseling, women underwent a structured interview based on a questionnaire we routinely use for our work at the Cervical Cancer Prevention and Training Centre in Catholic Hospital, Battor (additional file 1). Their responses were recorded directly into a Microsoft Excel spreadsheet database developed specifically for recording all data associated with cervical screening and treatment. Both the questionnaire and electronic data capture tool were developed at the CCPTC at the Catholic Hospital, Battor. These tools have been in use since 2017 for capturing all data on cervical screening and treatment conducted by the team from CCPTC.

To ensure the utmost privacy of clients, all clients were identified by unique alphanumeric identifiers and none of their personal identification data such as names and previous addresses were obtained during the screening.

Ethical considerations

Ethical clearance was obtained from the Ethical Review Committee of the Ghana Prison Service. All women whose images were used in the manuscript gave us consent to use the images.

HPV testing with the AmpFire HPV detection system

HPV testing was performed using the AmpFire HPV detection technology (Atila BioSystems, Mountain View, CA, USA). It is an isothermal polymerase chain reaction (PCR) assay that uses minimum instrumentation and detects15 high risk HPV (16, 18, 31, 33, 35, 39, 45, 51, 52, 53, 56, 58, 59, 66, 68) in a single tube reaction and simultaneously identifies specifically the presence of types 16 and 18. Dry brush samples were submitted immediately at room temperature to the laboratory for testing. Samples could be processed individually or batched (1 to 94 samples per run). DNA extraction was not required and sample processing to final results took less than two hours.

The AmpFire HPV screen kit contained the reaction mix (with buffer, enzymes, and dNTPs), primer mix (with primers and probes), positive control, and negative control. Twelve microliters of reaction mix was mixed with 11 µl of primer mix in a 0.2 ml reaction single tube, 8-well strip, or 96-well plate. One milliliter of lyse buffer was added to the dry sample brush in a 5ml empty tube and left to sit at room temperature for 20 minutes after it had been vortexed. After this, 2 µl processed samples were added to the reaction tube to bring the total volume to 25 µl. The reaction tubes were incubated at 60°C for 60 minutes in the Atila Power96 real-time PCR system (the PCR program is set with denaturation step at 60°C for 30 seconds, followed by extension step at 60˚C for 30 seconds while taking fluorescence reading. A total of 60 cycles were run with fluorescence recorded once per minute from the FAM/HEX/ROX/CY5 channels. The results of the Ct values for each amplification curve in all fluorescence channels were automatically reported by the thermocycling software system. For each sample, an exponential amplification curve in the CY5, ROX, FAM, and HEX channels indicated the presence of the DNA of HPV16, HPV18, non-16/18 HR-HPV types, and internal control, respectively. The lack of exponential amplification curve in the HEX channel was interpreted as an invalid result. The negative and positive controls were included in each assay to ensure the quality of the assay and avoid possible contamination.

Mobile colposcopy with the Enhanced Visual Assessment system

After passing a speculum and taking a sample with a dry brush for HPV DNA testing, each of the two trained nurses, working in different rooms, independently performed colposcopy with a mobile colposcope, the Enhanced Visual Assessment (EVA) system (MobileODT, Tel Aviv, Israel). The EVA System consists of a mobile colposcope built around a smartphone, and an online image portal for storing images. A smartphone app is used to control the mobile colposcope, and upload pictures to the image portal or to store images on the phone for review. The adequacy of colposcopy, the transformation zone (TZ) type, and any lesions found on the cervix or in the vagina were recorded by the nurses. The

images were anonymized by assigning them special codes. A gynecologist subsequently reviewed the images.

Key definitions

Transformation zone types

Type 1 (TZ 1): The entire circumference of squamocolumnar junction visible; fully ectocervical.

Type 2 (TZ 2): The entire circumference of squamocolumnar junction visible; partly or fully endocervical.

Type 3 (TZ 3): The entire circumference of the squamocolumnar junction is not visible; partly or fully endocervical.

Categories of prisoners

Remand prisoner: A person confined in prison whose case is awaiting hearing or pronouncement of sentence in a lower court (community tribunal, magistrate court, or circuit court).

Life prisoner: A person sentenced to spend the whole of his or her life in prison custody by a court of competent jurisdiction.

Condemned prisoner: Any person who is found guilty by the court of justice and sentenced to death by hanging or firing squad by a court of competent jurisdiction.

Convict prisoner: A person who has committed a crime and has been tried and found guilty by a court of competent jurisdiction and has been sentenced to serve a specific term in prison.

Statistical analysis

Percentages were calculated for categorical data and means and standard deviations were used to describe continuous data. Skewed continuous data (such as period of incarceration) were summarized using medians and interquartile ranges. For our primary objective of estimating the prevalence of high-risk HPV among female inmates, we used simple percentages and reported 95% confidence intervals (CIs). For the secondary objectives, we explored the association between age of inmates and period of incarceration and high-risk HPV positivity using grouped box plots. In addition, we compared the period of incarceration between those with high risk HPV positivity and those without using a Wilcoxon rank-sum test. This was done because the period of incarceration was highly right skewed. A student's *t*-test was used to compare the means of two populations in order to explore further the relationship between high risk HPV positivity and the age of inmates.

We reported 95% CIs for all key estimates obtained. All statistical analyses were performed using STATA version 15 (StataCorp LLC, College Station, Texas, USA). We considered a statistical significance level of 5% and reported all p-values for all our hypothesis tests.

Results

Informed consent was sought directly from all 90 female inmates at this prison for cervical screening. Five of the female inmates did not consent to be screened for the following reasons: Two(2) of them had undergone total abdominal hysterectomy and so did not have a cervix, one(1) said she was too old and did not expect to live much longer and so did not need cervical screening, one(1) had recently undergone cervical screening prior to our visit, and one(1) was uncomfortable with strangers observing her genitalia. Of the 85 female inmates who agreed to be screened, 1 of them did not have a cervix (due to a previous total abdominal hysterectomy); thus, 84 of the incarcerated women were screened. Figure 1 provides an overview of the screening process.

A majority (75%, 63/84) of the inmates were convicts with a median sentence of 5 years (inter quartile range: 2–10 years). Those on remand comprised14.3% (12 inmates), 6% (5 inmates) were condemned, and the rest (4.8%) had been sentenced to life imprisonment.

The median period of incarceration as at the time of screening of the inmates was about 1 year (inter quartile range: 0.5–2.5 years) and 13.1% had been in jail for at least 5 years. The mean age of the participants was 41.1 years (standard deviation, 15.5; range, 19–97). In terms of marital status, 25% of the inmates were married, 22.6% were divorced, 19.1% were single, and 17.9% were widowed. The remaining women were in some form of steady relationship with a partner. The highest education level for inmates was varied with 14.3% having attained tertiary education, 52.4% having attained secondary education and 15.5% having attained elementary education. The rest (17.8%) had had no formal education. An overwhelming majority (84.5%) of the inmates were of the Christian faith, 13.10% were of the Islamic faith, and the rest (2.4%) were practitioners of African traditional religion. As inmates, none of them earned an income.

About 11% of the inmates were current or past smokers. Most of the women had had multiple births in the past, with 17.9% having had no children, 21.4% having had 1 child, 14.3% having had 2 children, and the remaining 46.4% having had at least 3 children.

Fourteen percent (12/84) of the inmates reported having undergone cervical screening in the past, most (9/12) of them having been screened only once (either by Papor visual inspection with acetic acid [VIA]). None of them had been treated in the past following cervical screening. One inmate had been vaccinated for HPV in the past.

The self-reported prevalence rate of HIV among the inmates was13.1% (95%CI,7.5–21.9%) and all the HIV positive inmates were receiving treatment for that.

Of the 84 screened female inmates, 40 had high risk HPV infections, resulting in a high-risk HPV prevalence rate of 47.6% (95%CI,36.9–58.3%).Of the 40 women infected with high risk HPV, 4 were infected with HPV16 alone, 8withHPV18 alone, and 23withhigh risk HPV types other than HPV16 and HPV18. Some patients were infected with multiple high-risk HPV types. Two inmates had HPV16 and other high-risk HPV types and 3 inmates had HPV18 and other high-risk HPV types.

The positivity rate of high-risk HPV infection among the HIV positive inmates was 63.6% (95%CI,35.4–84.8%).

Cervicovaginal inspection using the EVA system was adequate for all 84 inmates; 13.1% hadTZ1, 24.1% hadTZ2, and 65.5% hadTZ3. Five inmates (6%) had lesions on the cervix (aceto-whitening). Three (3) were all treated with thermal coagulation and 2 with Loop Electrosurgical Excision Procedure (LEEP).

The inmates with high risk HPV infection were younger (mean age = 37.8 years) than inmates without (mean age = 44.0 years); however, this difference was not statistically significant (*t*-test p-value = 0.0686). Similarly, inmates with high risk HPV infection had spent less time (median period of incarceration = 0.80 years) in prison than inmates without high risk HPV infection (median period of incarceration = 1.25 years); however, the difference was not statistically significant (Wilcoxon rank-sum test p-value = 0.2845).The distributions of age and period of incarceration for inmates are shown in Fig. 2.

Discussion

The prevalence rate of HIV among women in Ghana aged 15–49 years according to the Joint United Nations Programme on HIV/AIDS estimates is 2.3% [20, 21]. The self-reported HIV positivity rate for the inmates was 13.1% (95% CI,7.5–21.9), which is lower than the rate of 15.6% (95% CI, 11.8–19.8) reported among prisoners in East and South Africa but higher than the rate of 8.2% (95% CI, 6.2–10.5) reported among incarcerated persons in West and Central Africa [22]. These differences are not statistically significant though since their CIs overlap. All women who declared being HIV positive were receiving antiretroviral therapy. The HPV positivity rate among the self-declared HIV positive inmates was 63.6% (95% CI, 35.4–84.8). The HPV positivity rate among the HIV negative women and those of unknown HIV status were 42.4% and 57.1%, respectively. Among HIV-negative and -positive women living in Kumasi, Ghana, the HPV prevalence rates were 42% and 76.6%, respectively [23].

The prevalence rate of high-risk HPV infection among the inmates (47.6%) washigher than the rate of 10.7% reported among outpatient gynecologic patients assessed in Accra [24], 13.9% among pregnant women living in the Western region of Ghana [25], and 32.3% among women living in the North Tongu District of the Volta Region of Ghana [26].

The national policy on cervical cancer in Ghana recommends screening with VIA for women aged 25–45 years and cytology/pap smear for women aged above 45 [27]. This is because the squamocolumnar junction generally recedes into the endocervical canal with age. This policy was developed before HPV DNA testing became readily available for clinical work in Ghana. The mean age of our study participants

was41.1 (standard deviation, 15.5) years. Thirty-five (35.7%) of the 84 inmates were above 45 years old, which means VIA or screening with mobile colposcopy would not have been the recommended screening modality for them. 65.5% of the women had TZ3. This means the full circumference of the squamocolumnar junction was not visible (Figs. 7 and 8). Using VIA or mobile colposcopy alone for screening would have been inadequate for these women as lesions in the endocervical canal could have been missed. Such women need to be screened with cytology or molecular tests (such as HPV DNA testing) to be able to detect possible endocervical lesions. Based on TZ type, VIA/colposcopy was appropriate for primary screening for 34.5% of the women. Of these women, 13.1% had TZ1 (squamocolumnar junction fully ectocervical) and 21.4% had TZ2 (squamocolumnar junction partly or fully in the endocervical canal but the full circumference was fully visible). This information is important for screening programs that would like to use visual inspection methods (because they are cheaper or easier to perform) as lesions may be missed when the full TZ is not visible.

Women who tested positive on screening were followed up using algorithms developed by and being used by the Cervical Cancer Prevention and Training Centre (CCPTC) at Catholic Hospital, Battor (Figs. 3, 4, and 5). We recommend pap smears after a year for women who test high risk HPV positive with TZ 3 with no lesions on the ectocervix. If the women are available and can afford it or resources are available, the pap smear can be taken after a month. Pap smears are not taken for these women at the initial screening because of low cell yield after taking a sample for HPV DNA testing and cleaning the cervix with acetic acid during VIA or colposcopy.

Twenty-one out of the 40 women who tested positive for high risk HPV (52.5%) had TZ 3 (entire circumference of the squamocolumnar junction not visible). The management per our protocol (Algorithm 1) is follow up with pap smears to rule out a high-grade lesion in the endocervical canal. Nineteen out of the 21 availed themselves for pap smears three weeks after the initial screening. One of the pap smears was reported as atypical squamous cells, cannot exclude high grade intraepithelial lesion (ASC-H) (Fig. 7). The other 18 pap smear test results were negative for intraepithelial lesion or malignancy (NILM).

Five women were treated. Three of them were treated by thermal coagulation on the same day of screening (Fig. 6a, b, and c) while 2 of them with lesions not amenable to ablation were treated with loop electrosurgical excision procedure (LEEP) under local anaesthesia in the Prison theatre some weeks after their pap smears (Fig. 7a and b, Fig. 8a and b).

Tables 1 and 2 show the categories of prisoners and the numbers and percentages of each category. Just over half (11 out of 21) of the women who had served for more than 3 years tested positive for high risk HPV. None of the 4 life prisoners but 1 (20.0%) out of the 4 condemned prisoners tested positive for high risk HPV. The last execution of condemned prisoners was carried out on the night of 17th July 1993 [28]. This means that condemned prisoners who are high risk HPV positive remain at risk of cervical cancer. The high prevalence of high-risk HPV infection among the inmates (47.6%) coupled with the absence of an organized cervical cancer screening program across Ghana including the prisons means there is a risk

of HPV infection persistence and progression to cervical cancer among many prisoners. This calls for an organized cervical cancer screening program for female prisoners, an at-risk population, that may not have the freedom to seek cervical cancer prevention services on their own.

Table 1
Sociodemographic and clinical characteristics of inmates who underwent cervical screening at the Nsawam Medium Security Prison on 27–28 September 2019

Inmate characteristics	Estimate
Age, mean (standard deviation)	41.1 (15.5)
Period of incarceration (years), median (interquartile range)	0.99 (0.47, 3.0)
Incarcerated for at least 5 years	13.1 (11)
Sentence type, % (n)	14.2 (12)
Remand	75.0 (63)
Convict	4.8 (4)
Lifers	6.0 (5)
Condemn	
Period of sentence (years), median (interquartile range) [denominator = 63]	5.0 (2.0, 10.0)
Marital status, % (n)	19.1 (15)
Single	15.5 (14)
Has a steady partner	25.0 (21)
Married	22.5 (19)
Divorced	17.9 (15)
Widowed	
Number of children	17.9 (15)
0	21.4 (18)
1	14.3 (12)
2	46.4 (36)
3+	
Highest level of education, % (n)	17.9 (15)
No formal education	15.5 (13)
Elementary education	52.4 (44)
Secondary education	14.3 (12)
Tertiary education	

Inmate characteristics	Estimate
Religious faith, % (n)	84.5 (71)
Christian	13.1 (11)
Islam	2.4 (2)
African traditional religion	
Smoker, % (n)	10.7 (9)
HIV positive, % (n)	13.1 (11)
Previous HPV vaccination, % (n)	1.2 (1)
Adequate view with mobile colposcopy, % (n)	100.0 (84)
Transformation zone types, % (n)	13.1 (11)
TZ 1	21.4 (18)
TZ 2	65.5 (55)
TZ 3	
Cervical lesions, % (n)	3.6 (3)
Treated for cervical lesions, % (n)	3.6 (3)
Thermal coagulation	2.4 (2)
LEEP	
High risk HPV positive, % (n)	47.6 (40)
High risk HPV types, % (n)	4.8 (4)
HPV 16 only	9.5 (8)
HPV 18 only	27.4 (23)
Other HPV types only	2.4 (2)
HPV 16 and other HPV types	3.6 (3)
HPV 18 and other HPV types	
High risk HPV among HIV + inmates, % (n) [denominator = 11]	63.6 (7)

Table 2
Prevalence of high-risk HPV by period of incarceration and prisoner category

	Number of high-risk HPV positive inmates	Number of inmates	Prevalence rate of high-risk HPV (%)
Period of incarceration (years)			
< 1	21	40	52.5
1–3	8	23	34.8
> 3	11	21	52.4
Prisoner category			
Condemned	1	5	20.0
Life	0	4	0.0
Convict	32	63	50.8
Remand	7	12	58.3

Limitations

This work was not done in the context of a research. The inmates were offered the same services as clients of the CCPTC at Catholic Hospital, Battor. The same prescreening forms were filled before the inmates were screened. Therefore, questions like history of intravenous drug abuse, sharing needles, illicit drug use, exchanging sex for drugs or money, among others, which are all risk factors for acquiring HIV and predisposing inmates to high risk HPV infection, were not directly asked. The AmpFire HPV detection system does not offer full genotyping and lumps 13 high risk HPV infections together. It was therefore impossible to assess the most common high risk HPV types among the prison inmates, and also impossible to detect multiple HPV infections especially when the multiple infections were due to high risk HPV types other than HPV 16 and 18. Also, it is likely that the true incidence of HIV infection among the inmates is higher than documented here as the figure presented here was based on self-report among inmates with no onsite HIV testing performed.

Conclusions

We present the first results of the prevalence of high-risk HPV among inmates in Ghana. With this high prevalence of high-risk HPV (47.6%), and 13.1% having been in prison for at least 5 years, many incarcerated women are at an elevated risk of developing cervical cancer if cervical cancer prevention services are not offered in the prisons.

We have demonstrated that it is possible to offer a high level of onsite screening and treatment of precancerous lesions of the cervix even for inmates in a prison using current technologies such as HPV

DNA testing by the AmpFire HPV detection system (Atila Biosystems, Mountain View, CA, USA), mobile colposcopy with the EVA system (MobileODT, Israel), and thermal coagulation and LEEP with the Cure/Liger Medical thermal coagulator and electrosurgical unit (Liger/Cure Medical LLC, Utah, USA).

Abbreviations

Ghana Association of Quasi Health Institution – GAQHI

Human Papilloma Virus – HPV

Deoxyribonucleic acid – DNA

Human Immunodeficiency Virus – HIV

Cervical Cancer Prevention and Training Center – CCPTC

Polymerase Chain Reaction – PCR

Enhanced Visual Assessment -EVA

Visual Inspection with Acetic Acid – VIA

Transformation Zone- TZ

Confidence Intervals – CI

Loop Electrosurgical Excision Procedure – LEEP

Negative for Intraepithelial Lesion or Malignancy -NILM

Atypical Squamous cells-favor High Grade- ASC-H

Declarations

Ethics approval and consent to participate

Ethical approval and institutional accent were granted by the Ghana Prisons (NSM/0023/V.1/32/20). Written consent was obtained from the study participants prior to screening.

Consent for publication

Written approval was given by the Ghana Prisons Service for the findings of this research to be published.

Availability of data and materials

All data generated or analysed during this study are included in this article and its supplementary information files.

Competing interests

The authors declare no competing interest.

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Authors' contributions

Conceptualization: KE, ET, and LKA. Participant screening, treatment, and data collection: ET, CMW, IG, SK, ACK, PAD, NOME, MA, DA, and KE. Data collation: ET, CMW, IG, SK, ACK, PAD, NOME, MA, and DA. Formal analysis: KE and JEA. Writing –original draft: NOME, LKA, PKA, JEA, and KE. All the authors read and approved the manuscript in its current form.

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Figures

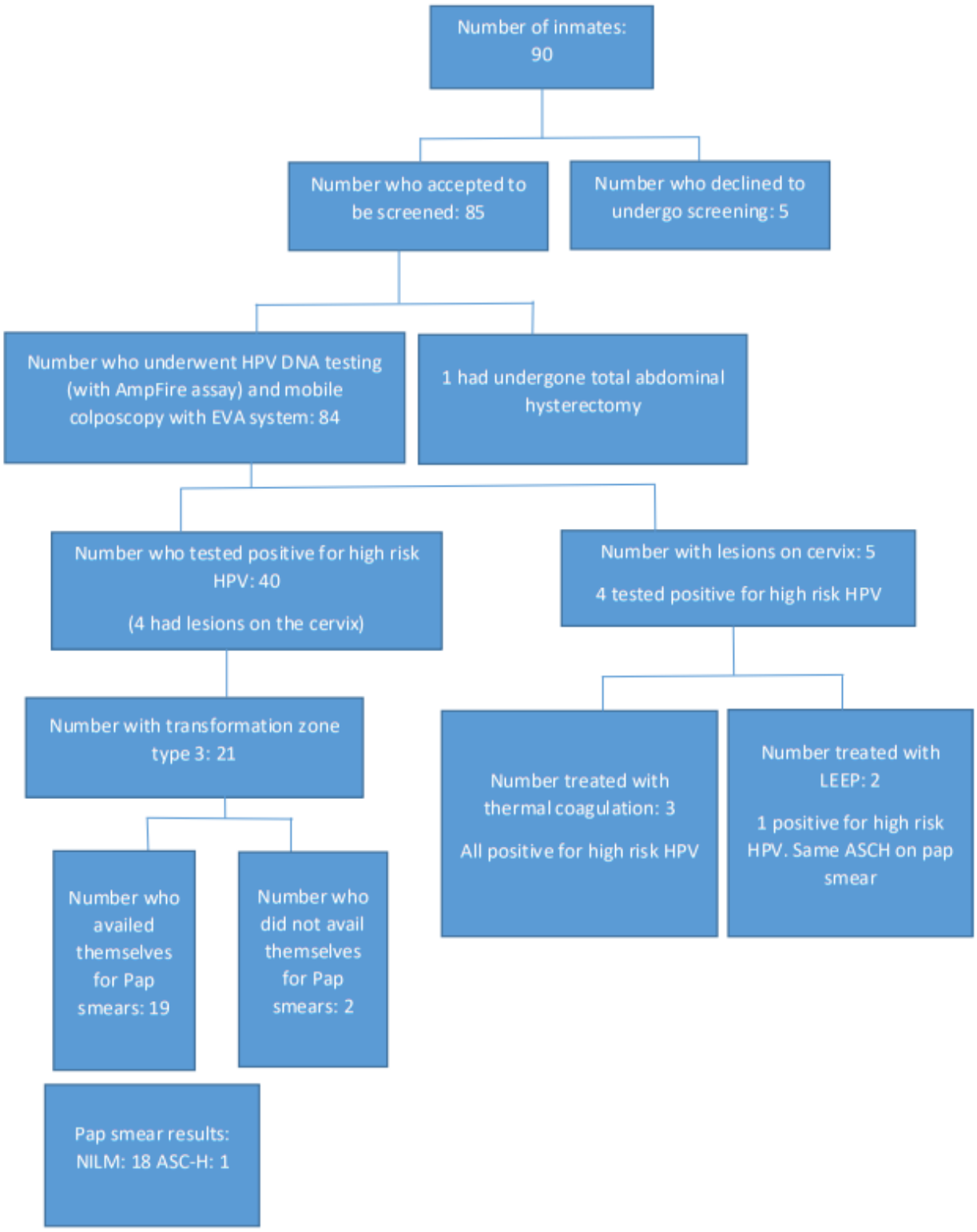

Figure 1

Overview of screening and treatment of female inmates of Nsawam Medium Security Prisons, Ghana

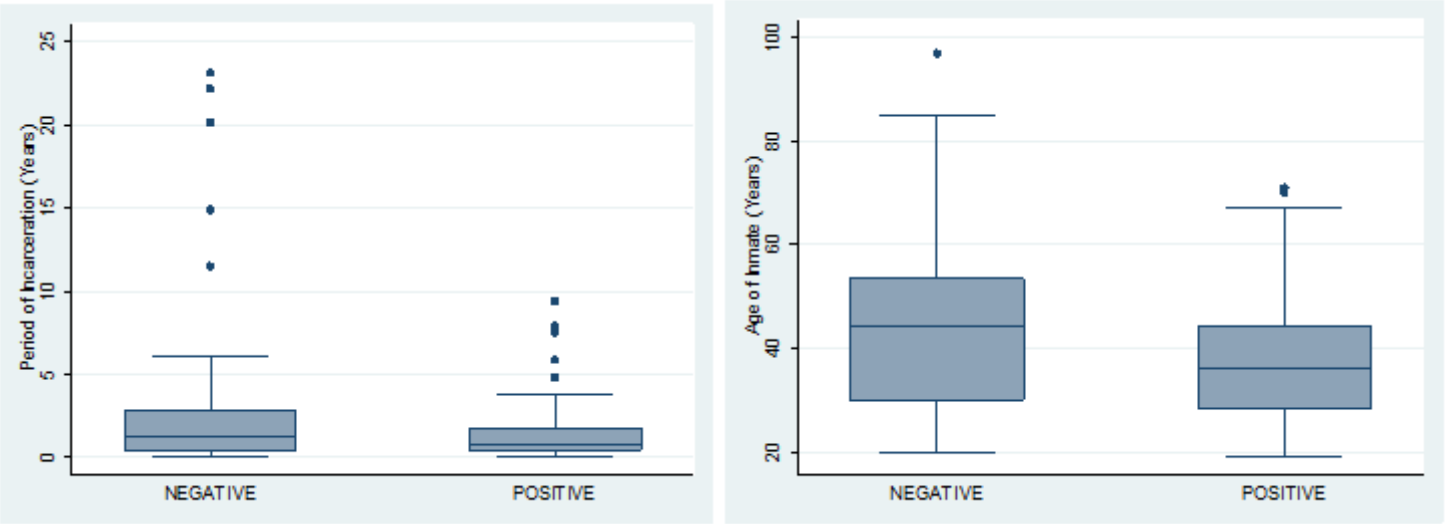

Figure 2

Distribution of period of incarceration and age by high risk HPV status of inmates

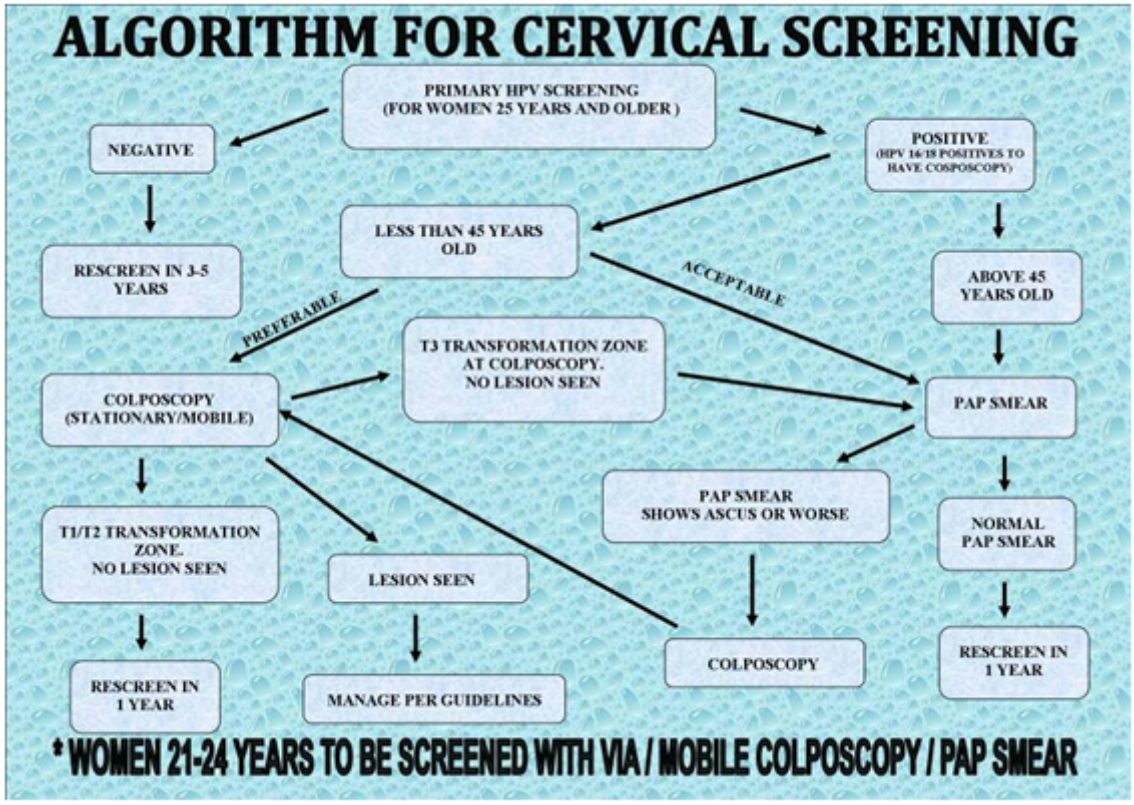

Figure 3

Algorithm for cervical cancer screening developed by the CCPTC, Battor

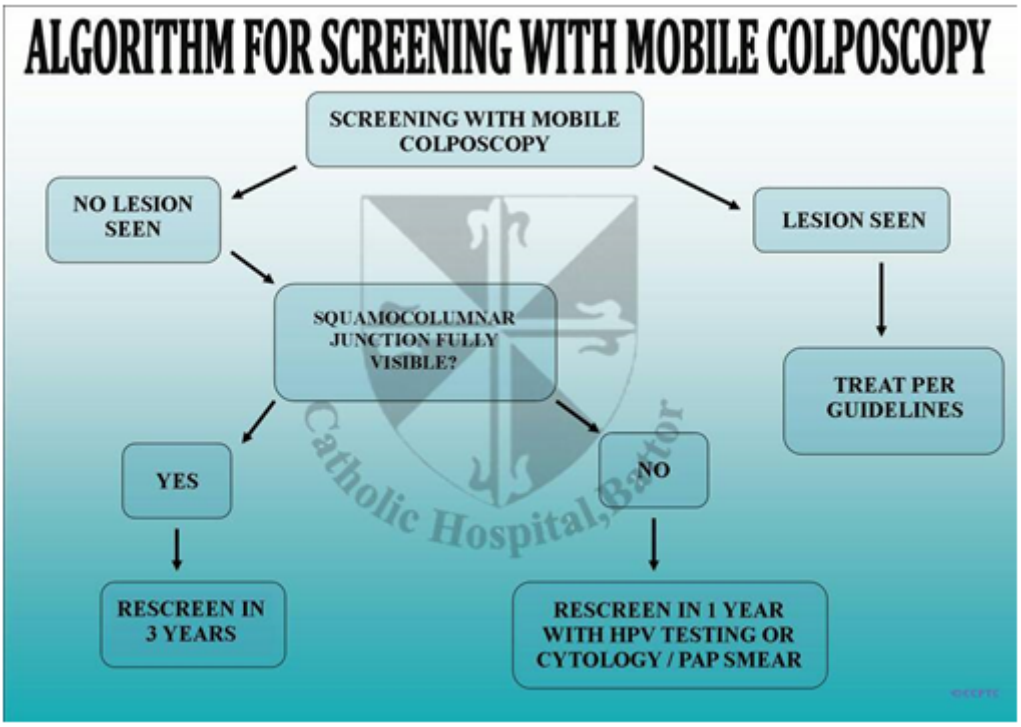

Figure 4

Algorithm for cervical cancer screening using the mobile colposcope

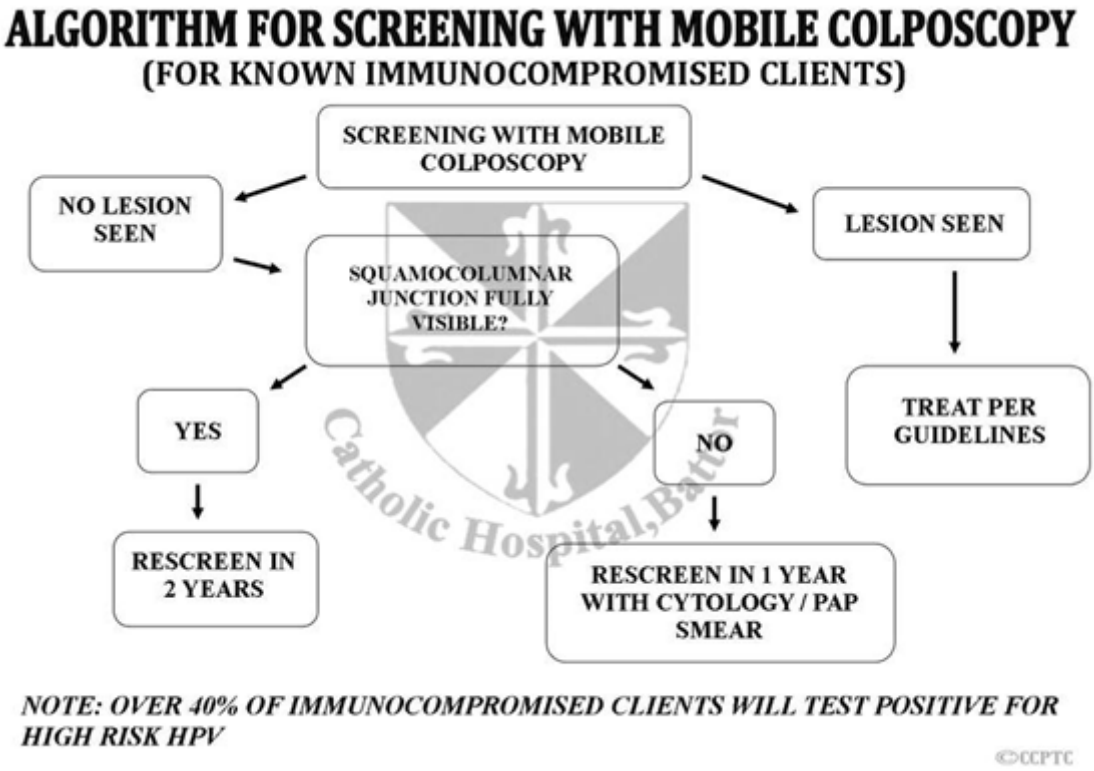

Figure 5

Algorithm for cervical cancer screening with the mobile colposcope for known HIV positive patients

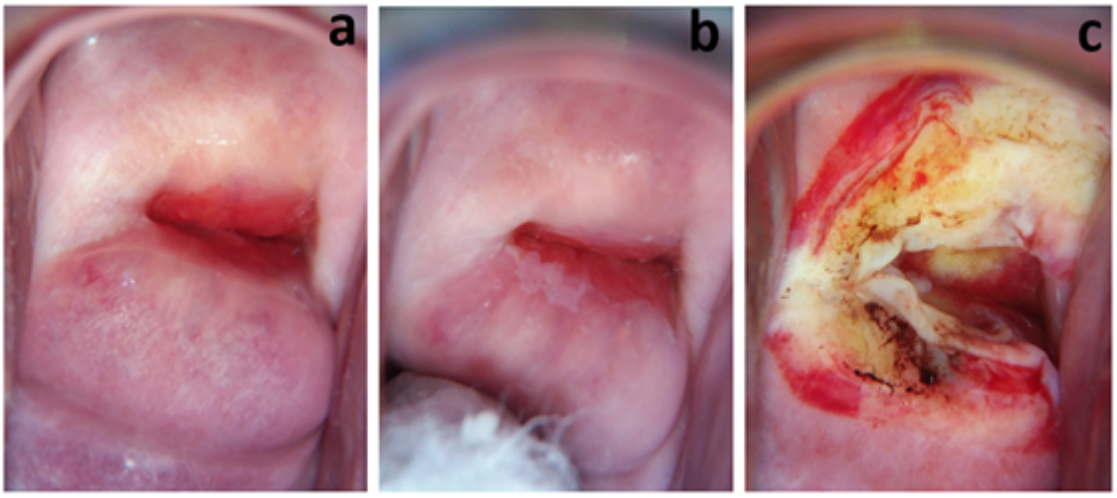

Figure 6

Colposcopy images of a 42-year-old inmate, para 2. HPV DNA testing - positive (for others). Colposcopy: TZ 1, minor change [before acetic (a), after acetic acid (b)]. Treatment: thermal coagulation (c)

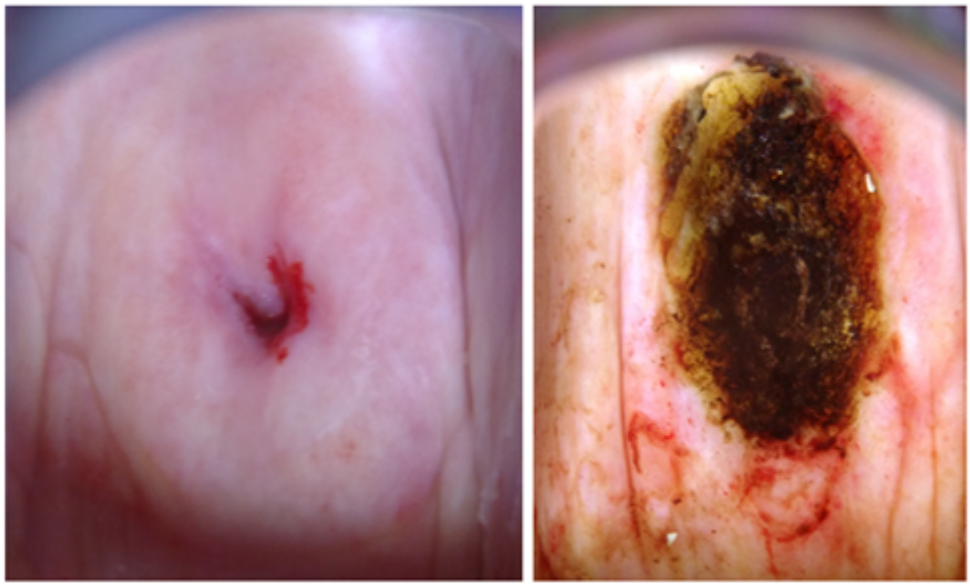

Figure 7

Colposcopy images of a 67-year-old inmate, para 7. HPV DNA testing - positive for high risk (others). Colposcopy: TZ 3, leukoplakia at 12 O'clock entering the endocervical canal. Colposcopy: adequate, TZ3. Pap smear: atypical squamous cells, cannot exclude high grade intraepithelial lesion (ASC-H). Treatment: LEEP. Histopathology: No dysplasia

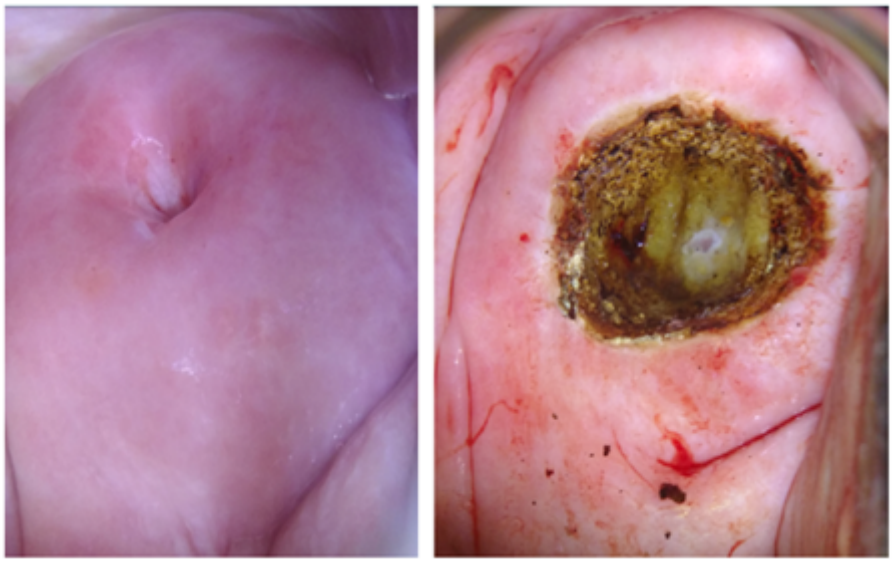

Figure 8

Colposcopy images of a 62-year-old inmate, para 4. HPV DNA testing - negative. Colposcopy: TZ 3, leukoplakia at 11 O'clock extending into the endocervical canal. Pap smear: negative for intraepithelial lesion or malignancy (NILM). Treatment: LEEP. Histopathology: No dysplasia

Supplementary Files

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- QUESTIONNAIR.pdf