

Annex A: Impact Modelling

In order to inform Gavi governance deliberations on potential future support for COVID-19 vaccination in 2024-2025, the Gavi Secretariat commissioned **Imperial College, London**, to generate estimates of the potential impact of COVID-19 vaccination over 2024-2025 based on several different epidemiological and programmatic scenarios. As such, this annex leads with their analyses and initial estimates. We were subsequently able to bring in outputs generated by the **Institute for Disease Modelling (IDM)** from the Bill & Melinda Gates Foundation as a partial comparator in part to address model uncertainty (noting that their work is based on a set of similar scenarios and assumptions to Imperial's, but not an exact match).

The primary outputs sought from these modelling efforts included cases, hospitalisations, deaths, years of life lost (YLL) averted as well as cost-effectiveness. Given that much of the disease burden is in the elderly, it would be beneficial to compare DALYs for COVID-19 vaccines versus other vaccines. Unfortunately, this was unable to be done given the uncertainties. Instead, YLL was used, which constitutes the largest portion of the DALYs lost. For more details on the specific scenarios, assumptions and limitations across both Imperial and IDM's work, technical summaries have been made available as appendices on Board Effect.

Topline summary based on modelled outputs from Imperial and IDM

Initial results from both Imperial and IDM suggest the following:

- Modelled estimates from both Imperial and IDM broadly support the proposed COVID-19 programme in 2024-2025 being brought for discussion to the Gavi PPC and Board (yearly boosting of high/highest priority groups) as laid out in Doc 10. Continuing COVID-19 vaccination in 2024-2025 has benefits, but the overall expected health impact is lower than that seen earlier in the pandemic.
- Initial projections for the proposed 2024-2025 programme show deaths averted ranges comparable to the current Gavi core routine immunisation portfolio (albeit on the lower end). However, after incorporating costs, the proposed programme appears to compare relatively less favourably from a value-for-money perspective than Gavi core supported vaccine programmes.
- While expanding the vaccination programme to include broader population groups such as all adults, adolescents and children results in greater total health impacts, it is less efficient in that the expected cases and deaths averted per fully vaccinated person declines when including younger age groups in the program.
- Results are **highly** sensitive across several key uncertainties including:
 - Epidemiological evolution
 - Assumptions around waning immunity and affinity maturation
 - Vaccine efficacy assumptions across different vaccine products
 - Coverage levels assumed at end of 2023 and for 2024 and 2025
 - Cost (both procurement and delivery)

Uncertainty intervals capture some but not all of these uncertainties. As such, these estimates should be considered preliminary in nature and will change as more evidence is generated and time progresses.

- As noted, Imperial and IDM did apply a number of the same key assumptions and scenarios across their models. However, there are some distinct areas of divergence between their models that influence these initial results. For example, Imperial ran models based on both prototype and bivalent vaccine product scenarios, whereas IDM applied prototype and next-generation vaccine product scenarios. Similarly, there was variance across assumptions about immune waning and breadth, boosting in 2023 and frequency of epidemiological waves in 2024-2025. Therefore, considering the results of both models is valuable in that it helps account for model uncertainty. Please refer to the appendices for more details.
- To aide the contextualisation and comparability of some of these estimates, we have indicated ranges for Gavi's current core vaccine portfolio where available.

Initial results¹

While the technical appendices provide significantly more details on the various scenarios and assumptions applied across Imperial and IDM's models, the following are important to help contextualise the following results:

- Both models assumed only those who had received the complete primary series by end of 2023 would be eligible for boosting in 2024-2025.
- While Imperial assumed those with complete primary series also received a booster dose in 2023, IDM assumed no boosting in 2023.
- AMC91 were categorized into lower (15-20%), medium (30-50%) and higher coverage (60-70%) groupings for assumed complete primary series coverage at end of 2023 for modelling purposes. While coverage levels in 2024-2025 forecasted for broader population groups (adults, adolescents and children) were more conservative, forecasted coverage amongst older adult populations (>60 years) in 2024 and 2025 was more optimistic.

Deaths averted

Imperial College outputs

Table 1: Projected future deaths averted from potential Gavi-supported COVID-19 vaccines in 2024-2025 across AMC91 (excluding India).

Future deaths averted AMC91 (excluding India)		
	Baseline epi scenario	Moderate epi scenario

¹ In terms of presentation of results, we have included summary tables from Imperial College London that incorporate estimates both for the >60 years population group and entire adult population to illustrate differential outputs based on targeted population groups. IDM summarized results are focused on the >60 years population group throughout. More detailed outputs generated from Imperial and IDM, including extending the programme out to include adolescents and children, are available in the appendices. Ranges reflect different assumptions on vaccine efficacy across different vaccine products.

Priority 60+ population	56,000 - 177,000	114,000 - 359,000
All adults	84,000 - 273,000	98,000 ² - 529,000

Table 2: Projected future deaths averted per Fully Vaccinated Person³ from potential Gavi-supported COVID-19 vaccines in 2024-2025 across AMC91 (excluding India).

Future deaths averted per 1 000 FVP (excluding India)		
	Baseline epi scenario	Moderate epi scenario
Priority 60+ population	0.35 - 1.11	0.71 - 2.3
All adults	0.08 - 0.25	0.09 - 0.5

IDM outputs

For the >60 year population group across AMC91, IDM generated a range of 178,000-536,000 for estimated deaths averted and a range of 1.59-4.8 for estimated deaths averted per 1,000 FVP across similar baseline and moderate epidemiological scenarios.

Comparability with Gavi core programme

The deaths averted per 1,000 FVPs for Gavi supported vaccines 2021-2030 ranges from 0.2-17.4. Deaths averted per 1,000 FVP for Gavi core vaccine portfolio ranges from 0.2-7.4.

Value for money

The value for money analyses and initial estimates presented below only incorporate assumptions for procurement costs (as such aligning with approach taken for modelling all vaccine investment cases considered via the VIS) and do not factor in delivery cost assumptions at this time.

Imperial College outputs

Table 3: Estimated cost per death averted from potential Gavi supported COVID-19 vaccines in 2024-2025 across AMC91 (excluding India) (in US\$, based on assumption of US\$ 6.50 per dose)

Cost per death averted AMC91 (\$6.50, excluding India)		
	Baseline epi scenario	Moderate epi scenario
Priority 60+ population	11,700 - 37,200	5,800 - 18,200
All adults	51,600 - 167,600	26,600 - 144,000

² Lower range here a function of stochasticity.

³ Fully Vaccinated Person (FVP) here refers to a person who has received complete primary series and each annual booster.

IDM outputs

For the >60 year population group across AMC91, IDM generated a range of US\$ 2,700-8,200 per death averted across similar baseline and moderate epidemiological scenarios and based on the same US\$ 6.50 per dose assumption.

Comparability with Gavi core programmes

Cost per death averted for Gavi core vaccine portfolio ranges from US\$ 310-26,200.

Years of life lost (YLL)

Both modelling groups are continuing to explore broader analyses and outputs. While it has not been feasible to generate disability adjusted life years (DALYs) estimates for COVID-19 at this point in time given the complexities associated, the below summarises years of life lost estimates.

Imperial College outputs

Table 4: Estimated years of life lost averted from potential Gavi supported COVID-19 vaccines in 2024-2025 across AMC91 (excluding India)

YLLs averted AMC91 (excluding India)		
	Baseline epi scenario	Moderate epi scenario
Priority 60+ population	409,000 - 2,018,000	1,461,000 - 4,255,000
All adults	1,474,000 - 4,617,000	1,541,000 - 9,831,000

Table 5: Estimated years of life lost averted per Fully Vaccinated Person³ from potential Gavi supported COVID-19 vaccines in 2024-2025 across AMC91 (excluding India)

Future YLLs averted per 1 000 FVP (excluding India)		
	Baseline epi scenario	Moderate epi scenario
Priority 60+ population	2.67 – 12.7	9.18 - 26.8
All adults	1.36 – 4.27	1.42 – 9.09

IDM outputs

For the >60 year population group across AMC91, IDM generated a range of 2,156,000-7,302,000 years of life lost averted and a range of 19-66 for estimated years of life lost averted per 1,000 FVP across similar baseline and moderate epidemiological scenarios.

Comparability with Gavi core programmes

Estimates for YLLs averted are not currently available for the Gavi core vaccine portfolio. However, estimates for YLLs represent the largest proportion / driver of disability-adjusted life years (DALYs), compared to the years of healthy life lost due to disability (YLD). For example, measles YLLs estimates breakdown as follows: 14.52m

YLLs = 14.49m YLLs + 0.03m YLDs. Therefore, while a comparison of YLLs to DALYs is imperfect, it can be used to inform a relative comparison, albeit on a slightly conservative side. The DALYs averted per 1,000 FVPs for Gavi-supported vaccines 2021-2030 ranges from 15-551, with the COVID-19 estimated range of YLLs generated by Imperial College overlapping with Rubella and Japanese Encephalitis estimates in particular.

Cases and hospitalisations averted

Imperial College outputs

Table 6: Estimated cases averted from potential Gavi-supported COVID-19 vaccines in 2024-2025 across AMC91 (excluding India)

Cases averted AMC91 (excluding India)		
	Baseline epi scenario	Moderate epi scenario
Priority 60+ population	59,038,000 - 205,550,000	69,723,000 - 218,950,000
All adults	463,478,000 - 1,538,101,000	519,831,000 - 1,533,185,000

Table 7: Estimated hospitalisations averted from potential Gavi supported COVID-19 vaccines in 2024-2025 across AMC91 (excluding India)

Hospitalisations averted AMC91 (excluding India)		
	Baseline epi scenario	Moderate epi scenario
Priority 60+ population	239,000 – 8,000	368,000 – 1,237,000
All adults	494,000 - 1,615,000	570,000 - 2,346,000

IDM outputs

For the >60 year population group across AMC91, IDM generated a range of 113,860,000-288,262,000 cases averted across similar baseline and moderate epidemiological scenarios. IDM estimates for hospitalisations averted were not available at time of submission.

Impact modelling for a worst-case epidemiological scenario

Both Imperial College, London and IDM also generated estimates that reflect potential impact in a worst-case epidemiological scenario (variant representing significantly increased severity, transmissibility and substantial immune escape). Detailed results for this scenario can be found in the appendices, but broadly demonstrate significantly higher impact ranges in terms of cases, hospitalisations, years of life lost and deaths averted and significantly more favourable costs per death averted.

Next steps

Both Imperial and IDM have recognised a number of limitations to their models and their sensitivity to differences across the wide number of assumptions used. As such, the Gavi Secretariat will continue to engage with these groups as they revisit and refine their models, particularly as more evidence is generated.