Differentiating between the natural course of an HIV epidemic and impact of sociobehavioural changes.
Choosing the correct HIV indicator as measure of the state of the HIV epidemic in a specific country.
What HIV indicators should we use to compare the epidemics across countries & what HIV indicators give us a sense of where the epidemic is?

- HIV incidence:

Expectation: lower numbers of new HIV infections per year a good sign

Contextualization: while a lower number of new HIV infections is obviously better than a higher number of new HIV infections, HIV incidence depends on multiple factors - how can HIV incidence be compared between countries without first acknowledging this fact ?

Example: Country A has a slightly higher HIV incidence than country B, but country A has 100% higher HIV prevalence than country B, which is doing better?

- HIV prevalence:

Expectation: lower HIV prevalence means less people living with HIV and should be good

Contextualization: while a lower number of people living with HIV is obviously better than a higher number of new HIV infections, HIV incidence depends on multiple factors - how can HIV incidence be compared between countries without first acknowledging this fact ?

Example: Take again country A with 100% higher HIV prevalence than country B, but country A has very little HIV mortality thanks to widespread use of ART while country B

$$36V^2 = A^2x^2 - 2Ax^4$$

which we may solve to get

$$V = \frac{1}{6}(A^2x^2 - 2Ax^4)^{1/2}.$$

At a maximum we have $dV/dx = 0$. Computing the derivative of (), we find

$$\begin{aligned}\frac{dV}{dx} &= \frac{2A^2x - 8Ax^3}{12\sqrt{A^2x^2 - 2Ax^4}} \\ &= \frac{A^2x - 4Ax^3}{6\sqrt{A^2x^2 - 2Ax^4}} \\ &= \frac{1}{6\sqrt{A^2x^2 - 2Ax^4}} Ax(A - 4x^2).\end{aligned}$$

So at a maximum either $A = 0$ or $x = 0$ or $x = \pm\sqrt{A}/2$. The positivity assumptions rule out the three cases $A = 0$, $x = 0$ and $x = -\sqrt{A}/2$, so the only candidate for a maximum is at $x = \sqrt{A}/2$.

Now we explain why this is in fact a maximum and not some other critical point…