

# Screening Strategies for Cervical Cancer in Cambodia – A System Dynamics Model

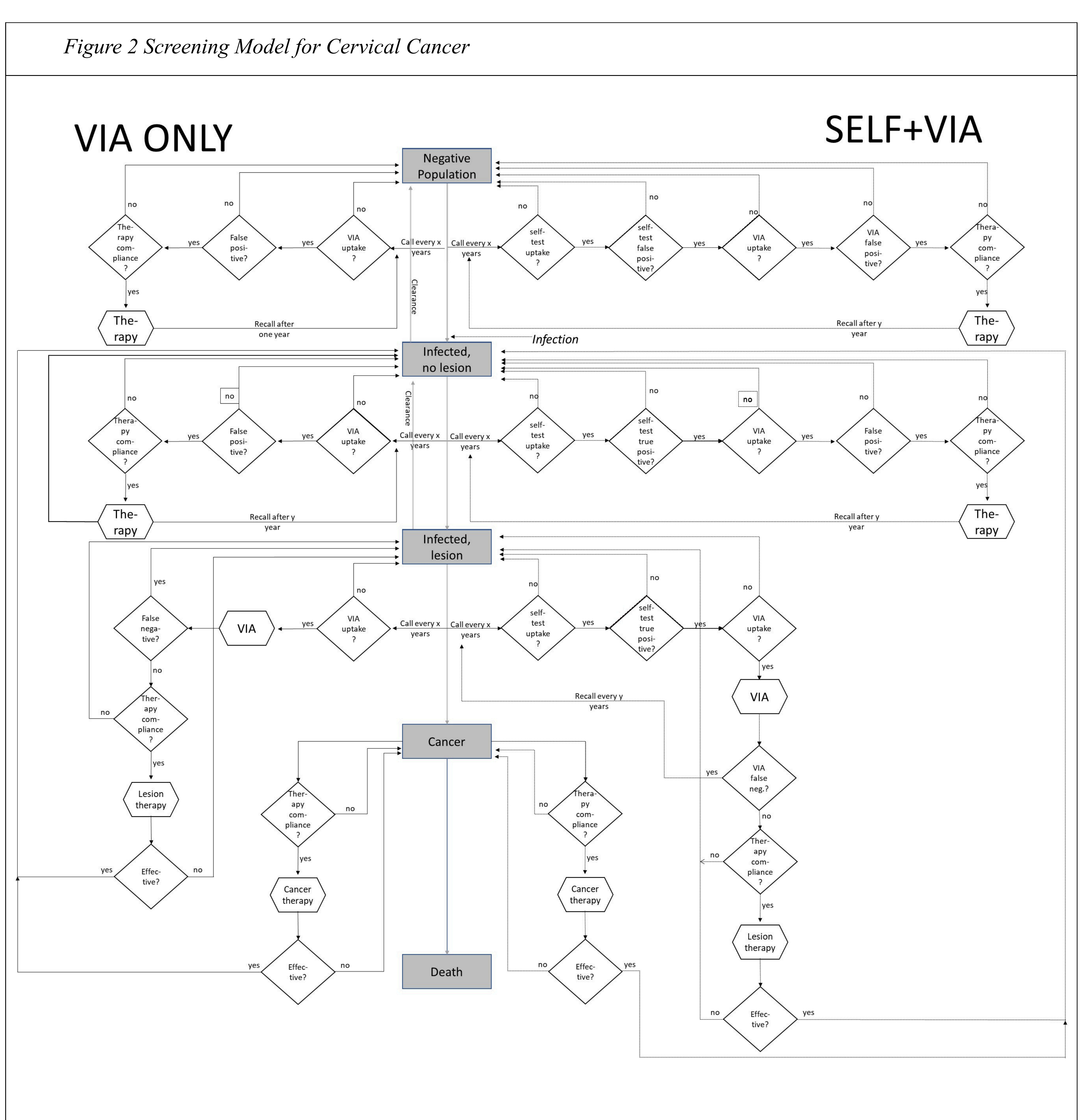
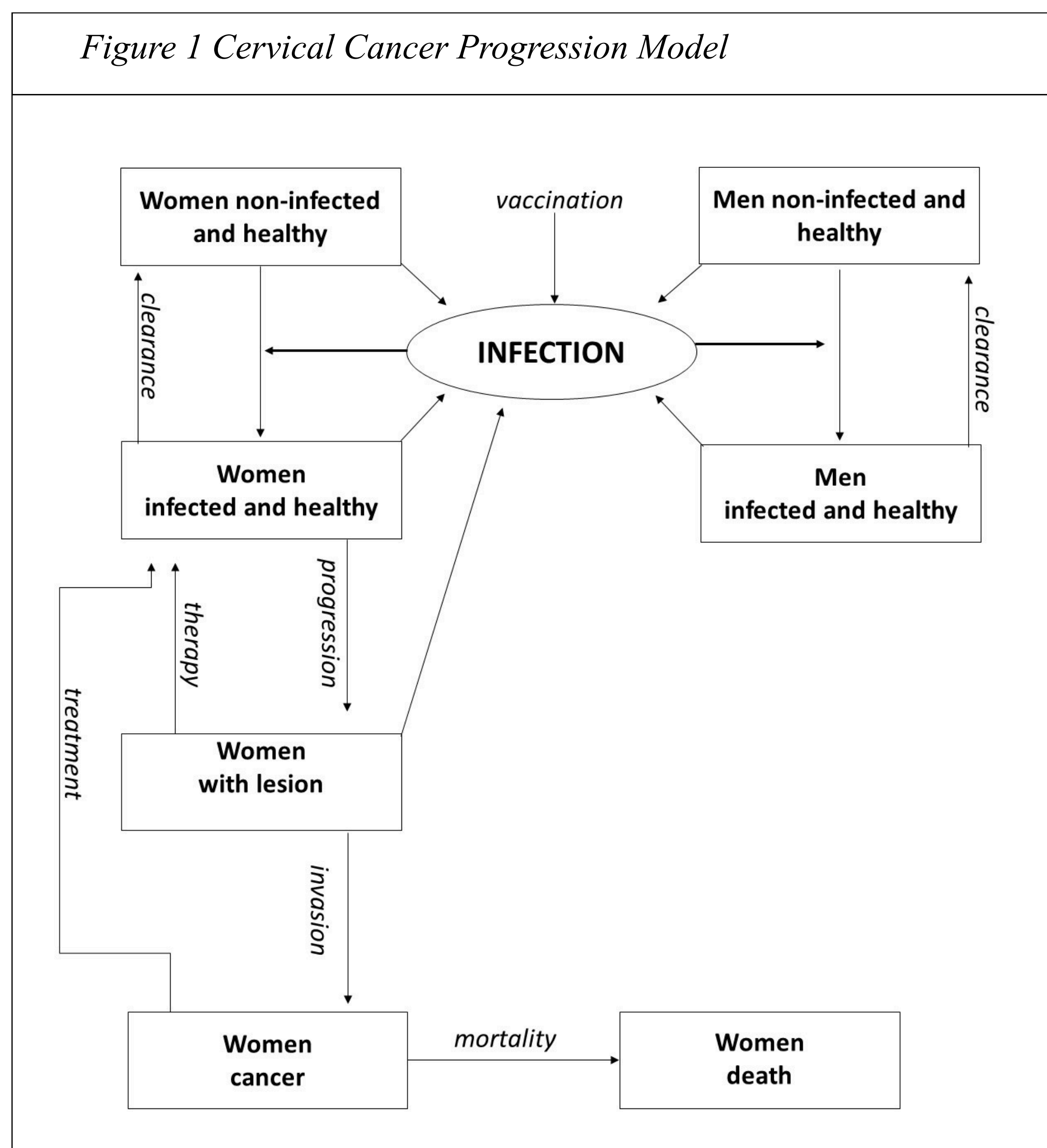
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## Background

Cervical Cancer is a major cause of suffering and deaths, particularly in low- and lower-middle-income countries like Cambodia. Screening and early treatment of lesions have been demonstrated to be cost-effective, but different screening strategies have to be analysed for their effectiveness and efficiency. This study explores a combined screening strategy only based on visual inspection with acetic acid (VIA) and in combination with a self-sampling strategy based on a combination of a self-sampling human papillomavirus (HPV) DNA test and VIA.

## Methods

The system dynamics model simulates the disease life cycle of cervical cancer (Figure 1) for the VIA and the VIA + self-sampling strategy (Figure 2). The baseline economic data values were obtained based on micro-costing analyses of the Cambodian healthcare sector. For original data on test accuracy, uptake, and treatment parameters, in Cambodia and locations within a similar socioeconomic context, PubMed, ScienceDirect, Google Scholar and grey literature were searched. These, in combination with data shared by our implementation sites, were utilised to construct a set of values that served as a baseline for this study. The model includes the demography (fertility, general mortality, ageing), disease transition (from “infected and healthy” to “infected with lesion”; clearance, “infected with lesion” to “cancer”, “cancer” to “death”) and the infection of women and men during partnership and short-term relationships. The model follows a standard mathematical representation of sexually transmitted diseases and applies it to cervical cancer.



## Results

In lower resource settings, VIA has become one of the most implemented screening techniques for Cervical Cancer prevention. However, recently, the attention has shifted to HPV DNA testing as a more accessible alternative. Particularly, HPV DNA self-tests are theorised to increase earlier detection of HPV infection to reduce the onset of lesions and decrease cost simultaneously. This study supports this evidence, however, some results call for further consideration.

Firstly, the simulations demonstrate that the strategy VIA + self-sampling leads to a decrease in cancer cases and cancer deaths, resulting in Years-of-Life-Gained (YLG). However, the impact on the population is rather small, and reducing the mortality of cervical cancer will result in a minor increase in incidence. This might be because treated women are still infectious. Thus, detecting and treating more women reduces cancer mortality, but can increase the incidence as cases are revealed at an earlier stage. Nevertheless, the impact on mortality is much higher than the incidence effect.

Secondly, the results show that the self-test is cost-effective (cost per year of life gained < 2 GNP p.c.) if the time horizon is long enough, but it still requires many more resources. The cost per year is about 5 times as high in the first year of intervention, but only 2 times in the 100<sup>th</sup> year of intervention. This difference is due to the reduced cost of cancer treatment based on improved lesion detection and lower cancer incidence. Thus, the time-preference rate determines whether an intervention program is seen as cost-effective or not.

Thirdly, VIA-screening uptake is crucial, i.e., it seems that the uptake of VIA tests without self-testing is a major determinant of the economic advantage of a self-test. If an existing VIA program already works very well, it is less efficient to introduce the self-test. If, on the contrary, the population rejects the VIA program because they do not want to be examined by a healthcare professional, the self-test constitutes an efficient method to fight cervical cancer. Thus, the self-sampling, plus VIA strategy, offers meaningful long-term health gains and becomes increasingly cost-effective over time. Its success depends on thoughtful program design, effective implementation, and strong community engagement. When implemented under favourable conditions, it provides a scalable and efficient method to improve cervical cancer outcomes in low-resource settings.

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## Conclusion

In summary, VIA in combination with HPV self-sampling delivers the greatest benefit when it expands screening in underserved populations, is paired with high compliance and accurate testing, and remains financially sustainable, particularly in settings with low VIA uptake. Consequently, the introduction of a self-sampling scheme is necessary to efficiently and effectively tackle cervical cancer and increase early detection. To ensure successful implementation, the most crucial factor is increasing screening uptake. Necessary policy reforms include eliminating financial barriers to implementing the self-sampling scheme, while strengthening community outreach and education campaigns. A subsequent factor involves enhancing access to quality care, and thus, increasing the uptake of a self-sampling tool and decreasing cervical cancer-related mortality rates.

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