UCT KNOWLEDGE CO-OP

COST-EFFECTIVENESS OF INCLUDING BOYS IN HPV VACCINATION

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The UCT Knowledge Co-op facilitated this collaborative project between CANSA and UCT.

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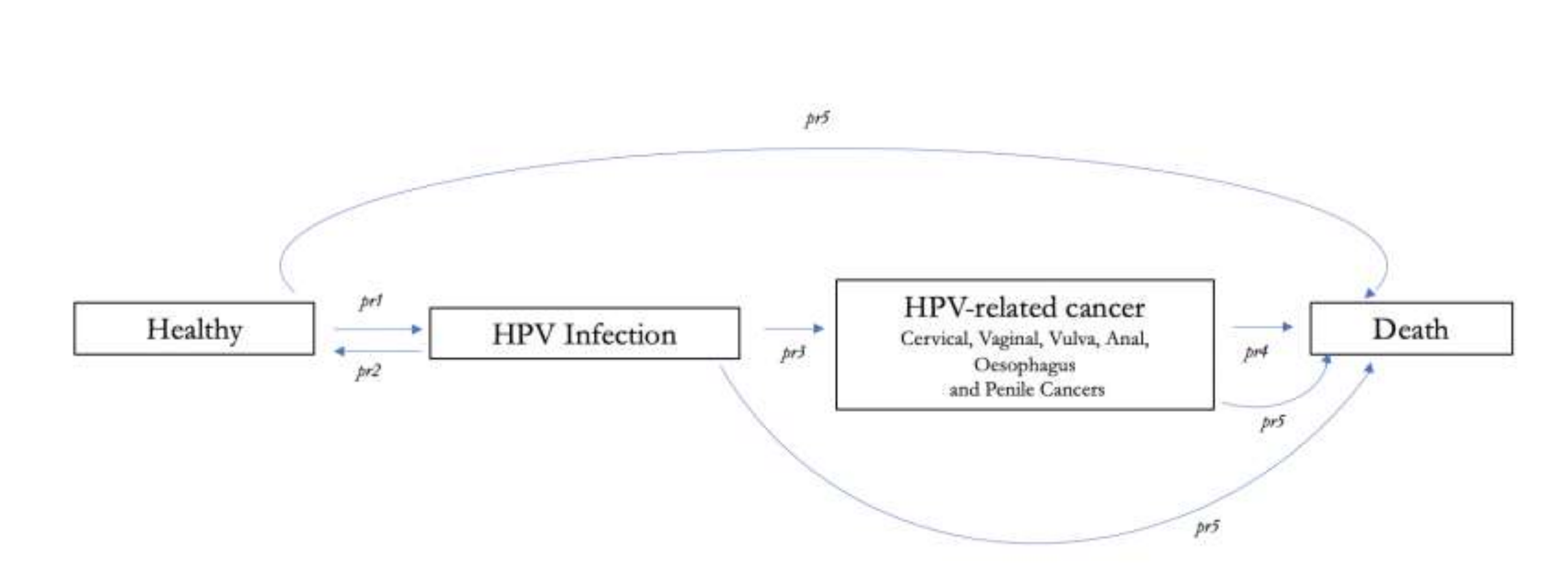
WHY IS AN HPV VACCINE NECESSARY?

Summary of the main literature and theoretical considerations.

- Internationally, there has been interest in the feasibility of universal HPV vaccination
- Males are susceptible to a growing burden of HPV-related forms of cancer.
- South Africa has a combined burden of HPV and HIV which worsens the impact of HPV-related illness
- The female-vaccine could provide herd-immunity, but has enough of the female population been vaccinated to do so?
- With a herd-immunity approach to male protection, the homosexual population remains vulnerable.

THE MARKOV MODEL



- Uses a Markov Model built on Excel
- Four *'Disease States'* to model how individuals develop an infection and eventually die
- States are mutually exclusive and exhaustive
- Transition probabilities were calculated by the researcher and represent the probability of moving from one disease state to another
- Necessary to note that precancerous lesions were left out of this representation of disease and were not accounted for in this study.

HOW DOES THIS WORK?

- Measures the costs (in monetary terms) and the benefits (the utility-gained) associated with spending a cycle in a specific disease state.
- These are aggregated over successive cycles for the whole cohort.
- The total costs and total benefits of different interventions, it is then possible to compare different scenarios.
- This can be done using the incremental cost-effectiveness ratio (ICER) which is compared to different cost-effectiveness thresholds.
- This study uses the WHO's threshold of R263 575 to be cost-effective.

HOW DID I CALCULATE THE INPUTS?

Explaining how I calculated the cancer and death probabilities, costs and benefits used.

PROBABILTIES

- Cancer probabilities were created using the anal, vaginal, vulva, cervix, penile and oesophagus cancer age-specific incidence rates **provided by the 2016 NCR reports**
- Death probabilities were created using the number of deaths provided by Statistics SA for 2017.

COSTS & BENEFITS

- Cost values were taken from a previous study in the UK (inflated and converted to ZAR)
- Benefit values were taken from a previous SA study by Li et al. (2015).

All values were weighted by proportion of HPV cancers.

ASSUMPTIONS

1. The model assumes that 10% of individuals within the cohort attend private schools. Individuals attending private schools are assumed to be vaccinated by the government programme and the possibility that they might seek the vaccine independently has not been considered.

2. Based on Kreimer et al.'s (2020) findings, the vaccine efficacy of the two-dose and single-dose schedule is assumed to be 84% and 82%, respectively. The model assumes lifetime vaccine efficacy, in line with the assumptions made by Sinanovic et al. (2009) in a previous cost-effectiveness analysis.

3. Importantly, the model assumes that people can only develop an HPV-related cancer after HPV- infection. The state *HPV*-Infection is modelled as any form of HPV . This assumption implies that HPV causes all cases of HPV-related cancer within the model. In reality, the proportion of each type of cancer caused by HPV-infection varies.

TWO-DOSE RESULTS

Cost-effectiveness of adding the boys to the HPV in 2019 ZAR under the two-dose schedule

Outcomes	No Vaccine	Girls-Only	Girls & Boys	Incremental Value *girls-only compared to universal*	ICER (ZAR/QALY) *girls-only compared to universal*
<u>Two-dose Scenario</u>					
discounted at 5%					
Initial Vaccine Costs	0	R15 618	R31 236	+ 100%	
Female Cancer Costs	R29 591 700	R25 035 389	R24 250 851	- 3,13%	
Male Cancer Costs	R2 760 374	R2 588 378	R 2 410 362	- 6,88%	R196 868
QALYS	1 795,55	1 824,05	1 828, 86	+0,26%	***cost-effective***
discounted at 3%					
Initial Vaccine Costs		R15 618	R31 236	+ 100%	
Female Cancer Costs	R55 831 956	R51 341 521	R50 127 687	- 2,36%	
Male Cancer Costs	R6 673 539	R6 403 514	R6 045 378	- 5,59%	R 330 436
QALYS	2 501,37	2 528,79	2 533,55	+ 0,19%	***not cost-effective***

Values are ***per 100 individuals***. QALYs stands for quality-adjusted life years. The incremental value reflects the percentage change in costs or benefits of adding boys to the existing girls-only programme. ICER indicates incremental cost effectiveness ratio of a universal vaccine compared to the girls-only programme. The WHO cost-effectiveness ratio of (3 x GDP/capita = ZAR 265 575) has been used to determine cost-effectiveness within the table. The girls-only vaccination programme is modelled to have reached 60% of girls attending public schools. The universal vaccine is assumed to reach 60% of boys attending public schools.

TWO DOSE RESULTS

- A universal vaccine, that is 84% effective and achieves a 60% coverage amongst public-school attending individuals, is seen to reduce female cancer costs by 3,13% and male cancer costs by 6,88%, using a 5% discount rate.
- This amounts to a 2,36% and 1,66% decrease female and male cancer costs respectively, under a 3% discount rate.
- Using a 5% discount rate, the ICER of adding boys to the existing vaccination programme is ZAR 196 868. **This is considered cost-effective according to the WHO.**
- The price per additional QALY (ZAR 196 868) using a universal vaccine instead of the girls-only programme, is higher than the price per additional QALY (ZAR 165 357) from first introducing the girls-only programme.
- The result contradicts previous studies which found a universal vaccination to be not cost-effective. This is could be attributed to higher levels of female coverage in both New Zealand (70%) and parts of the United Kingdom (above 80%) than the coverage (60%) assumed for South Africa in this model.

SINGLE DOSE RESULTS

Table 8

Cost-effectiveness of adding the boys to the HPV in 2019 ZAR under a single-dose schedule

Outcomes	**Girls-Only**	**Girls & Boys**	**Incremental Value** *girls-only compared to universal*	**ICER** (ZAR/QALY) *girls-only compared to universal*
Single-dose Scenario				
discounted at 5%				
Initial Vaccine Costs	R10 412	R20 824	+ 100%	
Female Cancer Costs	R24 653 270	R23 578 352	- 4,36%	
Male Cancer Costs	R 2 459 437	R2 283 534	- 7,42%	R185 412
QALYS	1 825, 52	1 831, 21	+ 0,31%	***cost-effective***
discounted at 3%				
Initial Vaccine Costs	R10 412	R20 824	+100%	
Female Cancer Costs	R51 019 852	R49 713 114	- 2,56%	
Male Cancer Costs	R6 456 478	R6 156 253	- 4, 65%	R246 762
QALYS	2528,79	2535,26	+ 0,26%	***cost-effective***

SINGLE DOSE RESULTS

- This programme would be cost-effective using a 3 and 5% discount rate.
- The price per QALY in a single dose universal vaccination programme (ZAR 185 412) is unsurprisingly lower than the price of a two- dose universal schedule (ZAR 196 868)
- This is the result of lower vaccination costs and the higher proportion of the population vaccinated
- **Relies on the assumption that the single-dose programme is as effective as the two-dose schedule** in reducing HPV prevalence.
- Should this assumption hold, it is likely that a single dose programme would also reduce the cost of vaccination by removing the administrative burden of tracking individuals to administer the second dose.

LIMITATIONS

Due to the complexity of this type of modelling, several assumptions and simplifications have been made within this model. These effect the credibility of the results.

1. Health Costs Used
2. Cancer and Mortality Probabilities
3. Single HPV-related cancer state
4. Assumptions on sexual behaviour
5. Effect of HIV+ and homosexual populations omitted
6. Further reaching benefits not quantified

THANK YOU!

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with any further questions.

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