Modelling to support routine PCV introduction in Somaliland

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Conflicts of interest

All authors declare no competing interests.

Ethics

This analysis was specified as a secondary analysis of the collected data in the protocol for EEPICC, which was reviewed by the ethics committee of the London School of Hygiene & Tropical Medicine.

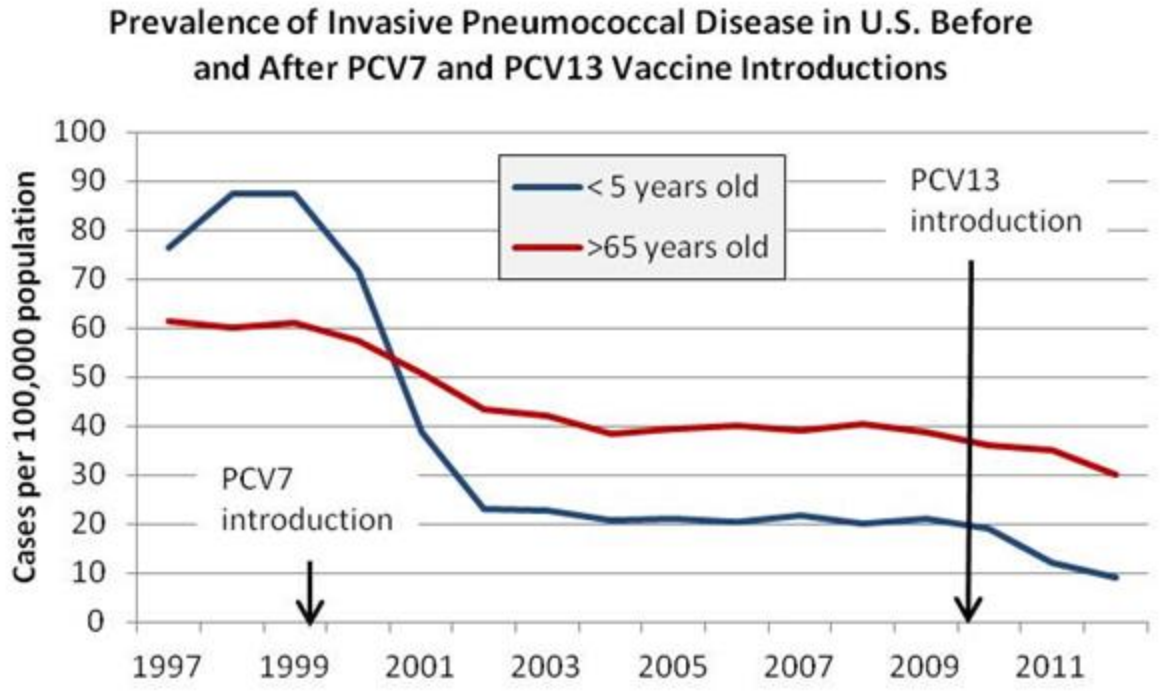
Streptococcus pneumoniae

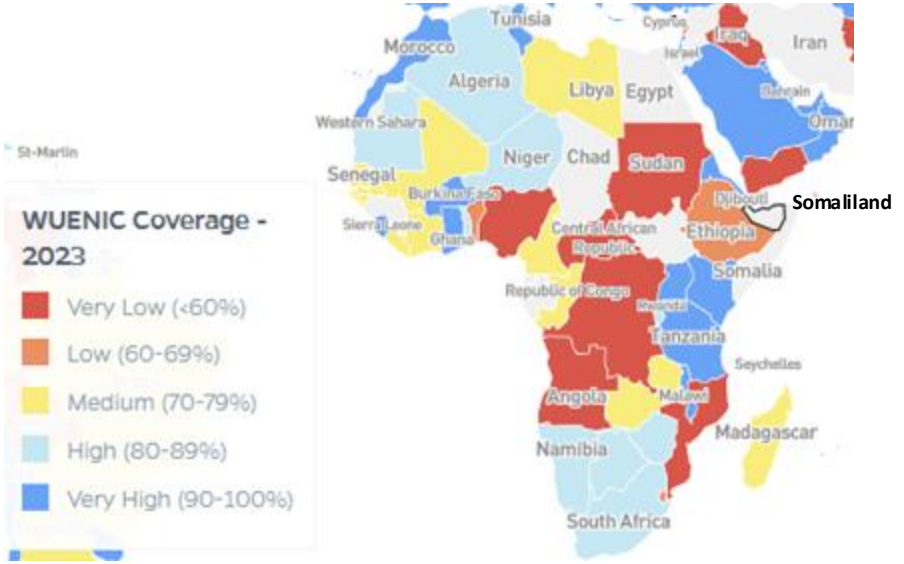
Epidemiology

- Bacteria carried in nasopharynx
  - ~5-20% of adults and 30-80% of children
- Causes **pneumonia**, **meningitis,** and **sepsis** in young children, immunocompromised, and the elderly
- Over 100 serotypes, though a handful of serotypes dominate carriage and disease

Pneumococcal Conjugate Vaccines (PCVs)

- Protect against carriage and disease of most virulent serotypes
- Have substantially reduced pneumococcal disease burden in majority of countries
- PCV still not introduced in a number of countries, and underutilized in humanitarian crises
  - coverage issues in several LMICs





PCV developments relevant for low-coverage and humanitarian settings

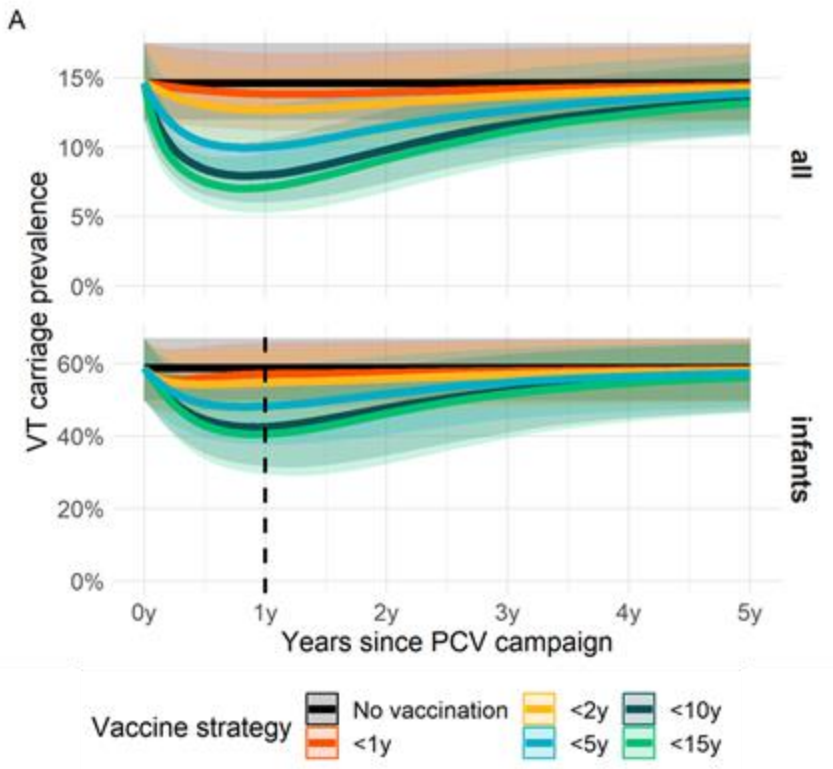
- 2015 onwards: MSF Access campaign to reduce price of PCV in humanitarian settings
- 2017: humanitarian mechanism (WHO, Unicef, Médecins Sans Frontières and Save the Children) guarantees access for humanitarian use of PCV at Gavi-level pricing
- 2019: Pneumosil (SII) vaccine WHO prequalified, substantially reduced price
- 2019 - ongoing: LSHTM-led studies on effectiveness of PCV campaigns in humanitarian crises
- 2020: Gavi dropped requirement of DTP3 coverage >70%, for PCV eligibility
- 2022 - 2024: Epicentre trial finds fractional (20%) dose Pneumosil campaign is non-inferior to full dose

Somaliland

- Low-income country in the horn of Africa
- Affected by food insecurity and droughts
  - substantial levels of displacement in the country
- High childhood mortality associated with respiratory diseases
- Somaliland (and Somalia) introducing PCV in 2025
- Low routine vaccination coverage of other vaccines

PCV studies in Somaliland

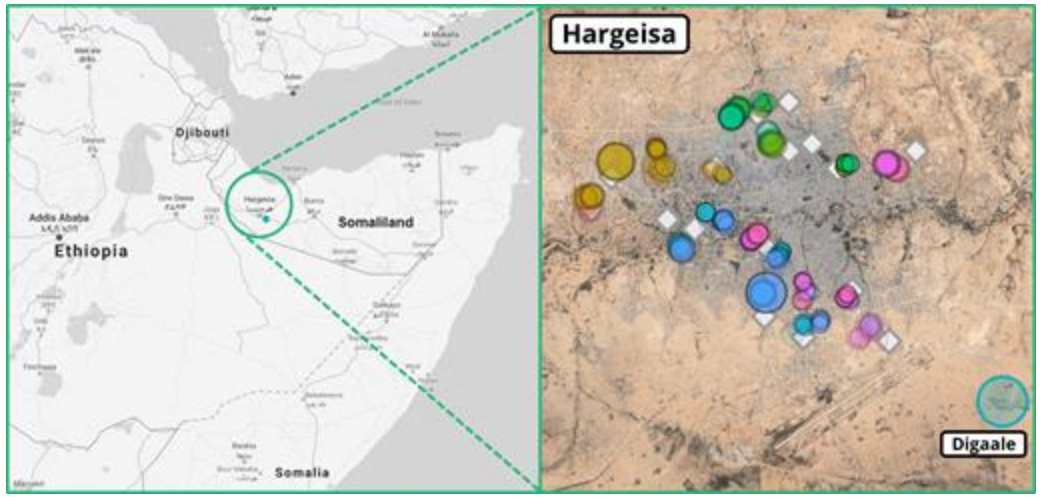
Modelling the potential impact of PCV vaccination strategies in humanitarian crises (MSF Scientific Days 2023)



Validating modelling work with an intervention study (EEPICC study)

1. *Evaluating the Effectiveness of a PCV campaign in Somaliland IDP camp*

2. *Cross-sectional survey in Somaliland capital of Hargeisa, to support national decision making*



Supporting national PCV decision makers in Somaliland

Aim: to explore the likely impact of introducing PCV in the national childhood vaccination programme

Support decision makers to understand:

1. What is the effectiveness and efficiency of PCV at realistic coverage levels?
2. What PCV product should be introduced?
3. Which vaccination schedule should be used?
4. Should catch-up campaigns be used to accelerate PCV impact?

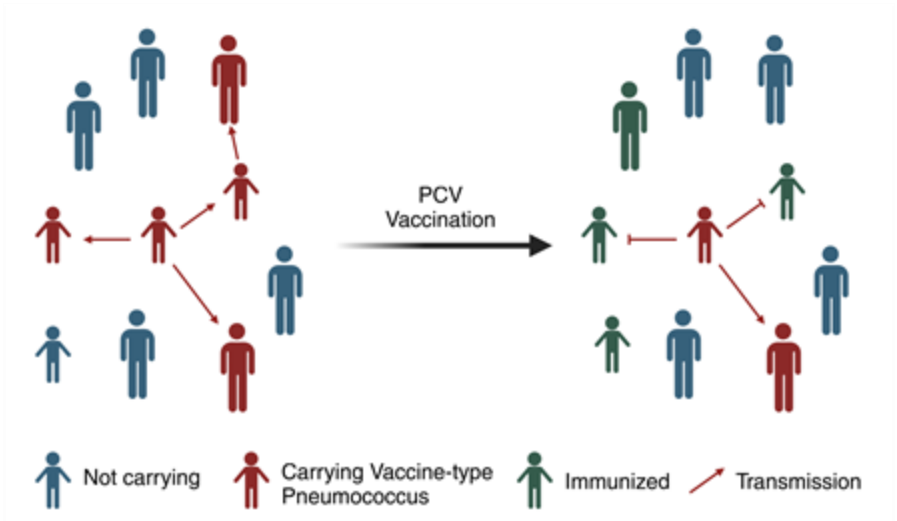
Modelling vaccination impact

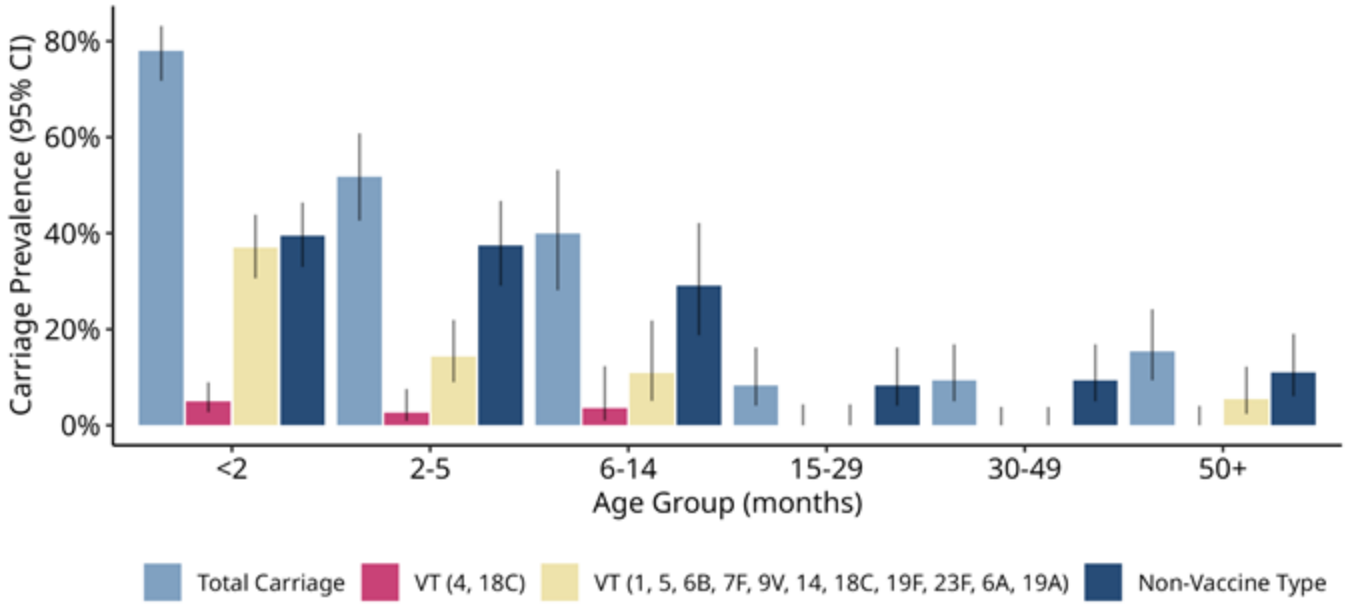
Key data

- Cross-sectional study estimating pneumococcal carriage prevalence in Hargeisa in 2022

Methods

- Mathematical modelling to simulate impact of different vaccination scenarios on carriage and disease





Routine PCV coverage

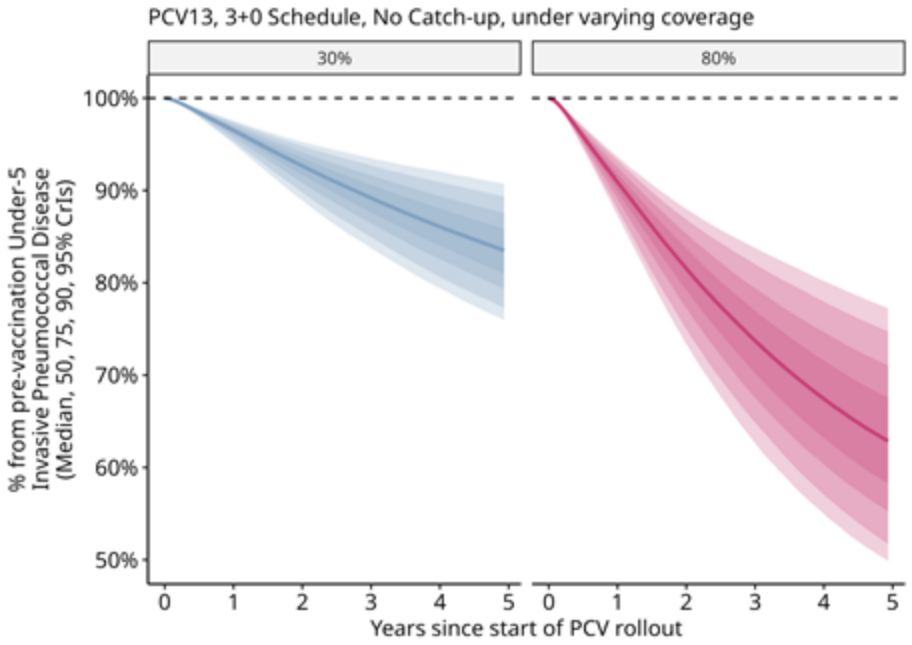
Coverage Assumptions

Based on a 2020 survey, coverage for 3rd dose DTP is 14% to 52%. Two scenarios are modelled:

- *Realistic*: 30% coverage
- *Ideal*: 80% coverage

Pentavalent vaccine dose 3	Number	Valid data (%)	Percentage %	Age group in months Minimum age	Maximum age
Not vaccinated	368	48.2%	13.8%	3	56
On time vaccinated	82	10.7%	3%	3	18
Delayed time vaccinated	127	16.6%	4.7%	19	52
Not applicable	186	24.4	7%	0	2
Subtotal	763	100%			
Missing values	1910	..	71.5%	3	59
Grand total	2673	..	100%	---	----

https://doi.org/10.3390/vaccines12050509
Somaliland Demographic and Health (Household) Survey 2020



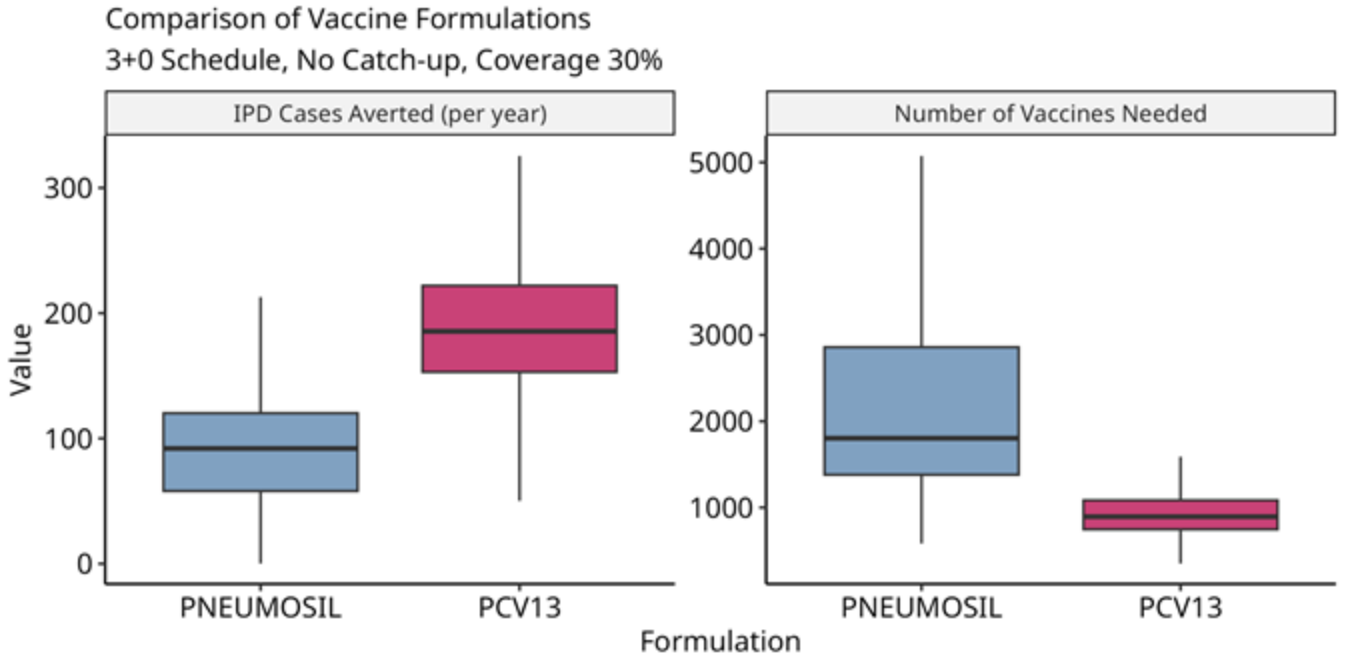
Impact of varying coverage

Coverage	Realistic (30%)	Ideal (80%)
Annual IPD Cases averted, first 5 years Median (95% CrI) % of Baseline IPD	54 (36 - 86) **9% (5% - 13%)**	131 (89 - 201) **21% (13% - 29%)**
Annual IPD Cases averted, Equilibrium Median (95% CrI) % of Baseline IPD	186 (93 - 300) **30% (14% - 47%)**	301 (206 - 429) **49% (32% - 62%)**

Vaccine Formulation

Formulations:

- Prevenar 13 (PCV13) vs Pneumosil (PCV10)
- Both covered by Gavi
- Pneumosil ~ 30% cheaper, but PCV13 covers an additional 3 serotypes
- Pneumosil designed to prioritise serotypes relevant to LMICs



Number of Vaccines Needed (NVN):
NVN is the number of vaccinations needed to prevent one case of IPD in under 5s

NVN equilibrium at 30% coverage		**NVN relative to PCV13**
PCV13	**Pneumosil**	**Pneumosil**
895 (553 - 1780)	1800 (906 - 18900)	2.0 (1.2 - 18.7)

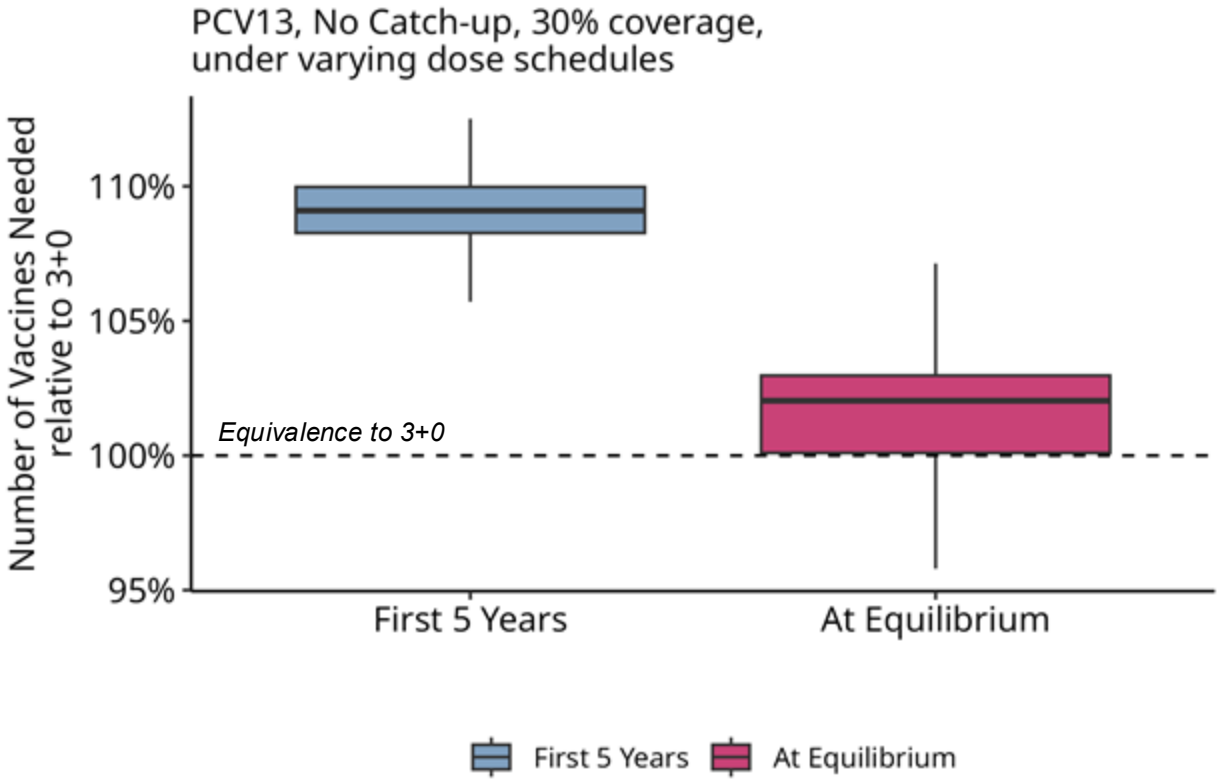
Dosing Schedule

3p+0:

- Standard schedule recommended by WHO
- All 3 doses by 6 months of age

2p+1:

- Reduced primary series (with reduced VE) and a booster dose at 1 year of age
- Reduced coverage for booster (based on MCV vs DTP coverage)
- Provides longer lasting protection at older ages

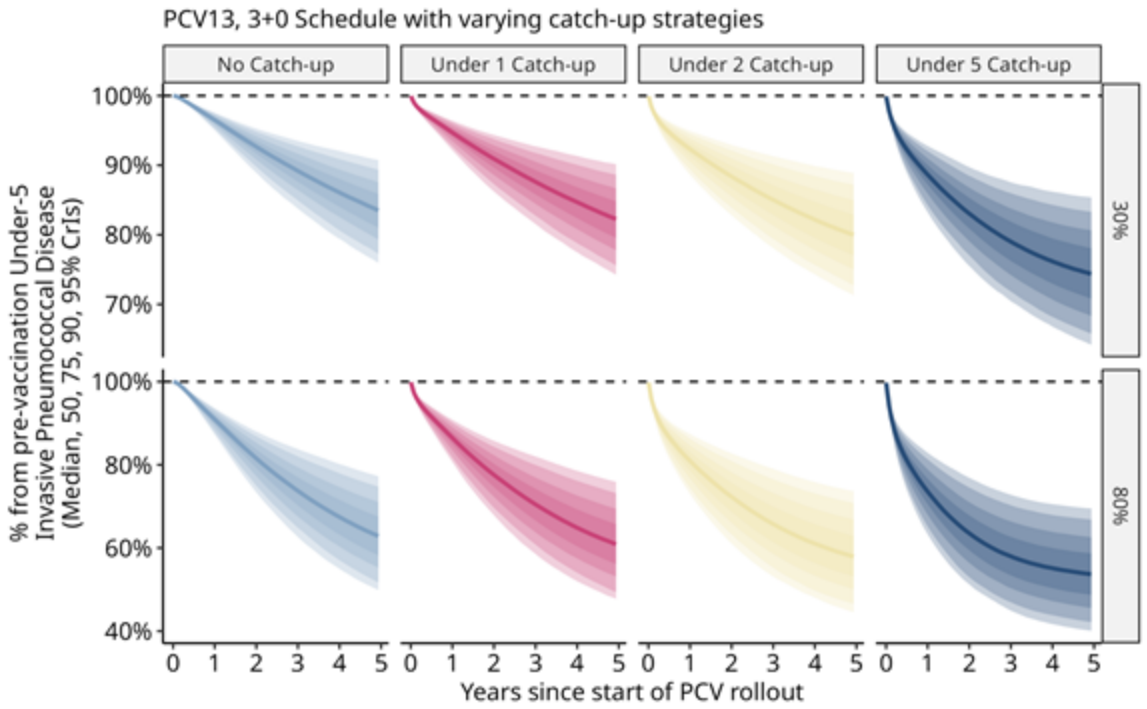


NVN of 2+1 relative to 3+0	Coverage	
	30%	**80%**
Over first 5 years	1.09 (1.07 - 1.12)	1.04 (1.00 - 1.09)
At equilibrium	1.02 (0.91 - 1.07)	0.81 (0.81 - 0.97)

Accelerating impact

Catch-up campaign

- Considered campaign in <1, <2, and <5yo
- Assumed coverage is the same as for routine immunisation
- Accelerates the impact of PCV, and under 5 catch-up would **accelerate the impact on IPD by 2.5 years**
- A catch-up campaign is an efficient use of doses over the first 5 years



Conclusion

- PCV is likely to have a substantial impact on the pneumococcal disease burden in Somaliland.
- At realistic coverage levels, PCV would prevent **30% (14% - 47%) of pneumococcal disease** burden. This could increase to **49% (32% - 62%)** at 80% coverage.
- Both **PCV13 and Pneumosil would be effective** in reducing the pneumococcal disease burden. PCV13 impact is higher, but considerable uncertainty around estimates.
- A **3p+0 schedule may be more beneficial** than a 2p+1 schedule at realistic coverage levels, but differences are negligible.
- A catch-up campaign in <5yo could **accelerate the gain of indirect protection,** particularly at realistic routine coverage levels
- Alternative vaccination strategies may be considered for specific sub-populations, e.g. nomadic and displaced populations

Acknowledgements

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