



G20
SOUTH AFRICA 2025



REPORT ON FINANCING FOR PANDEMIC PREPAREDNESS: ENSURING SUSTAINABLE AND EFFICIENT FUNDING

WHO/OECD/WB
10 OCTOBER 2025



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1. Executive Summary

1.1. Background

This report has been prepared by the World Health Organisation (WHO), the Organisation for Economic Co-operation and Development (OECD) and the World Bank (WB) for the G20 Joint Finance and Health Task Force (JFHTF). It builds on previous work by the JFHTF focused on the link between health and economic trends and how to strengthen pandemic prevention, preparedness and response (PPR) by examining health, social and economic vulnerabilities (FEVR) and financing gaps and needs. This report examines PPR financing in the context of health sector financing, acknowledging that PPR requires whole government action but also recognising that much of PPR spending is channelled as part of health sector expenditure.

1.2. Key findings

- Health sector spending has increased globally over the past 20 years, driven by the dual challenge of demographic change and demand for more joined-up action to combat global health threats and economic growth.** Whilst in high-income countries this increase was mainly financed through government or compulsory health insurance schemes, in low- and middle-income countries spending growth has largely been driven by out-of-pocket (OOP) spending and external assistance, raising concerns about both equity and sustainability of financing.
- The health financing gap between developed and developing countries is stark.** In 2022, average public sector spending on health in low- income countries was around USD 9 per capita per year. This compares with average public spending on health per capita of USD 2700 in high-income countries and 300 USD in upper-middle income countries.
- In line with broader health spending trends, these same disparities are also reflected in PPR expenditure.** While measuring PPR expenditure is challenging and requires further work, current best estimates of the health sector spending contributing towards PPR across low- and middle-income countries are around USD 2-3.5 per capita per year from all sources, compared with USD 19 in upper-middle countries and over USD 120 in high-income countries. Conversely, the share of funding from all sources going to PPR is far greater in poorer countries than in wealthier ones: PPR-related spending accounts for around 10% of total health spending in low-income countries (LICs), 8% in lower-middle income countries (LMICs), and 3% in upper-middle and high-income countries.¹
- The rapid decline of ODA poses significant new risks for national health systems and global health security, at least in the immediate term.** Approximately 80% of the spending contributing to PPR in low-income countries and 30% in lower middle-income countries is reported as externally financed, mostly from ODA budgets. **Bilateral health ODA from OECD Development Assistance Committee (DAC) countries declined by 40% in 2023 from its Covid-driven peak in 2022.** Meanwhile, OECD projections show a **further 19-33% drop between 2023 and 2025, potentially reducing health ODA to levels last seen in the mid-2000s**, despite calls for additional financing to deal with future health threats and the establishment of a new Pandemic Fund.

¹ Note that these PPR numbers are best estimates rather than observed expenditure, reflecting limited data availability (the methodological approach is detailed in the report).

- This changing development finance landscape, coupled with broader fiscal conditions add pressure to existing structural challenges such as insufficient public spending on health and PPR in low- and middle-income countries, compared to needs. This places additional challenges for the stability of health systems in countries where the greatest risks for global health security are likely to occur.** Current health sector funding is insufficient to achieve Universal Health Coverage (UHC) (ensuring populations have access to a set of essential services to achieve the Sustainable Development Goals, without financial hardship), with many governments and development assistance providers facing difficult choices in an increasingly tight fiscal environment.
- In this new financing environment, more effective spending to balance trade-offs between different priorities will be more important than ever to achieve the dual goals of UHC and health security.** While evidence is emerging on potential ‘best buys’, substantial evidence gaps remain in targeting investments that benefit both PPR and other health priorities of national concern in limited resource settings, and the most cost-effective pathways to realise both. At low levels of spending it is important to consider the co-benefits of PPR investments for the wider health system; strengthening the capacity of health systems in areas which benefit both endemic and epidemic diseases are clear win-wins for both national and global health security. Technical efficiency must also be addressed with domestic processes to ensure the most efficient intervention design, prices and use of PPR resources.
- Increased domestic resource mobilisation has the potential to address some of the gap in financing needs for both PPR and UHC over the medium to longer-term.** Potential for increased tax mobilisation in low- and middle-income countries may be as high as 9% of GDP. Health taxes may also have potential to increase financing in certain contexts, while also helping to improve health outcomes.² In addition, strengthening domestic institutions in areas such as public financial management can improve both the raising and efficient flow of resources. Ensuring PPR and health security plans are fully integrated into National Health Strategic Plans and other investment/priority setting and public financial management processes will be critical to ensuring sustainable domestic spending.
- The source of increased domestic spending makes a difference. Domestic public spending on health tends to be positively associated with higher scores for pandemic PPR capacity.** Conversely, higher shares of out-of-pocket spending from private sources can reduce the access of populations to the basic health services required to ensure effective PPR and, as such are not an effective way to finance PPR. It is therefore important from both a PPR and financial protection perspective to continue to reduce reliance on out-of-pocket spending for domestic resource mobilisation.

² At present, health taxes in the form of excise duties raise only moderate amounts of tax revenue, only 0.3% of GDP in low-income countries on average. Across the OECD, the share is 0.74% on average.

1.3. Recommendations

The report recommends an urgent policy response from Ministries of Finance and Ministries of Health to protect gains and sustain PPR. The report provides a set of actionable policy options to enhance domestic resource mobilisation, and improve the effectiveness of health and PPR ODA, strengthening global health financing. These are outlined below:

Promoting aligned and sufficient domestic funding for PPR

Recognising that domestic resource mobilisation (DRM) is critical for financing PPR, DRM requires renewed action in the context of recently announced declines in ODA. Maximizing domestic resource mobilisation requires the strengthening of domestic institutions and a multi-pronged tax policy approach that spans all potential revenue sources, considers equity and supports economic growth, in line with the wider efforts of the G20 in tax reform. The report recommends:

- **Renewed commitment to provide sufficient financing for PPR in line with the progressive realisation of UHC and health security.** While the appropriate proportion of government spending on the health sector varies by setting, where required, governments should re-examine domestic health sector funding allocations in the context of the reductions of development assistance for health to ensure service continuity and maintenance of PPR capacity.
- **Enhancing regional and global collaboration to reduce economic and labor force-related informality and improve the effectiveness and efficiency of tax administration.** Tax revenue is the foundation of public spending on health and PPR. Reducing disincentives to formalisation, implementing well-designed presumptive tax regimes, and supporting digital transformation of tax administrations present critical opportunities. The global Platform for Collaboration on Tax – as well as regional collaboration, can guide technical cooperation to enhance the capacity of developing countries tax administrations.
- **Ensure high quality costed action plans for PPR, integrated within National Health Strategic Planning and public financial management systems, with sufficient consideration of multi-sectoral co-ordination. This would also include strengthened Public Financial Management (PFM) which is critical to ensure better allocation, use, and accounting of domestic resources,** including in relation to health emergencies. A consolidated planning and budget framework is necessary to enable more efficient and coordinated use of PPR funding for both preparedness and response, reduce overlaps, and ensure comprehensive financial tracking, and accountability. This should include formal inter-ministerial coordination mechanisms—such as joint budgeting committees and integrated public investment plans—to align PPR financing with national development agendas.
- **Strengthen country-led processes to improve the technical and allocative efficiency of PPR spending along phased investment paths to achieve UHC,** including the consideration of PPR investments into health technology assessment, regular comparative reviews of costs and other indicators of efficiency, and the incorporation of PPR into evidence-informed priority setting processes (that consider co-benefits) used to define service/intervention packages for different health platforms and health systems investment plans.

Improving the effectiveness of external assistance for health and PPR

The report recognises that external assistance will remain critical for supporting PPR financing, particularly in low-income countries. Given recent reductions in ODA, it becomes increasingly important to ensure all development assistance for health and PPR (including from ODA and other external development sources) is spent as effectively as possible to maximise impact while also targeting those most left behind. The report recommends the following policy options:

- **Improve co-ordination and alignment of the different external funding flows for PPR with domestic processes, in line with the Lusaka Agenda (which expresses a consensus around the role and future of the global health initiatives (GHIs)).** Improve the effectiveness of their global health investments in PPR, G20 development finance providers strengthen implementation of the Lusaka Agenda, ensuring ODA for health and PPR is aligned with priorities of national concern, and strengthens national health systems.
- **Leveraging loans with grants for PPR.** There is a need for renewed external financing modalities, which incentivise structured shifts away from external grant financing towards more sustainable domestic public spending with the longer-term goal of self-reliance. This should go hand in hand with improved targeting of ODA grant funds to geographies and purposes where it is most needed. It is important to support countries to increase domestic resource mobilisation capacities in a transitional phase and explore scaling blended finance and other innovative solutions **to crowd-in domestic spending in line with the objectives of the 4th International Conference on Financing for Development (FfD4).** Time-limited, transitional external financing can set the right incentives for development cooperation providers, recipients and implementers, and can equip countries with the greatest needs to build resilient systems. Further work is urgently required to explore the feasibility and suitability of the different instruments available to carry forward this agenda.
- **To limit impact on the debt service burden, including ensuring the provision of concessional financing,** in line with a phased approach to transition from grant funding for countries most in need.

Enhance regional and global collaboration on PPR financing and economics

The report recognises the need to develop standardised approaches, data and analytics to both understand PPR contributing expenditures and costs. It recommends action to:

- **Improve health expenditure tracking of both domestic and external funding, and specifically on PPR at subnational, national and global levels.** This should build on existing mechanisms, including the System of Health Accounts (SHA) and the Creditor Reporting System (CRS) and current efforts to better align health spending, and to take advantage of the digitalisation of financial management information systems (tagging FMIS) to not overly burden countries with additional reporting requirements.

- **Ensure evidence and cross-learning regionally and globally on value-for-money of different PPR investments**, informing global guidance and adaptation to local health systems to inform investments by Ministries of Financing and Health. This could include identifying research agendas, generating evidence on best buys, development of methods that can analyse value across diseases and consider joint economic impact, and providing datasets for PPR costing. Enhancing learning from best practice in improving the performance and efficiency of PPR spending across countries, by providing shared learning platforms to improve understanding of common challenges and how they have been addressed, while acknowledging context specificity.

2. Introduction

In 2025, and as part of its work plan under the South Africa Presidency, the G20 Joint Finance-Health Task Force (hereinafter ‘JFHTF’ or ‘the Task Force’) set out its priority 1 to improve finance and health coordination for key health financing issues, especially pandemic preparedness and response (PPR). This report examines domestic and international PPR financing for the health sector in the context of domestic health expenditures and the achievement of Universal Health Coverage (UHC). The report does not consider funding of PPR strategies delivered outside the health sector, such as in One Health, nor does it consider specific additional mechanisms for surge financing. Spending in these areas is critical, but the focus of this report is financing policy options to ensure health sector spending achieves PPR objectives.

The purpose of this report is to guide the G20 on action to improve the sustainability and impact of PPR financing in the context of health financing. As many countries continue to experience constrained fiscal situations and budgetary pressure in health spending, the JFHTF could facilitate wider discussions on the implications of the state of health financing for resilience to future health emergencies. This report complements the work done on the Framework for Economic Vulnerabilities and Risks (FEVR). It summarises spending trends for both PPR and the health sector overall, identifies the costs of investment in the health sector to achieve PPR aims, and sets out broad actions to ensure smart and sustainable domestic and external funding for PPR going forward.

2.1. Measuring health sector PPR expenditures and costs

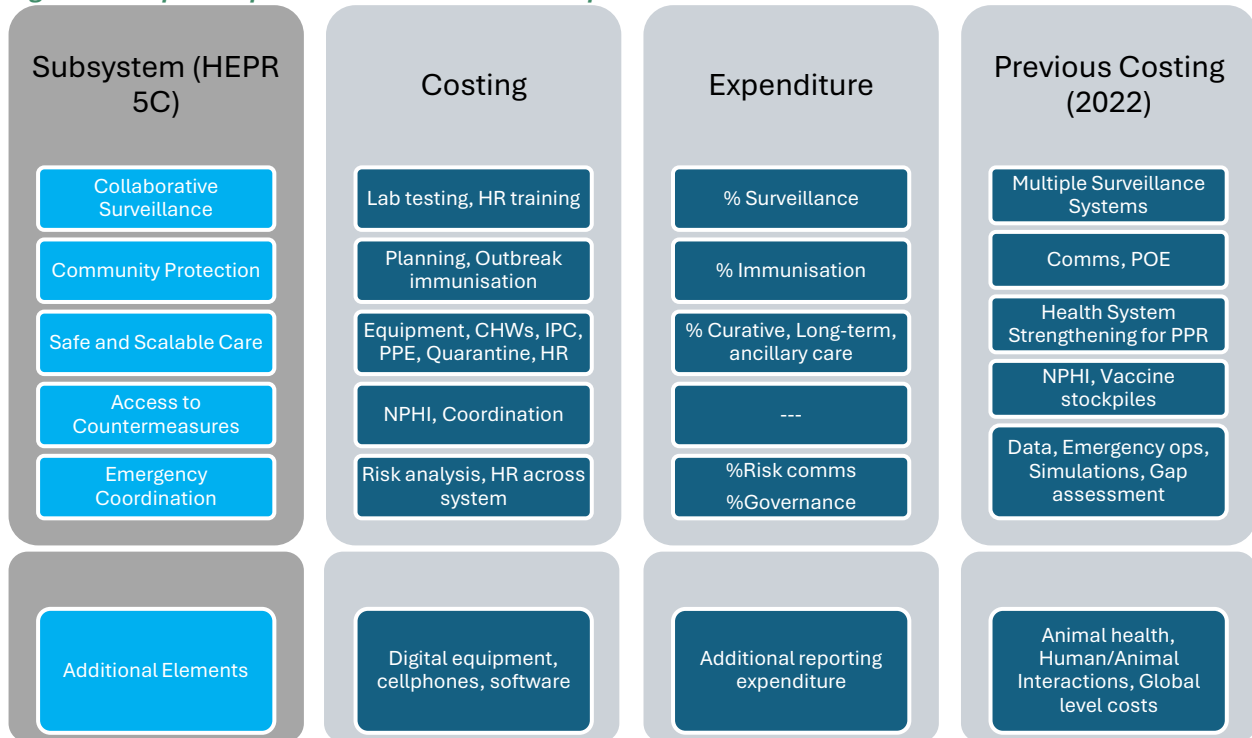
Defining the scope of PPR spending within the health sector is challenging. For this analysis, we concentrate on spending required with health systems to prevent, detect and respond to pathogens with epidemic and pandemic potential. We define pathogens with epidemic and pandemic potential as those which have high transmissibility and where there are limited (biomedical) interventions to prevent transmission or limit severity. These compare to endemic diseases, such as TB and HIV, where interventions are available to effectively control the spread of infection and the impact of disease. Preventing and responding to endemic and pandemic disease requires specific actions to identify, signal and respond to outbreaks and address the impact of disease. These actions would not be required in a world only facing endemic disease; however, both types of infectious diseases commonly share health system platforms, from community engagement to laboratory systems, and thus have investments co-benefits. Finally, for the purposes of this report, we see the capacity to address epidemic and pandemic disease burden and other health hazards as an intrinsic part of achieving UHC.

To frame PPR, we use the WHO Health Emergency Preparedness, Response, and Resilience (HEPR) framework, which outlines five interconnected subsystems for PPR, also referred to as the “five C’s”. It is important to note that this report does not include surge financing in its analyses but does include long-term capacity building to respond. HEPR aligns with the capacities required for the implementation of International Health Regulations (IHR) and its amendments. HEPR capacities include collaborative surveillance, community protection, safe and scalable care, access to countermeasures, and emergency coordination. While this framework can be used to address preparedness and response for all health threats, it provides a recommended set of interventions that enhance countries’ health systems prepare for and respond to epidemic and

pandemic threats. It also is aligned with the Preparedness and Resilience for Emerging Threats (PRET) initiative from the WHO.³

Figure 1 provides a list of the 5 C’s with actions. The schematic below shows the scope of the estimates of PPR costs and expenditure produced for this report, and the estimates for PPR costs produced in 2022 for the G20 JFHTF.^{4,5} The extent to which costs of actions are mapped to PPR differs. One of the core recommendations of this report is to standardise approaches and ensure consistent estimates of both costs and expenditures over time.

Figure 1: Scope of inputs included in cost and expenditure estimates



CHW= Community Health workers, IPC: Infection prevention control, NPHI National Public Health Institute

³ <https://iris.who.int/bitstream/handle/10665/380525/9789240094246-eng.pdf?sequence=1> (accessed 12 March)

⁴ <https://thedocs.worldbank.org/en/doc/5760109c4db174ff90a8dfa7d025644a-0290032022/original/G20-Gaps-in-PPR-Financing-Mechanisms-WHO-and-WB-pdf.pdf>

⁵ Methods to estimate costs and expenditure also differ. Our expenditure estimates use data from 2022 sources, employ a top-down proportion of expenditure approach across countries and are limited to the human health sector. Our costing uses a bottom-up approach listing and costing each input. The scope for the costing is the “five Cs” developed to guide the strengthening of the national, regional and global operational systems of HEPR 5 but the costing does not cover the full set of HEPR capacities and benchmarks. In comparison, the 2022 costing estimate takes a top-down approach. For example, health system strengthening for PPR is considered as a proportional cost per capita across all countries. The 2022 costing also includes costs for animal health and global level costs for items such as vaccine manufacturing and global coordination. More details can be found in the table in the Appendix 1 and in the details presented in the other technical appendices.

3. Health sector expenditures contributing to PPR capacity

3.1. Key findings

- **Total health spending has increased over the past decades in all countries. In LICs and LMICs**, where investment gaps are the greatest, these increases have been driven primarily by out-of-pocket payments (or direct payments made by households) and external aid.
- **Domestic public and aid spending on health is positively associated with higher scores in respect of IHR scores.** Whereas no such association is observed with out-of-pocket spending.
- Estimating PPR expenditure is not straightforward. In the absence of ‘PPR tagged’ spending data, PPR spending is approximated by attributing different categories of health spending to PPR, with attributions based on analysis in four countries. Based on this approach, we estimate that approximately **USD 2 billion (around USD 3.5 per capita) was spent in LICs and USD 8 billion in LMICs (around USD 2.6 per capita), compared to USD 23.4 billion of additional funding identified previously for LMICs.**⁶ Overall, USD 230 billion was spent in 2022 at country, regional and global levels, within health sectors that contributes to PPR. The vast majority of this spending was in high-income countries. These estimates need to be validated with more direct measurement of PPR expenditures at the country level in a larger sample of countries.
- **Overall, PPR related spending is estimated to account for a greater share of total health spending in low-income countries (10%) and in lower-middle income countries (8%), as compared with upper-middle and high-income countries (approximately 3%).**

3.2. Implications for action

- **Standardised and timely tracking of PPR and health expenditures (both domestic and external)** is essential to support an effective allocation of resources for global health and to be better prepared for global health threats. Tracking can be improved through three actions:
 - First, **improve global cooperation and action on tracking PPR spending**, improving standardised reporting, integrated within current tracking and reporting systems, for example, using national health accounts.
 - Second, **strengthen digital systems for collecting and analysing spending data** to improve the timeliness of expenditure reporting, including considering approaches to tag PPR spending at the country level.
 - Third, **reflect the multisectoral nature of PPR spending**, including animal health, agriculture, education and social services.
- These actions would benefit from applying a **common approach for categorising and monitoring spending that contributes to PPR, aligned with tools that cost PPR investments** to improve data comparability. Such efforts could build on existing tools,

⁶ HLIP report “A global Deal for our Pandemic Age” June 2021

notably the System of Health Accounts and the Creditor Reporting System to track Overseas Development Assistance and other external source tracking system.

3.3. Estimating PPR spending within the health sector

Measuring PPR expenditure at both country and global levels is not straightforward. Within the health sector, activities and spending that improve PPR encompass both spending on pandemic-prone diseases and other global health threats and also non-disease specific spending to strengthen health system capacities. Ideally, ‘PPR tagged’ spending data on these different PPR activities within and beyond the health sector would be used to estimate PPR spend.

The methodological approach used here does not reflect spending tagged by countries as PPR spending. Instead, it draws on recent work by the OECD⁷ to map System of Health Accounts (SHA) spending data on different categories which contain at least some PPR-related spending. This builds on work from four countries, conducted by the World Bank, that estimates the proportion of different categories of health spending that contribute to PPR. For each of the SHA spending categories, these shares are then attributed as PPR spending. This ensures a comprehensive range of healthcare functions are captured but is an approximate approach, as it extrapolates from a limited number of countries. The approach is broad, including diseases that can lead to epidemics as well as pandemics and other forms of global health threats, such as antimicrobial resistance and other public health hazards. Further methodological factors are provided in Appendices 1 and 2.

3.4. Trends in health sector expenditures

Total health spending per capita, adjusted for inflation, has been on an upward trend since 2000 across all country income groups, though significant disparities remain. **In 2022, health spending in low-income countries was lower than what lower-middle-income countries spent in 2000.** A variety of public health functions, notably immunisation, infection prevention and control, disease surveillance, and other preventive care activities are critical to PPR. These support early detection, risk communication, and containment. Primary care, as the first point of contact for communities, is also crucial, as it helps ensure access to these PPR activities and other essential health services.

Domestic public spending on health surged in the early years of the Covid-19 pandemic and declined across all income groups in 2022. In middle-income countries, domestic public spending on health fell below the long-term trend observed during 2000 and 2019, while in high-income countries, it returned to pre-pandemic levels. In low-income countries, although domestic public spending on health remained above the pre-pandemic trend, it showed a downward trajectory. Early data from a small set of countries, mostly high-income, indicate a continued downward trend in 2023.⁸

In many low- and lower-middle income countries, out-of-pocket (OOP) payments remain the main source of health financing, accounting for over 40% of total health spending on average. In 20 low- and lower-middle income countries, OOP payments are the dominant source of funding for health systems. Excessive reliance on OOP payments risks reducing access to essential health

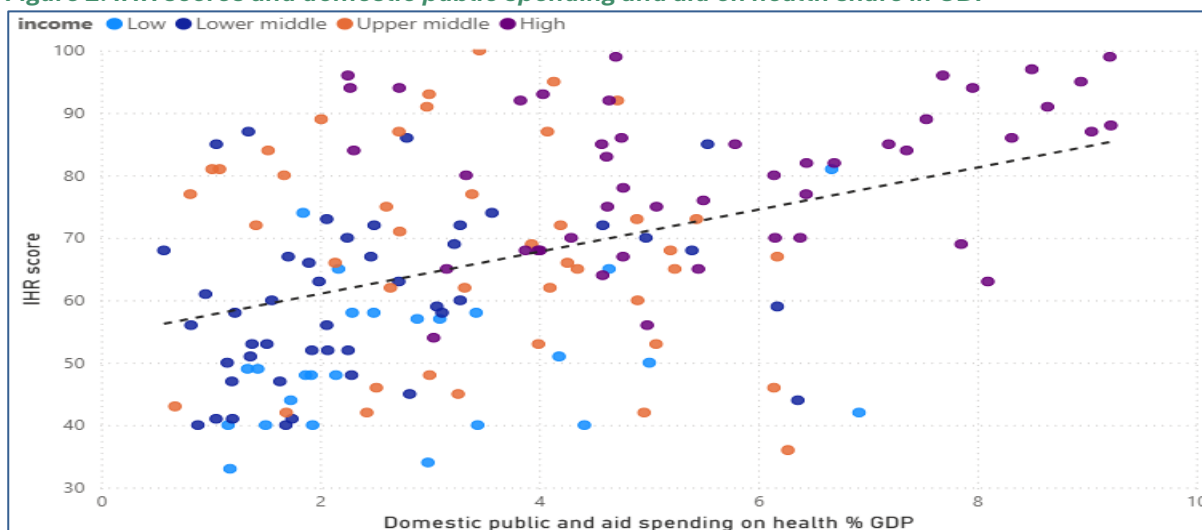
⁷ OECD (2025). Smart spending to combat global health threats.

⁸ Global spending on health: emerging from the pandemic. Geneva: World Health Organization; 2024. Licence: CC BY-NC-SA 3.0 IGO

services and increasing households' financial hardship and, in the absence of other actions, can affect systems' ability to weather future pandemic shocks.

Over the past 15 years, development assistance for health has surpassed public spending in LICs, with aid averaging USD 12.8 per capita compared to USD 8.8 for public spending in 2022. **Countries with higher domestic public and development assistance spending on health as a share of GDP tend to have better PPR capacity as measured by the International Health Regulations (IHR) score, but this is not observed for OOP payments and is weaker for overall health expenditure (Figure 2).** At the same time, Figure 2 also shows that there remain important variations across countries in IHR scores at similar spending levels. In particular, the IHR score measures a country's PPR capacity based on 35 indicators across 15 capacities, most of which fall under the health sector.⁹ The positive association with a country's IHR scores for pandemic PPR capacity is weaker with total health spending and not observed with OOP payments. It is also important to know that while IHR scores reflect capacities they do not reflect eventual outcomes, where other factors may contribute to the overall impact of a pandemic (for example the different patterns of transmission and mixing of populations/ ages across countries).

Figure 2. IHR scores and domestic public spending and aid on health share in GDP



Note: IHR scores are from 2022, while domestic public and aid spending on health as a share of GDP is taken from 2019 to account for the time lag in capacity improvements and to avoid distortions caused by pandemic-related spending fluctuations.

Source: Global Health Expenditure Database, 2024. IHR States Parties Self-Assessment scores.

3.5. Trends in PPR expenditure

An estimated USD 230 billion was spent on activities contributing towards PPR in 2022 at country, regional and global levels (see section above for areas of expenditure included).¹⁰ Most of this spending was in high-income countries (USD 167 billion), compared to estimates of USD 53 billion, USD 8 billion and USD 2 billion in upper-middle, lower-middle and low-income countries, respectively. Pre-pandemic, global spending on PPR increased gradually, by an average of 4% in real terms from 2016 to 2019. It then surged during the COVID-19 pandemic, increasing by an average of 40% between 2019 and 2021, before decreasing by 20% from 2021 to 2022 (in real terms). It is important to reiterate that these and subsequent figures on PPR spending are

⁹ IHR (2005) States Parties self-assessment annual reporting tool, 2nd ed. <https://www.who.int/publications/i/item/9789240040120>

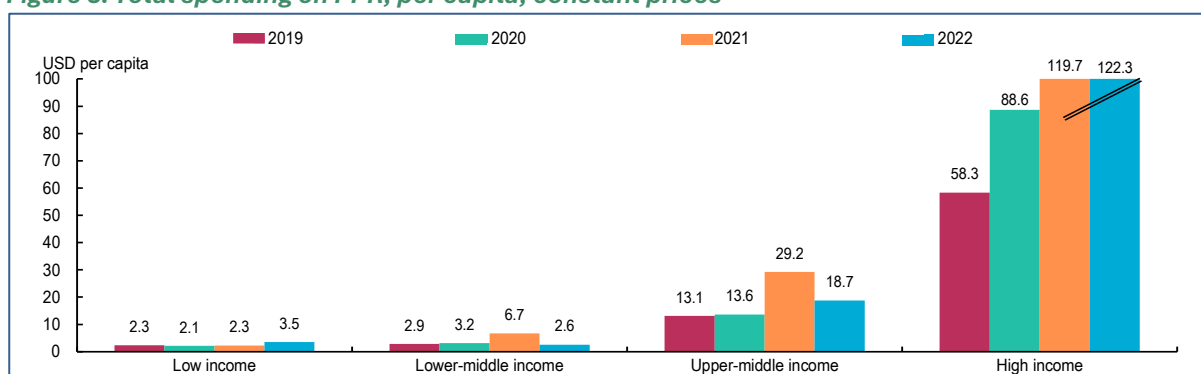
¹⁰ This and other figures on PPR spending come from OECD (2025). Smart spending to combat global health threats.

estimated rather than directly reported. With these estimates based on proportions of different health spending categories that are attributed as PPR-related spending.

High-income countries are estimated to spend substantially more per capita on activities contributing towards PPR than low- and middle-income countries (Figure 3). In 2022, high-income countries spent over USD 120 per capita on PPR, six times the per capita spending of upper-middle income countries (USD 19),- and around thirty times higher than the spending by lower-middle income (USD 2.6) and low-income countries (USD 3.5).¹¹

Combining estimates of PPR with overall health spending figures, **lower-income countries allocate a much higher share of health spending to PPR as compared with high-income countries**. In 2022, spending on PPR accounted, on average across countries, almost 10% of health expenditure in low-income countries and 8% in lower-middle income countries. Similar patterns can be observed in terms of PPR spend within the overall economy, with low-income countries allocating 0.65% of GDP to PPR, compared to 0.42% in lower-middle income countries and around 0.2% of GDP in upper-middle and high-income countries.

Figure 3. Total spending on PPR, per capita, constant prices



Source: OECD Health Expenditure and Financing Database and WHO Global Health Expenditure Database

In terms of how such PPR spending is financed, external sources are the main funding source in low-income countries. In 2022, PPR spending from external aid accounted for an estimated 78% of PPR spending in low-income countries, with domestic governments covering 16% of PPR spending and domestic private sources the remaining 6%, on average. This reliance on aid to fund PPR activities appears much greater than for the health sector overall. In lower-middle income countries, external sources accounted for 30% of PPR spending, with domestic governments funding 50% and domestic private sources 20%, on average.

The increase in ODA for health during 2020–2022 was primarily driven by spending which contributes to PPR. External spending on PPR related activities increased substantially during the COVID-19 response, though it has since returned to pre-pandemic levels). At the same time, aid to some other health areas has reduced.

3.6. Potential impact of ODA reductions

The deteriorating health financing and aid environment is expected to negatively impact PPR financing and outcomes. Recent announcements of reductions in aid budgets from many OECD countries pose additional challenges to health and PPR financing. From 2022 to 2023, bilateral

¹¹ Note that these figures are based on a broad definition of PPR that extends beyond pure pandemic-prone diseases to include other global health threats, derived from the Joint External Evaluation of the International Health Regulations (see Annex for further details).

health ODA from Development Assistance Committee (DAC) countries declined by 40%. While this drop can be largely attributed to a decline in COVID-19 response expenditure, it occurred in parallel to the G20's recognition of the need for additional PPR financing, including through the establishment of a new Pandemic Fund, largely financed through ODA budgets. Further to this decline, the latest estimates from the Organisation for Economic Co-operation and Development (OECD) show a further 19-33% drop between 2023 and 2025, potentially reducing health ODA to levels last seen in the mid-2000s.¹² Uncertainties remain in both the volume of these cuts and their impacts across sectors and recipient countries. However, analysts agree that the decline in funding from major donors will have far-reaching impacts on global health finance, at least in the near term. Shifts in global health financing will need to be closely monitored in the future.¹³

Complementary country-level estimates are needed to evaluate the expected impact in specific countries more precisely and to inform domestic leaders of the financial implications and the need for domestic resource mobilisation for the health sector. Several uncertainties remain including potential changes in sectoral and geographical priorities affecting health sector funding, and commitments to multilateral aid channelled through health funds (e.g., the Global Fund, GAVI) and further disbursed to recipient countries.

3.7. Way forward

This section identifies trends in health and PPR related expenditures. It provides an approximately summary of overall trends, using methods that estimate rather than directly measure PPR related spending. There is an urgent need to improve expenditure tracking for PPR to ensure expenditures can be tracked over time, in a way that is integrated with health and development expenditure tracking more broadly. While initial efforts are underway to standardise the scope of PPR-related expenditure and better align measurement of these flows, further co-ordination is needed so that there is a clear picture of PPR spending at both the national and global level. Any approach should not be vertical but build on and be integrated into existing initiatives, including the System of Health Accounts, the Creditor Reporting System, and links to country-specific measures of PPR such as the Joint External Evaluation of International Health Regulations.

Alongside such measurement work, improving the availability and timeliness of spending data is critical for country level priority setting and planning of PPR spending. Many countries lack disaggregated health expenditure data in sufficient detail to monitor overall expenditures made by different funders towards key health areas. Aligning budgets, on budget funding (see section below on public financial management) is critical. Investing in digital infrastructure for data reporting and analysis and institutionalising its routine collection and use offers a way forward.

Taken together, efforts to improve measurement and data availability will equip all stakeholders with a clearer picture of what is being spent across PPR and related activities, and with it the insights needed for informed investment planning to improve PPR-related capacity as part of the progressive realisation of UHC.

¹² OECD (2025), "Cuts in official development assistance: OECD projections for 2025 and the near term", OECD Policy Briefs, OECD Publishing, Paris, <https://doi.org/10.1787/8c530629-en>. Note these projections do not take into account the implications of the United States new [global health strategy](#), published in September 2025.

¹³ Apeagyei, Angela E et al. (2025), "Tracking development assistance for health, 1990–2030: historical trends, recent cuts, and outlook," *The Lancet*, Volume 0, Issue. <https://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2825%2901240-1/abstract>

4. Health sector costs contributing to PPR capacity

4.1. Key findings

- **The WHO and World Bank have previously estimated that an international investment of USD 15 billion annually is required** to support equitable global access to vaccines, testing and therapies, global surveillance, research and development, manufacturing and health system strengthening, particularly in the world's poorest countries where risks to global health security are greatest.
- Our analysis adds to previous findings by looking in detail at a few illustrative country scenarios whereby we examine the total cost of recommended investments to expand PPR capacity across the health system. We estimate that strengthening the health sector to achieve a high level of PPR capacity (JEE/SPAR score of 5) may require investments ranging from **USD 3.8 to 16.9 per capita for LICs and between USD 2.5 – 24.4 per capita for LMICs depending on the current health system structure, the strategic approach taken, price levels, and geographic coverage**. As costs depend on context, investment needs may currently be higher in LICs with weak health systems than in LMICs, due the additional investment required to motivate, train and equip the community health workforce. Our analysis broadly confirms previous findings that substantial additional international funding may be required above current spending (approximately 3 USD per capita).
- **PPR spending requirements may represent between 5-15% of total UHC health spending needs**. PPR investments are likely to have co-benefits for overall health system strengthening and the fight against infectious diseases (see section below). To maximise these synergies, countries need to identify optimal pathways for PPR investment as part of the progressive realisation of UHC, within their contexts, in the face of increasing fiscal constraints and a rapidly changing development financing environment.

4.2. Implications for action and policy

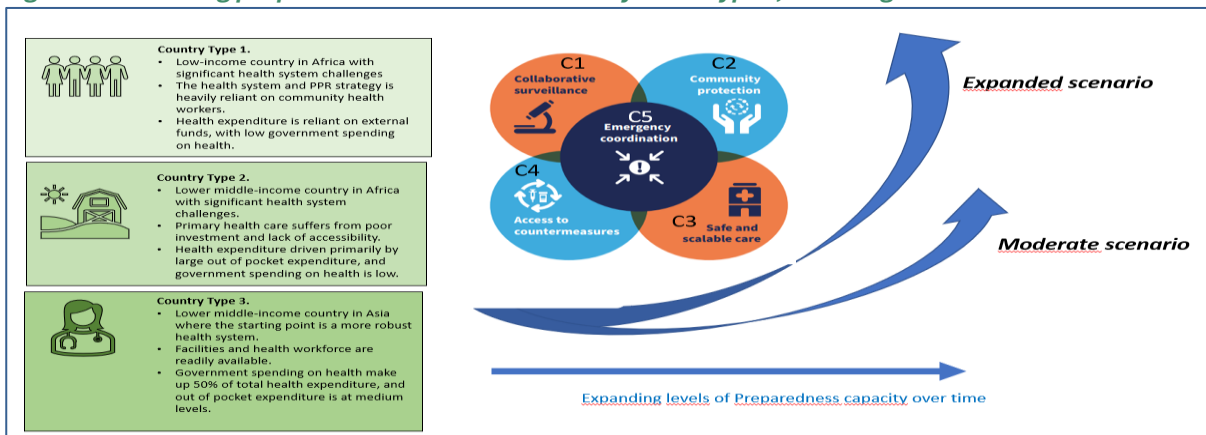
- **Improved understanding of the costs and of the relationship between costs and risk reduction is essential to support countries to understand optimal pathways to more effective PPR and integrate these into overall health sector planning and budgeting**. National Action Plans for Health Security (NAPHS) should be included within broader health system strategies and aligned with national budget cycles. Specifically, to scale and inform country level costed plans, information on the interventions and activities required to scale-up PPR should be transparently shared, along with methods and tools for investment planning. Additional guidance is required on the resource requirements, in terms of the quantities of inputs and coverage required to effectively reduce risk, and align these with expenditure reporting.
- **Improving the quality of costing for national planning** will require further global collaboration, share information and understanding the different drivers of costs, and global price and cost datasets to inform plans and budgets, as well as agreement around methods, tools, and approaches to align costed plans with national budgetary processes.

4.3. Estimating the costs of improving PPR within the health sector

In March 2022, a previous G20 report estimated that USD 16.2 billion (of the USD 31 billion) would be required annually across LICs and LMICs to expand PPR capacity and highlighted that the largest gaps were to be found in the countries with the least fiscal space to address them.^{14,15} Here we present an analysis that looks further at country scenarios, with a focus on health sector investments specific to PPR capacity. Full details of our methods can be found in Appendix 3, but in summary:

We apply a progressive investment approach that links JEE/SPAR capacity scores to specific investments and costs (for further details on JEE scores, please see appendix 3). **We estimate costs for three country archetypes:** one LIC and two LMICs, as shown below in Figure 2A. **We modelled two scenarios for investment**, where the main differential is the extent to which PPR-specific investments are made across first-line facilities: one base case scenario where PPR capacity is strengthened at 10% of health provider networks (including community health workers) to provide a foundational network for health emergencies, ensuring that in the event of a crisis, a basic response can be mounted. A second, expanded scenario where PPR capacity is strengthened in 30% of primary level facilities along with the majority of district and province-level facilities would require higher levels of investment. Both scenarios include investment in national institutions. Estimated costs represent investments needed to expand capacity from JEE/SPAR scores 1 up to level 5.

Figure 3. Modelling preparedness costs for 3 country archetypes, focusing on the 5 “Cs” for HEPR

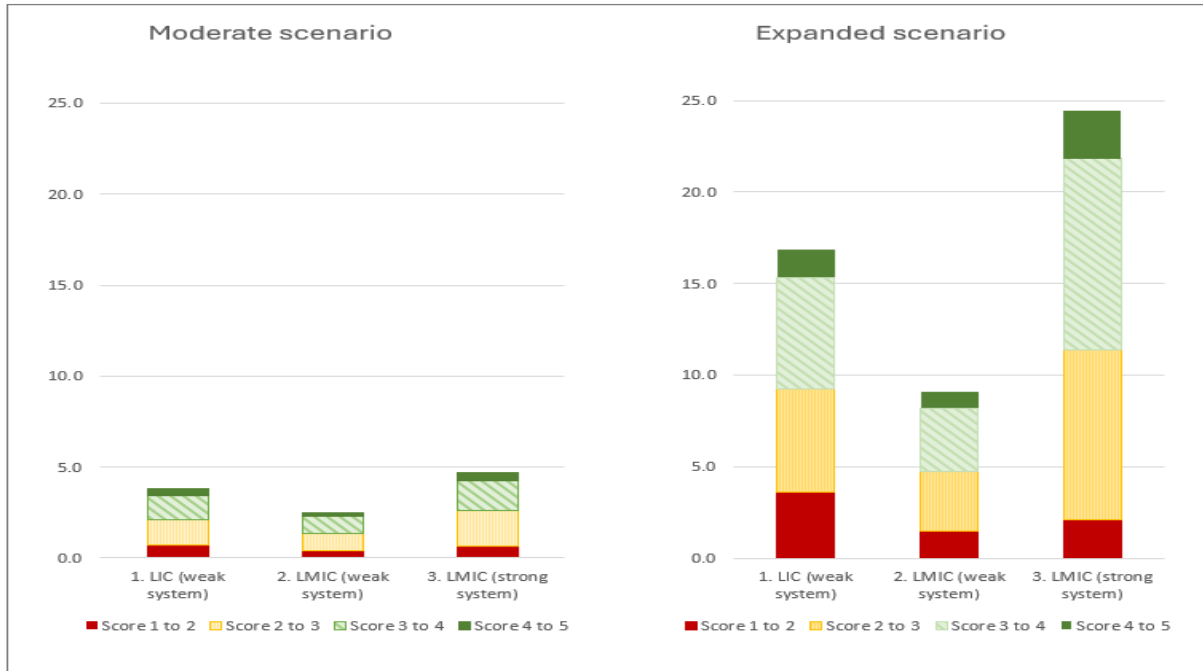


The estimated investment cost to improve PPR to full capacity (JEE/SPAR score 5) would require around **USD 3.8 per capita for LICs, and between USD 2.5 and USD 4.7 for LMICs** with a 10% coverage of first level-facilities. In the expanded scenario, costs increase **further to USD 16.9 for LICs, and from USD 9.1 to 24.4 for LMICs** (Figure 4). The costs are higher in the LIC scenario due to the additional investment to motivate, train and equip the community health workforce.

¹⁴ HLIP report “A global Deal for our Pandemic Age” June 2021

¹⁵ [G20-Gaps-in-PPR-Financing-Mechanisms-WHO-and-WB-pdf.pdf](#)

Analysis of Pandemic Preparedness and Response (PPR) architecture, financing needs, gaps and mechanisms Prepared for the G20 Joint Finance & Health Task Force Paper prepared by the World Health Organization & the World Bank 22 March 2022

Figure 4: Costs of improving JEE scores by country archetype, USD 2023

Cost per capita is highly context-specific, and countries do not start from score 1. The average starting point in LMICs is a JEE score of 3. We estimate that the additional cost to advance all 5 “Cs” from JEE score 3 to 4 is USD 1-2 per capita per year in the 10% scenario. An expanded approach that covers a larger number of health facilities to provide greater readiness would require greater additional investments of USD 4 -10 per capita to move one step up from level 3 to 4 (Figure 4 and Appendix 3).

The profile of investment vs. recurrent costs also vary over time. **Capital investment is an important cost driver to set the foundation for lower levels of capacity (JEE score 1 to 2) in LMICs which can also benefit other services (Appendix 3).** Previous studies have noted the need for LICs to invest proportionally more in frontloaded capital investment to boost the existing system, while higher-income countries will incur greater recurrent costs per capita.¹⁶

Our analysis highlights that a large share of PPR cost is determined by the specific context in each setting and how the health system is set up, notably the number of health facilities and health workers per capita that need capacity improvement in PPR. At the lower level of JEE assessed capacity, costs to upgrade capacity are related to collaborative Surveillance (c1) and Safe and Scalable Care (c3). To achieve higher levels of capacity requires greater investments in Overall Health Emergency Preparedness (c0) along with c3 Safe and Scalable Care (see Appendix 3 for details).

¹⁶ Clarke, Lorcan et al. (2021), The costs of improving health emergency preparedness: A systematic review and analysis of multi-country studies

4.4. PPR investments in the context and broader health sector spending

If health systems in LMICs were strengthened to meet PPR and UHC investment benchmarks, PPR-contributing health sector investments may be equivalent to between 5% and 15% of total UHC health costs. Most of the elements of PPR spending contribute to wider health systems strengthening and delivery, and there are substantive synergies between investments in PPR and investments to strengthen overall health system performance and UHC. This may include whether to focus on strengthening readiness in the community, primary-level health facilities, or to build capacity at more central levels. Strengthening primary-health care infrastructure will support preparing for health emergencies and contribute to shared goals on service delivery through accessible quality health care services. Investments in integrated data systems and national public health institutes would support national coordination processes not just for preparedness but for health service delivery overall. Supporting community engagement will strengthen community response and build trust in governing institutions.

The modelled investments for PPR consider a **digitalised health information approach** and will support the broader digitalisation of health information systems. PPR relies on the available **health workforce**, particularly those at primary-level. The costs presented here primarily consider training and may not include all salary costs, especially if new staff are required rather than transferring staff time from other health system strengthening activities.

In countries with limited resources, the costs of achieving a JEE/SPAR score of 5 may take up considerable proportions of the overall health budget, and hence substantial additional external funding needs to be made available. For our one LIC, PPR spending requirements may be as much as 76 % of all current domestic expenditure on health, and it were between 8% and 17% for our LMIC country examples (see Appendix 3) for our moderate scenarios. The resource constraints underline that the pathway to PPR needs to be considered jointly with the broader strategies for health security and UHC (see Box 1).

Box 1 Country experiences of integrated PPR-UHC approaches for planning and resource allocation

Country experiences demonstrate the benefits of integrated PPR-UHC approaches for planning and resource allocation. In Cuba, the COVID-19 epidemic led to the development of a national Plan for Coronavirus Prevention and Control, where the implementation relied on existing primary health care teams supported by medical school staff and students. The incorporation of active case finding activities into regular care provision led to high coverage and enabled the response to draw on the Cuban National Health System.¹⁷ Another example is Uganda, where efforts have been made to link the MoH strategic health plan and the National Action Plan for Health Security (NAPHS) (ref: [MoH-Strategic-Plan-2020_25.pdf](#)). Furthermore, Uganda is an example where the government has recognized funding constraints as a challenge for the NAPHS implementation. This led to a process that helped decision makers to identify a reduced set of activities to be prioritized and covered by available funding within a 1-year operational plan.

¹⁷ Mas Bermejo P, Sánchez Valdés L, Somarriba López L, Valdivia Onega NC, Vidal Ledo MJ, Alfonso Sánchez I, Seuc Jo A, Almeida Cruz Y, Morales Ojeda R. Equity and the Cuban National Health System's response to COVID-19. *Rev Panam Salud Publica*. 2021 Jul 1;45:e80. doi: 10.26633/RPSP.2021.80. PMID: 34220992; PMCID: PMC8238257.

4.5. Way forward

PPR investment approaches will differ across countries, and per capita needs will vary by context and over time. While there has been considerable investment in supporting countries making costed action plans, including through NAHPS, there is a lack of standardised costing methods to do this. This costing exercise used a costing tool developed by WHO to cost HEPR. However, some of the elements included here are not included in the expenditure tracking and vice versa. Further standardisation of the key activities and functions to include in both is required.

LMICs that seek support to assess the costs of different strategies should have access to standardised cost methodologies and tools. Costing methods and tools need to be developed that transparently link investments in preparedness to outcomes in the different scoring systems available and the overall benchmarks for PPR. Specifically, there needs to be further validation of whether the quantities used in current costing tools are sufficient to generate JEE/SPAR improvements¹⁸, and beyond that which models of delivery and population impact will most mitigate health and economic outcomes. In practice, countries may be more or less efficient, and real-world costing studies are required to validate current costing models.

¹⁸ In addition to evidence on the type of inputs/investments needed, the extent to which geographic coverage of investments (in our scenarios set to 10 and 30%) determines PPR capacity should be established.

5. Smarter spending on PPR capacity

5.1. Evidence and rationale

- **PPR investments may have high returns in terms of reducing risk for economies and health.** There is some evidence for high returns on the foundational elements of surveillance and collaborative and integrated systems. At the same time, the value for money of investments may vary depending on context, co-benefits for other diseases and technical efficiency, particularly in low-resource settings.
- **Technical/operational efficiency varies between health systems.** Important considerations that impact technical efficiency for infectious disease include a) intensity of populations coverage, b) prices and capacity of diagnostics infrastructure, c) pathways of care/response, d) utilisation of digital technologies, and e) level of integration and good governance and institutional arrangements.
- **There are substantial gaps in global evidence** to evaluate the value for money of PPR and frameworks for cross-country evaluation/learning – that appropriately consider investments from a societal and health sector perspective and the joint returns to UHC and health security.

5.2. Implications for action

- **Country-led evidence-informed prioritisation and health technology assessment** have been demonstrated as being feasible and have the potentials to improve efficiency. **It is important to integrate PPR investments within these processes**, that examine efficiency and equity of both health service and systems investments in the progressive realisation of UHC and health security.
- **However, methods need further development to ensure these processes are multi-sectoral and adequately address investment with highly uncertain but potentially substantive economic and health outcomes.** It will be critical to incorporate pandemic risk into national priority-setting and investment planning processes. A risk-based approach enables more strategic allocation of limited resources across the health system, including health security – it can also strengthen multisectoral collaboration.
- **There is a need to enhance global and regional efforts to generate evidence, learn across settings and develop frameworks to evaluate value for money for PPR.** Implementing a **co-benefit framework** for pandemic PPR is essential for positioning these investments within national priority-setting processes and informing strategic allocation of resources to achieve joint UHC and health security objectives.
- **Institutionalising prioritisation frameworks and processes, particularly in resource-constrained settings can provide a domestically driven basis for examining the value for money in PPR investment.** For example, by using these process to examine PPR investment, countries can explore optimal phased approaches/pathways for PPR, examine the most essential capacities in collaborative surveillance and community protection, and expand based on fiscal space and external support.

5.3. Value for Money of PPR: Co-benefits and technical efficiency

Spending on PPR yields a positive return and protection against potentially catastrophic societal and economic impacts. Estimates from 2021 for the G20 High-Level Independent Panel

on Financing the Global Commons for Pandemic PPR indicate that every dollar invested in pandemic preparedness could return high levels of economic savings.¹⁹ A country-based analysis estimates that these returns correspond to 4.5% to 11.5% of pre-pandemic GDP in four countries in the event of a COVID-19-like pandemic within a decade, assuming no closures of economic activity.²⁰ At the same time there is uncertainty around the type of pathogen, timing of the next pandemic and responses to such an event. The risk of another global pandemic as deadly as COVID-19 in the next 10 or 25 years has been estimated to range between 22-28% and 47-57% respectively²¹ and the returns of pandemic preparedness could be lower (or even negative) depending on the pathogen and country.²² Preliminary estimates from 2024 for the HEPR Investment Case on increasing collaborative surveillance capacities for a COVID-19-like event²³ found a return of USD 2 for every dollar invested, possibly increasing to USD 5 when expanding to all additional health emergencies such as high-threat epidemics, climatic disasters, and antimicrobial resistance (AMR), among others.²⁴

PPR returns are mostly additive to high-return investments in UHC. For instance, interventions to address tuberculosis can deliver USD 28 to USD 84 for every dollar invested.²⁵ PPR investments can help strengthen the response to TB by supporting strong laboratory systems. Similarly, in the case of maternal and neonatal mortality, a key priority in lower income countries, emergency obstetric care and family planning can return USD 87.²⁶ Meanwhile, immunisation can yield returns greater than USD 100 for every dollar invested when considering long-term impacts.²⁷ However, despite these high returns, on average LICs have USD 9 per capita to spend in the health sector, compared to the overall cost of UHC at around USD 100-150 per capita. Where health budgets are highly constrained it governments need to define an efficient pathway to strengthening health systems and services, to achieve UHC and health security.

To ensure efficient pandemic preparedness investments, it is therefore important that the co-benefits for health systems need to be considered, particularly in countries that have not yet achieved UHC. Co-benefits refer to the additional benefits of PPR beyond their primary goal of reducing pandemic risks and response costs. For instance, collaborative surveillance interventions can also enhance systems for managing endemic infectious diseases, offering more value than setting up separate, parallel structures. Such co-benefits strengthen the case for domestic health financing for PPR. Appendix 4 contains an example of such a framework applied

¹⁹ The Health and Economic Benefits of Preparing for the next pandemic. Report for the G20 High Level Independent Panel on Financing the Global Commons for pandemic PPR. Final draft, 10 August 2021.

²⁰ Preparedness measures related to vaccines, behaviors and government capacities increased to highest capacity level based on WHO's Joint External Evaluation (JEE) . ref: The Health and Economic Benefits of Preparing for the next pandemic. Report for the G20 High Level Independent Panel on Financing the Global Commons for pandemic PPR. Final draft, 10 August 2021.

²¹ Metabiota estimates How might probability inform policy on pandemics? Metabiota has ideas | Devex

²² Pathogens considered included SARS, Spanish flu, and Swine flu-like. The Health and Economic Benefits of Preparing for the next pandemic. Report for the G20 High Level Independent Panel on Financing the Global Commons for pandemic PPR. Final draft, 10 August 2021.

²³ Increase in average surveillance JEE by 14. WHO. HEPR Investment Case. Model 1 output. Discussion document. May 2024

²⁴ WHO. HEPR Investment Case. Model 1 output. Discussion document. May 2024.

²⁵ [Halftime for SDGs: Tuberculosis; One Million Lives Saved Per Year: A Cost-Benefit Analysis of the Global Plan to End Tuberculosis, 2023-2030 and Beyond | Journal of Benefit-Cost Analysis | Cambridge Core](#)

²⁶ [Halftime for SDGs: Maternal and Newborn Health; Achieving Maternal and Neonatal Mortality Development Goals Effectively: A Cost-Benefit Analysis | Journal of Benefit-Cost Analysis | Cambridge Core](#)

²⁷ Copenhagen consensus

to collaborative surveillance. A co-benefit framework supports governments considering both the long-term, uncertain future benefits of pandemic preparedness as well as the more immediate, tangible impacts on public health and economic development.

Any framework that examines investment must consider equity. Partial preparedness coverage raises equity concerns, and decision-makers should also determine which measures offer sufficient but fair protection against pandemic risks and potential impacts. The insurance value from the prevention of catastrophe, which justifies ensuring emergency readiness beyond regular infectious disease control, may be considered.²⁸ Strengthening health systems to deliver UHC contributes to reducing the risk of economic catastrophe, particularly for poor households, both from epidemic and endemic disease.²⁹

The underlying technical efficiency of the systems will drive value for money of PPR investment. In recent years there has been increasing evidence of substantial variation in the technical efficiency of health systems both within and between countries. Some estimates demonstrated a potential to reduce costs by up to 40%. Key considerations include ensuring effective planning, decentralisation of some functions, stability of funding, economies of scope and scale, accountability structures, such as improved monitoring and evaluation of expenditures, the extent of corruption, effective pricing of commodities, effective human resource management and management/financial/information systems and financing incentives that support efficiency improvement.³⁰

5.4. Country-led priority setting and investment planning

Priority-setting can be defined as an inherently political process to decide between strategic options based on societal values with respect to the available resources.³¹ Health systems, no matter how well developed or financed, can achieve good priority-setting by implementing processes that are evidence-based, transparent and inclusive. Explicit priority-setting processes should also differentiate between the current health needs and those that are expected to emerge in the future, and include the assessment of value for money, usually as the primary criterion against which other criteria (such as equity) are traded off.

Institutionalised evidence-informed priority-setting processes are recognised as the foundation for funding, investment, and pricing decisions in the health sector. In the World Health Assembly Resolution WHA 67.23, member states recognise the crucial role of health technology assessment (HTA) in informing priority-setting and are urged to systematically utilise “*independent health intervention and technology assessment in support of universal health coverage to inform policy decisions, including priority-setting, selection, procurement supply system management and use of health interventions and/or technologies, as well as the formulation of sustainable financing benefit packages*”.³² HTA is a multidisciplinary process that uses explicit methods to determine the value of a health technology at different points in its

²⁸ (Ling-Hu et al. 2022; WHO 2022b).

²⁹ Ghazy RM, El Saeh HM, Abdulaziz S, Hammouda EA, Elzorkany AM, Khidr H, Zarif N, Elrewany E, Abd ElHafeez S. A systematic review and meta-analysis of the catastrophic costs incurred by tuberculosis patients. *Sci Rep.* 2022 Jan 11;12(1):558. doi: 10.1038/s41598-021-04345-x. PMID: 35017604; PMCID: PMC8752613.

³⁰ Exemplars in Primary Health Care. Forthcoming

³¹ <https://www.who.int/publications/i/item/9789241549745>

³² Resolution WHA67.23. WHO. In: Sixty-seventh World Health Assembly, Geneva, 19–24 May 2014. Resolutions and decisions, annexes. Geneva: World Health Organization; 2014 (https://apps.who.int/gb/ebwha/pdf_files/WHA67-REC1/A67_2014_REC1-en.pdf#page=73, accessed 9 October 2024)

lifecycle. An example of success is Thailand, where HTA was introduced following increasing costs and budget constraints faced due to the implementation of the universal health coverage scheme and has led to careful consideration of value for money in the adaptation of new technologies, including both vaccinations and diagnostic technologies.³³

Domestic priority-setting processes can be central gateways to both the introduction and coverage expansion of PPR in LMICs for development assistance. Either aligning or pooling resources from different sources to fund a health benefit package under the leadership of the recipient country can further country ownership of external resources and reduce fragmentation, which can contribute towards sectoral efficiency improvement.³⁴ There are few examples of such processes being applied to PPR. There are several in high-income countries, however. For example, in Belgium, stakeholders followed a multi-criteria decision framework to make priorities based on explicit criteria.³⁵

5.5. Way forward: global evidence and local prioritisation

Global evidence generation and learning

Action is required to ensure sufficient research and evaluative funding goes to the assessment of value for money of PPR. Several steps/areas warrant further work:

- 1. Standardised definitions of PPR interventions, both shared system elements and pandemic preparedness additional interventions that can be used by analysts and build a global evidence base that can be used across countries.** A critical gap is the lack of a clear and standardised typology of pandemic PPR interventions that can be costed, evaluated and compared across other health interventions, sectors and settings.
- 2. Define appropriate methods to estimate co-benefits of PPR within the health sector across multiple pathogens, including the use of multi-sectoral economic evaluation frameworks, which also fully consider the relationships between benefits and risk reduction and decision-making under high levels of evidential uncertainty.** Analytical approaches that inform both health sector and societal payers need to be considered.³⁶
- 3. Independent rigorous economic evaluations of PPR investment to inform a global database and community of learning.** Very few PPR investments have undergone impartial, rigorous economic evaluation. This would help assess what works, for whom and under what conditions, with a view to prioritise high-value investments.
- 4. Incorporation of equity and distributional impact considerations.** The extent of coverage of interventions improves both effectiveness and equity. It is useful to further build evidence on how PPR investments affect equity, e.g., reaching marginalised population, strengthening PHC in underserved areas, or reducing urban-rural disparities.

³³ Teerawattananon Y, Tantivess S, Yothasamut J, Kingkaew P, Chootipongchaivat S, Tritasavit N. Health technology assessment in Thailand: Institutionalization and contribution to healthcare decision making – A review of literature. *Int J Technol Assess Health Care*. 2016;32(2):80-87. DOI: <https://doi.org/10.1017/S0266462319000321>

³⁴ Chi Y, Regan L. The Journey to Universal Health Coverage: How Kenya Managed the Inclusion of Disease Programmes in its Health Benefits Package; 2021 (<https://www.cgdev.org/publication/journey-universal-health-coverage>, accessed 9 October 2024)

³⁵ <https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-020-09566-9#citeas>

³⁶ McGuire F, Vijayasingham L, Vassall A, Small R, Webb D, Guthrie T, Remme M. Financing intersectoral action for health: a systematic review of co-financing models. *Global Health*. 2019 Dec 18;15(1):86. Remme M, Martinez-Alvarez M, Vassall A. Cost-Effectiveness Thresholds in Global Health: Taking a Multisectoral Perspective. *Value Health*. 2017 Apr;20(4):699-704.

6. Sustainable domestic and global financing of PPR

6.1. Key findings

- **Substantial untapped potential for domestic revenue mobilisation.** There exists considerable, yet underutilised, potential for enhancing domestic revenue generation in low- and middle-income countries.
- **Stagnation and decline in health budget prioritisation.** Over the past two decades, lower-middle-income countries have exhibited stagnation in prioritizing health within national budgets, while LICs have experienced a marked decline. This trend has constrained the availability of domestic resources for the health sector, undermining efforts to strengthen health systems and PPR capabilities.
- **Overlooked role of Public Financial Management in the health sector.** The efficacy of PPR systems is contingent not only on the volume of financial resources but also on the predictability of domestic funding streams and the robustness of PFM frameworks. Effective PFM systems are essential to ensure the strategic allocation, efficient utilisation, and transparent oversight of PPR investments.
- **Enduring the importance of external assistance. While its composition and scope are changing rapidly,** external aid remains a cornerstone of PPR financing, particularly in low-income countries. The COVID-19 pandemic highlighted the indispensable nature of PPR investments, yielding benefits that transcend national borders and income classifications.

6.2. Implications for policy

- **Prioritise domestic public funding.** Domestic public funding should remain the cornerstone of PPR investment, ensuring both equity and long-term sustainability. Governments may need to re-prioritise existing budget allocations to protect and enhance investments in both UHC and health security.
- **Expand fiscal space for health, including PPR, through growth and tax reform.** There is considerable potential to increase domestic revenues by strengthening the design and administration of core taxes. There is scope to further scale up cooperation in this area, including redressing the ODA imbalance in this area: in 2023, support for DRM accounted for just 0.1% of DAC countries' bilateral ODA.
- **Strengthen PFM systems in the health sector.** Robust and adaptable PFM systems are essential to ensure that resources are allocated, utilized, and accounted for effectively. Reforms should aim to build systems that are agile and resilient, capable of responding swiftly and transparently to future health emergencies.
- **Align domestic and external flows.** External assistance for PPR and broader health initiatives should be more systematically aligned with national priorities and increasingly channelled through domestic PFM systems, in line with the Lusaka Agenda. These efforts should be guided by integrated data and evidence for planning and priority setting so that domestic and external health resources are targeted where they are most needed for the greatest impact.

- **Innovate external financing approaches.** Renewed and diversified financing modalities—such as blended finance and transitional funding mechanisms—should be explored to complement domestic efforts.

6.3. Domestic financing for PPR: role, opportunities and constraints ahead

Amid tightening global health financing conditions, domestic public resources remain the cornerstone of sustainable and equitable PPR. While private sector contributions can play a complementary role—particularly in areas such as capital investment, innovation, and support for local manufacturing—prior *G20 Joint Finance and Health Task Force* reports have underscored that domestic public funding is indispensable to ensuring that PPR interventions are equitable, comprehensive, accountable, and fiscally sustainable.³⁷ The COVID-19 pandemic provided a real-world stress test of this principle. Between 2020 and 2022, upper-middle-income countries financed, on average, 90% of their COVID-19 health expenditures through domestic public sources. Several lower-income countries also demonstrated notable fiscal resilience, mobilising substantial domestic resources to meet urgent response needs—primarily through budget reprioritisation and reallocation.³⁸ These experiences highlight the critical importance of strengthening domestic fiscal capacity and aligning national budgetary processes with PPR priorities.

Expanding fiscal space for PPR requires a conducive macro-fiscal environment and an effective tax system. These factors determine governments' capacity to sustainably mobilise and allocate resources toward health security and resilience (Figure 5). Sustained economic growth serves as a critical enabler—not only by expanding fiscal space, but also by generating long-term health gains through improved living standards, employment, and public investment capacity.³⁹ A stable and inclusive growth trajectory strengthens the foundation for resilient health systems and enhances countries' ability to respond to future shocks. This, in turn, creates opportunities to bolster fiscal capacity through taxation. Recent projections by the IMF suggest that the potential for additional domestic revenue mobilisation remains substantial in many LMICs. The estimated untapped tax potential in LMICs is as high as 9 percentage points of GDP.⁴⁰ Realising this potential will require a dual approach: first, by enforcing and optimising existing tax regimes; and second, by refining tax policy where appropriate. This may involve adjusting tax rates, broadening the tax base, and introducing new instruments—such as health taxes—that simultaneously promote public health and generate additional revenue.⁴¹

³⁷ [G20-Gaps-in-PPR-Financing-Mechanisms-WHO-and-WB-pdf.pdf](https://thedocs.worldbank.org/en/doc/16c7e5b734f1d9953f0582c837b11b64-0290032022/original/G20-Paper-on-PPR-Financing-Modalities.pdf)

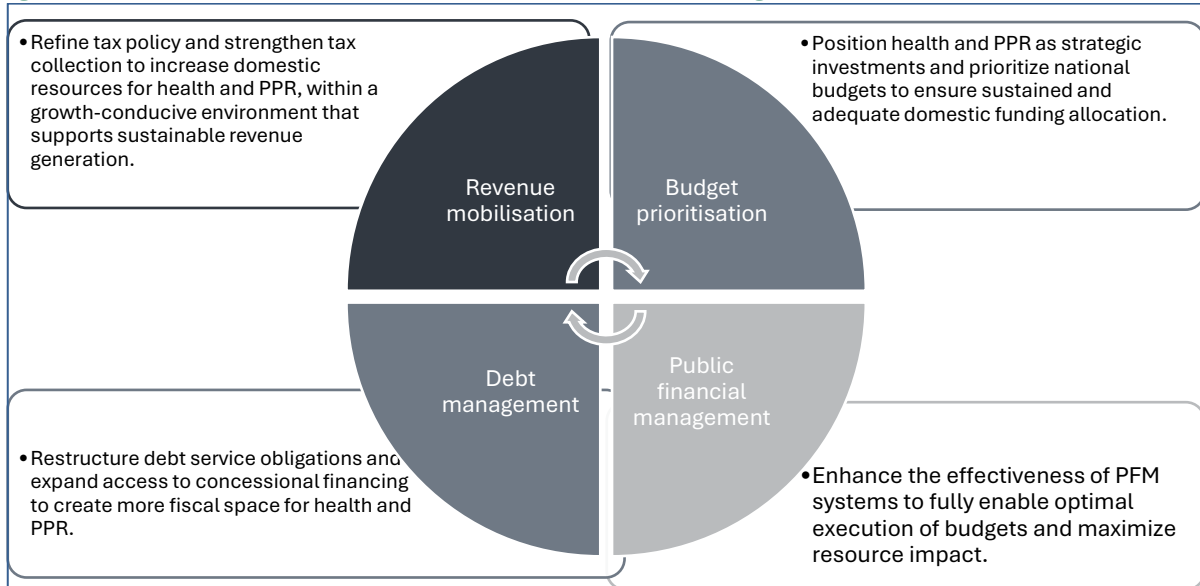
<https://thedocs.worldbank.org/en/doc/16c7e5b734f1d9953f0582c837b11b64-0290032022/original/G20-Paper-on-PPR-Financing-Modalities.pdf>

³⁸ <https://www.who.int/teams/health-financing-and-economics/global-spending-on-health-2021>

³⁹ [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(24\)01873-7/fulltext#:~:text=The%20Council%20reimagined%20how%20economics%20and%20health%20relate,77th%20World%20Health%20Assembly%20%28WHA%29%20in%20May%2C%202024.](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(24)01873-7/fulltext#:~:text=The%20Council%20reimagined%20how%20economics%20and%20health%20relate,77th%20World%20Health%20Assembly%20%28WHA%29%20in%20May%2C%202024.)

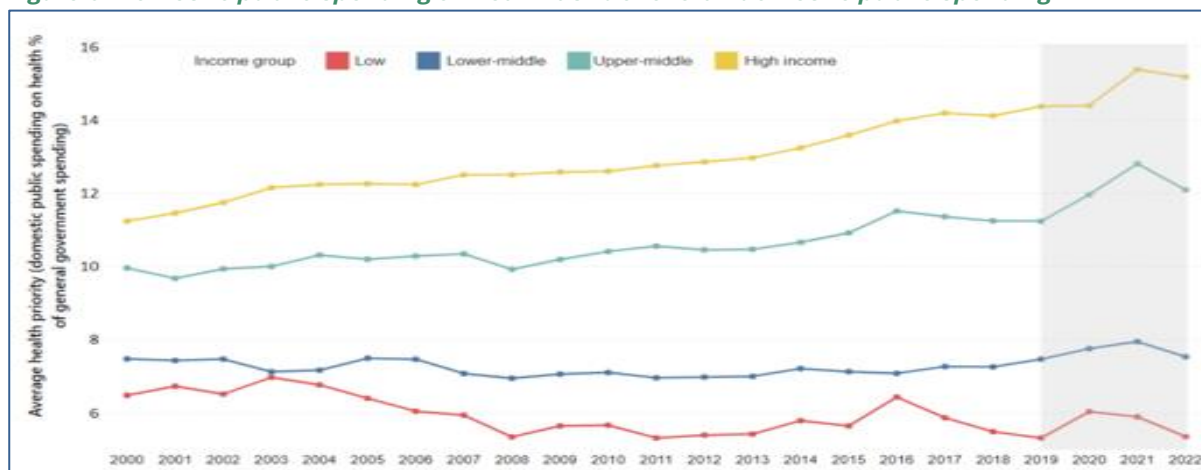
⁴⁰ <https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2023/09/15/Building-Tax-Capacity-in-Developing-Countries-535449>

⁴¹ At present, health taxes in the form of excises raise only moderate amounts of tax revenue, only 0.3% of GDP in low-income countries on average, due to the narrow tax base. Across the OECD, the share is 0.74% on average.

Figure 5. Interconnected actions to foster domestic PPR funding

Funding availability for PPR is not solely a function of macro-fiscal conditions—it also depends critically on the capacity and political will of governments to prioritise health within national budgets. This is particularly relevant for low-income countries, where fiscal constraints are most acute and competing demands on public resources are intense. Over the past two decades, the budgetary priority allocated to health has remained largely stagnant in lower-middle-income countries and has shown a declining trend in low-income countries. Although proportional health spending increased across income groups during the initial years of the COVID-19 pandemic, this momentum was not sustained. By 2022, health spending in LICs had fallen below 5% of total government budgets (Figure 6). Projections from the World Bank indicate that if the share of health spending remains fixed at 2020 levels, real per capita government health expenditure in a sample of 44 low- and middle-income countries will decline post-2022 and remain below 2022 levels through 2028. This trajectory poses a serious risk to the sustainability and effectiveness of PPR financing and undermines efforts to build resilient health systems. Reversing this trend requires deliberate policy action to elevate health as a strategic investment priority.⁴²

⁴² From Double Shock to Double Recovery: Government Health Spending Trends and Outlook

Figure 6. Domestic public spending on health as % of overall domestic public spending

Source: Global Health Expenditure Report 2024, WHO

Debt servicing obligations further constrain the ability of many governments to prioritise health and PPR in national budgets is currently constrained by debt servicing obligations.

Elevated debt burdens significantly limit fiscal space and reduce the flexibility of governments to allocate adequate resources to essential sectors, including health. Since the onset of the COVID-19 pandemic, external debt servicing has, on average, outpaced public spending on health across low- and lower-middle-income countries. This trend directly undermines countries' capacity to invest in the foundational systems required for effective PPR and resilient health systems. While sovereign debt levels were already high prior to the pandemic, many countries were compelled to borrow further to respond to the dual health and economic crises triggered by COVID-19.⁴³ In this context, comprehensive debt restructuring and relief efforts can help to restore fiscal sustainability and to “unlock” budgetary space for critical investments in health and PPR. Without such interventions, many countries risk falling into a cycle of underinvestment, vulnerability, and dependence on external aid. These interventions however must be accompanied with sustainable economic policies that support long-term growth and robust domestic institutions and credible regulatory frameworks.

Robust PFM systems are critical to maximising the impact of public spending and unlocking additional budgetary space for health and PPR.

Between 2010 and 2020, an average of 13% of health budget allocations went unspent across a sample of 91 LMICs, equivalent to a loss of approximately 4 international dollars per capita.⁴⁴ This figure is comparable to the annual per capita spending on primary health care in low-income countries, underscoring the urgency of addressing inefficiencies in health budget execution. Evidence also indicates a declining trend in health budget execution rates over time, particularly in low-income settings. While revenue shortfalls contribute to these challenges, inefficiencies in expenditure management—such as complex administrative procedures, misaligned cash requests, and delays in disbursement—further constrain the effective use of allocated resources. Improving budget execution requires coordinated action between ministries of health and finance. Key measures include streamlining spending procedures, reducing administrative bottlenecks, aligning budget and cash planning, and enhancing transparency and accountability mechanisms. To support these reforms, multilateral and bilateral partners must scale up their assistance to strengthen domestic PFM systems, particularly within the framework of the *Montreux Collaborative on fiscal space, PFM*

⁴³ [Fiscal Monitor October 2024: Putting a Lid on Public Debt](#)

⁴⁴ <https://openknowledge.worldbank.org/entities/publication/8878fbd9-879d-43d4-ab1f-ecaed1a4576a>

and health financing.⁴⁵ In parallel, health grants should be urgently realigned with national PFM processes to ensure coherence, reduce fragmentation, and enhance the overall efficiency and impact of health spending.

PFM systems must be adapted during preparedness periods to ensure they are agile and responsive during health emergencies. Proactive adjustments across the budget cycle can significantly enhance the efficiency and impact of PPR financing by maximising the use of existing resources and enabling timely action. These reforms are needed across all three stages of the budget cycle: (i) Budget formulation and allocation: Response funding must be systematically incorporated into national budgets, with mechanisms that allow for flexible allocation across budget lines and funding sources; (ii) Budget execution and disbursement: Funds should be disbursed rapidly and managed flexibly at the frontline level to ensure timely delivery of essential services and supplies; (iii) Monitoring and accountability: Expenditures must be transparently tracked and reported to build public trust and ensure accountability (see Appendix 5). New financing instruments—such as the Pandemic Fund and the IMF’s Resilience and Sustainability Facility (RSF)—have been designed, with support from WHO and the World Bank, to accelerate the implementation of PPR-relevant PFM reforms. These instruments offer technical and financial support to countries seeking to modernise their PFM systems and integrate PPR priorities into core processes. Accelerating the uptake of these reforms represents a win-win opportunity: enhancing both the level and quality of PPR financing while strengthening the institutional foundations for long-term health system resilience.^{46,47}

6.4. PPR and international aid architecture reform

While external assistance remains a critical pillar of PPR, a re-evaluation of how this assistance is channelled in the health sector is essential to ensure long-term sustainability and impact. The COVID-19 pandemic triggered an unprecedented scale up of resources from the international development cooperation and humanitarian assistance community. From 2020 to 2022, official providers and philanthropic organisations disbursed USD 126 billion of assistance targeting the COVID-19 response, within an overall international assistance package topping more than USD 886 billion (USD 1.1 trillion gross). Official health assistance increased by 73% from 2019 to 2020 (USD 47 billion committed) and reached a record high of USD 59 billion in 2021, before falling sharply again from 2022-2025.⁴⁸ While some assistance efforts worked well, the pandemic also exposed significant inefficiencies in aid delivery, particularly when resources were routed through multiple recipient entities and fragmented processes outside regular budgetary systems. This fragmentation led to duplication, inconsistent responses, and an excessive reporting burden for recipient governments—challenges highlighted by the Independent Panel for Pandemic Preparedness and Response.⁴⁹ To enhance the efficiency and alignment of external financing, greater use of pooled funding mechanisms and increased channelling of resources through national systems are imperative. These principles are central to the Lusaka Agenda, which calls for a shift toward country-led, integrated financing approaches that strengthen national ownership

⁴⁵ <https://www.pfm4health.net/>

⁴⁶ [Jordan—IMF Executive Board Completes Third Review of the Extended Fund Facility Arrangement and Approves US\\$ 700 Million Arrangement under the Resilience and Sustainability Facility](#)

⁴⁷ [WHO welcomes IMF support to Jordan for pandemic preparedness and response](#)

⁴⁸ [Strategic Joint Evaluation of the Collective International Development and Humanitarian Assistance Response to the COVID-19 Pandemic \(2025, forthcoming\)](#)

⁴⁹ The Independent Panel for Pandemic Preparedness and Response reports: [Independent Panel reports & publications - The Independent Panel for Pandemic Preparedness and Response](#)

and accountability.⁵⁰ Aligning external funding flows with domestic PFM systems can significantly improve the effectiveness of PPR investments, particularly when such investments also contribute to broader health system strengthening. Reorienting ODA for health to align with national priorities—while balancing efficiency, equity, and resilience considerations—is a strategic imperative in the evolving global health financing landscape. G20 members and partners have a critical role to play in supporting this transition by promoting harmonised funding practices, incentivising alignment with domestic systems, and fostering mutual accountability between donors and recipient governments.

Innovative and blended financing approaches are essential to closing PPR investment gap, as underscored by the establishment of the Pandemic Fund. To support countries' progression toward sustainable financing and self-reliance, there is a need to accelerate the deployment of concessional resources by blending grants and loans and crowding in domestic public resources. The Pandemic Fund exemplifies this model, operating with a blended finance structure that achieves a leverage ratio of approximately 1:7—mobilising significant additional resources for PPR from multilateral development banks (MDBs), bilateral donors, and domestic stakeholders.⁵¹ Looking ahead, systematising the use of grant financing from Global Health Initiatives (GHIs) to catalyse MDB investments offers a scalable pathway for health ODA. This approach aligns with the recommendations of the *High-Level Independent Panel* (HLIP), which called for enhancing the grant element of MDB funding through dedicated concessional windows for pandemic preparedness. The HLIP further emphasised the importance of partnerships with grant-based GHIs—such as Gavi and the Global Fund—to leverage complementary funding streams and strengthen health system resilience.^{52, 53}

Transitional financing may offer a complementary fit-for-purpose approach to allocating and disbursing pandemic PPR aid as countries advance toward more sustainable and domestically driven financing pathways. As defined under the *Financing for Development and Finance in Common* frameworks,^{54,55} transitional financing typically involves time-bound grants—often spanning two to three years—designed to strengthen national systems and institutional capacity. The core objective of transitional financing is to establish the right set of incentives for donors, recipients, and implementing partners, while equipping countries with the greatest needs to build the foundations for long-term self-reliance. This includes targeted financial and technical support in critical areas such as PFM, data and surveillance systems, supply chain management, and procurement of essential medical countermeasures. A key feature of transitional financing is its blended structure. A predetermined portion of the grant—based on transparent criteria such as income level or fiscal capacity—is blended with concessional loans. This approach increases the overall concessionalality of the financing package while enhancing its programmatic focus, often through a defined leverage ratio. It also encourages co-investment and accountability while preserving fiscal sustainability.

⁵⁰ [Roadmap for Implementation of the Lusaka Agenda in Africa 12.08.24.indd](#)

⁵¹ https://www.thepandemicfund.org/sites/default/files/2024-04/Pandemic_Fund_Strategic_Plan_4-12-2024.pdf

⁵² [Main Report & accompanying work - The Independent Panel for Pandemic Preparedness and Response](#)

⁵³ [Partnering with multilateral development banks to build sustainable immunisation systems](#)

⁵⁴ https://financing.desa.un.org/sites/default/files/2025-02/ICE_Final%20Report.pdf + [FFD4 Outcome First Draft.pdf](#)

⁵⁵ [FICS 2025 Final Communique | Finance in common](#)

Closing the persistent funding gaps for PPR will require truly transformational financing approaches—extending beyond traditional health-sector mechanisms. As the global community seeks to build more resilient and self-reliant systems, there is a pressing need to explore and scale innovative financial instruments that draw on lessons from broader development, climate, and private sector mechanisms. The findings of the *Independent High-Level Expert Group on Vertical Climate and Environmental Funds*,⁵⁶ appointed by the Brazilian G20 Presidency, can offer ideas for global health financing, although certain aspects may be more beneficial and applicable than others.⁵⁷ These include improving operational efficiency, reducing fragmentation, aligning with country priorities, and enhancing leverage through blended finance models. Applying these principles to PPR financing can help unlock new sources of capital and improve the effectiveness of existing resources. Several underutilised modalities in the health sector also hold significant promise: (i) Leveraging MDBs to provide guarantees and incentives that crowd in private investment aligned with PPR objectives; (ii) Issuing local development bonds—such as green bonds, SDG bonds, and sustainability-linked bonds—within sound regulatory frameworks and robust risk management systems;⁵⁸ (iii) Harnessing national public development banks to mobilise domestic resources for crisis preparedness and health system strengthening. Together, these efforts can work to enhance broader health architecture reforms, including through the new FfD4 Sevilla Platform for Action initiative on a renewed global health ecosystem, launched on 2 July 2025, and action to implement the IMF/World Bank package of actions to strengthen i) domestic resource mobilisation ii) lower cost international support and iii) reductions in debt service burdens.⁵⁹

These efforts should be complemented by coordinated regional market-shaping strategies, such as pooled procurement mechanisms, to attract foreign direct investment (FDI)—particularly in areas like local manufacturing of medical countermeasures. All initiatives must be grounded in realistic projections of additional resource mobilisation and designed with precision to generate long-term economic and public value.⁶⁰ G20 members are uniquely positioned to champion this agenda by fostering cross-sectoral collaboration, supporting financial innovation, and ensuring that PPR financing is embedded within broader sustainable development strategies.

Finally, in the evolving global health financing landscape, the newly established Coordinating Financing Mechanism (CFM)—introduced under the amended *International Health Regulations (IHR 2024)*⁶¹ and the *WHO Pandemic Agreement*⁶²—marks a pivotal step toward harmonizing and streamlining international support for PPR. The CFM is designed to enhance coherence in global action by aligning financial flows with national priorities and ensuring equitable access to surge financing during health emergencies.⁶³ This approach also directly addresses long-standing challenges in global health financing, including fragmentation, duplication, and delays in disbursement. By improving the predictability,

⁵⁶ <https://g20sfdg.org/wp-content/uploads/2024/10/G20-IHLEG-VCEF-Review.pdf> +

⁵⁷ <https://www.devex.com/news/opinion-how-do-we-fix-global-health-financing-this-review-can-help-109253>

⁵⁸ [RSA HIV bond](#)

⁵⁹ <https://www.imf.org/en/Blogs/Articles/2024/08/01/now-is-the-time-to-help-countries-faced-with-liquidity-challenges>

⁶⁰ <https://www.ucl.ac.uk/bartlett/publications/2025/jun/mind-mission-not-gap-rethinking-blended-finance-public-purpose>

⁶¹ [World Health Assembly agreement reached on wide-ranging, decisive package of amendments to improve the International Health Regulations](#)

⁶² [Pandemic prevention, preparedness and response agreement](#)

⁶³ [World Health Assembly agreement reached on wide-ranging, decisive package of amendments to improve the International Health Regulations](#)

timeliness, and coordination of financial support, the CFM can contribute to a more resilient and responsive global health support. As the global community moves toward the implementation phase of the Pandemic Agreement, the effective design and governance of the CFM will be critical to its success. This includes ensuring transparency, country ownership, and alignment with broader sustainable financing strategies.

7. SECTION 3 – TECHNICAL APPENDICES (ONLINE)

7.1. Appendix 1: Methods summary

Full references expenditures

https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/03/smart-spending-to-combat-global-health-threats_9985a31e/166d7c57-en.pdf

| | Estimate of PPR Costing (examples, non-exhaustive list) used in section ³ | Estimate of PPR Expenditures (based on 2022 data) used in section ² | 2022 Estimate of PPR Costing ¹ |
|---|---|--|---|
| Approach⁶⁴ | | | |
| | <ul style="list-style-type: none"> Countries: archetype taken as indicative of income group Methods: bottom-up costing model based on country health system characteristics and default data Private vs. Public Funding: unspecified but most costs likely to be public | <ul style="list-style-type: none"> Countries: all LIC/LMIC/UMIC/HIC Methods: mapping of health accounts categories to JEE/IHR with proportional attributions developed from a study of several countries. Private vs. Public Funding: both included Only current health expenditure. Capital investment is not included. | <ul style="list-style-type: none"> Countries: LIC/LMIC Methods: Top down costing model with multiple data sources harmonized Private vs. Public Funding: unspecified but most costs likely to be public |
| Scope of National-level Costs/Expenditures (by HEPR 5C model2) | | | |
| C.0 Core Health System Structure for Preparedness | <ul style="list-style-type: none"> Equipping facilities to carry out PPR functions (i.e., digital equipment) Establishing community-based systems for PPR (putting CHWs in place, equipping and supervising them) | | |
| C.1 Collaborative Surveillance | <ul style="list-style-type: none"> Expand laboratory testing capacity Training laboratory staff, PH officials and CHWs on procedures, data collection, reporting and risk assessment | <ul style="list-style-type: none"> Surveillance (65%) | <ul style="list-style-type: none"> Population-level surveillance (CRVS) Pathogen surveillance Specialized surveillance Notifiable disease surveillance |
| C.2 Community Protection | <ul style="list-style-type: none"> Planning, monitoring and evaluation of population and environmental public health intervention | <ul style="list-style-type: none"> Immunisation (65%) | <ul style="list-style-type: none"> Communications and messaging Border health/POE |

⁶⁴ For more details on the 2025 estimates of costing and expenditure estimation, please see Appendices 1 and 2

| | Estimate of PPR Costing (examples, non-exhaustive list) used in section ³ | Estimate of PPR Expenditures (based on 2022 data) used in section ² | 2022 Estimate of PPR Costing¹ |
|---------------------------------------|--|---|--|
| | <ul style="list-style-type: none"> Limited costs of Immunisation related specifically to outbreaks | | |
| C.3 Safe and Scalable Care | <ul style="list-style-type: none"> Medical equipment (hospitals and health centers), including: <ul style="list-style-type: none"> Infection Control: incl. Sanitation, Hygiene, Waste Management PPE kits, Oxygen, ventilators Establishment of Quarantine units and Isolation units Share of health workforce time at Provincial Hospital for providing services | <ul style="list-style-type: none"> Curative care (1.25%) Long-term care (1.25%) Ancillary care (1.25%) | <ul style="list-style-type: none"> NPHI's Health System Strengthening |
| C.4 Access to Countermeasures | <ul style="list-style-type: none"> Efforts to coordinate and negotiate at the global level, including global supply chains. Salary costs for staff working at National Public Health Authorities | <ul style="list-style-type: none"> Governance and health system administration (11%) | <ul style="list-style-type: none"> Vaccine stockpiles |
| C5. Emergency Coordination | <ul style="list-style-type: none"> Risk analysis and coordination Salary costs for staff working at District Offices, National Public Health Authorities, and National Laboratories | <ul style="list-style-type: none"> Risk communication (65%) Governance and health system administration (11%) | <ul style="list-style-type: none"> Data integration Emergency Operations and Funds Regular simulations Assessments of system gaps |
| Additional noteworthy elements | | | |
| | <ul style="list-style-type: none"> Digital equipment, cellphones and software to facilitate reporting | | <ul style="list-style-type: none"> Animal health and Human/Animal interactions Global level costs <ul style="list-style-type: none"> Virome mapping Vaccine and therapeutics gap Vaccine manufacturing Global stockpile Emergency Operations and Funds |
| Conclusion on scope | | | |

| | Estimate of PPR Costing (examples, non-exhaustive list) used in section ³ | Estimate of PPR Expenditures (based on 2022 data) used in section ² | 2022 Estimate of PPR Costing¹ |
|--|---|--|---|
| | <p>Narrowest in terms of scope, mainly addressing non-disease specific capacities for PPR. Excludes costs for general health system strengthening as included in overall UHC costing (reduce overlap). Excludes costs incurred above national level. Availability of flexible country-level costing template.</p> | <p>Includes a broad range of healthcare functions, with varying degrees of attribution to PPR. Focuses exclusively on the health sector, based on the SHA 2011 boundary (excluding therefore animal health).</p> | <p>Quite top down in it's approach to national level costs. Broader in scope in that animal health is included as well as global costs for several different activities. Global costs estimated for needs during or post-Covid.</p> |

7.2. Appendix 2: Measuring PPR spending

BOX S2A Methodological approach to estimate PPR spending

Tracking health expenditure on PPR requires defining the scope of activities covered. Estimates of PPR spend in recent years extend beyond pure pandemic-prone diseases, to include activities that are needed to combat global health threats. This includes major epidemics, and other forms of global health threats, notably antimicrobial resistance.

Total spending on PPR is estimated using the System of Health Accounts (SHA), a global accounting framework developed by OECD, WHO, and Eurostat. While the SHA does not specifically include a category on PPR, many healthcare functions contain PPR-related spending. A proxy measure of PPR spending is therefore developed, based on an OECD and WHO mapping of health accounts classifications with the Joint External Evaluation (JEE) Tool of the International Health Regulations, used to evaluate a country's PPR capacity. Much of the work building a preliminary mapping between the SHA and JEE frameworks was undertaken by the OECD and WHO health accounts teams on tracking health security expenditure. This conceptual mapping provided an assessment of the extent to which expenditures reported under each SHA functional category (and sub-category) could be allocated to the JEE technical areas.

In particular, the SHA categories under preventive care referring to Immunisation programmes (HC.6.2) and Preparing for disaster and emergency response programmes (HC.6.6) can be considered as fully or almost fully integrated within the JEE technical areas and therefore within the scope of PPR. Similarly, it was considered that much of the expenditure on epidemiological surveillance and risk and disease control programmes (HC.6.5), albeit with some exceptions, could generally be considered as within the PPR scope.

For other functional categories, expert opinion concluded that only a small percentage of the spending could be allocated to PPR. For example, under the spending categories of curative care (HC.1) and long-term care (HC.3), expenditure on activities related to Antimicrobial Resistance (P.3) and the National Laboratory System (D.1) is relevant. Similarly, part of spending on medical goods (HC.5) might be allocated to Antimicrobial Resistance, and part of the preventive sub-category of Information, education and counselling (IEC) programmes (HC.6.1) has relevance in Risk Communication (PR.5). Finally, part of the overall governance and administration function (HC.7) can be linked to National legislation, policy and financing (P.1) and the IHR coordination, communication and advocacy (P.2) technical areas.

This is the first attempt to estimate PPR using existing health accounts data, the exact allocation shares by different health care function categories is derived from a World Bank study analysed spending elements in Vietnam, Indonesia, Pakistan and Bangladesh⁶⁵ (Table 1). Future work could explore how to further refine these allocation shares across different country groupings.

Table 1. Allocation of health accounts categories to PPR

| PPR CATEGORY | SHA 2011 CATEGORY | ALLOCATION SHARE |
|--|------------------------|------------------|
| Immunisation, surveillance, and risk communication | HC.6.2, HC.6.5, HC.6.6 | 65% |
| Governance and health system administration | HC.7.1 | 11% |
| All other health spending | All other HC | 1.25% |

Source: OECD (2025). *Smart spending to combat global health threats*

⁶⁵ Chawla and Schumini (2024). Estimating country-level spending on pandemic preparedness.

These allocation shares were then applied to estimate total PPR spending and PPR spending by funding source – namely, domestic public, domestic private, and external aid – utilizing data from the OECD Health Expenditure and Financing Database and the WHO Global Health Expenditure Database (GHED). While this disaggregated data was available for most high-income countries, country coverage was lower in low- and middle-income countries. Estimates for each country income group are extrapolated from countries with available data, assuming countries without data have a similar health spending pattern by healthcare function. Total PPR spending is calculated by summing the total spending of each income group, using the average per capita spending multiplied by the population in each region. The estimation presented in this report include only recurrent health spending, capital investment is not included.

See OECD (2025), Smart spending to combat global health threats for further details on the methodology for estimating PPR spending.

7.3. Appendix 3: Methods to estimate PPR costs

This appendix outlines the approach used to estimate the costs for increasing preparedness capacity across a typology of Low- and Middle-income countries (LMICs).

Introduction

Despite the increasing attention given to pandemic prevention, preparedness and response (PPR) in recent years, there is uncertainty around what level of investments are required to achieve different levels of system readiness. Clarke et al (2022) examined multi-country studies looking specifically at the preparedness component and found that costing methods and results varied substantially, with global cost estimates ranging from USD 1.6-4.9 billion per year for LMICs, to USD D43 billion per year for all countries including global-level activities worldwide. Previous WHO–World Bank analyses have indicated that financing effective national, regional and global health emergency preparedness alone will require approximately USD D 30 billion per year.¹ However global PPR cost numbers do not always indicate the per-capita cost implications at country level.

At national level, National Action Plans for Health Security (NAPHS) are used to estimate costs and budgetary needs. While many countries have developed a NAPHS (or an equivalent national plan), they have faced challenges in prioritizing actions, and few countries have managed to fully resource and implement the plan.² Our objective here is to produce indicative estimates of the costs required to strengthen preparedness in typical (generic) LMIC settings, and to examine how costs may vary across different health system contexts and across levels of preparedness capacity. We examine different resource components driving the costs, and to what extent investments may be considered costs for activities that benefit PPR capacity improvement alone or are shared costs within the overall health system, that may also have substantial co-benefits.

Emergency Preparedness Capacity Assessment

The assessment of PPR capacity has evolved over time and there are several approaches used within the International Health Regulations (IHR) Monitoring and Evaluation Framework,³ including the Joint External Evaluation (JEE) and the States Parties Self-Assessment Annual Reporting (SPAR) tool. The JEE is a voluntary, collaborative, and multisectoral process that evaluates a country's strengths and weaknesses in various technical areas, and assigns a score from 1 to 5 to reflect the level of capacity.⁴ The SPAR is a self-assessment tool used by countries to report on their capacities to detect, assess, notify, report, and respond to public health risks and acute events of domestic and international concern, done annually, with a high reporting rate.^{5 6} The SPAR also uses a five-level assessment scale per indicator (level 1-5). Scores are translated into percentages when aggregated by capacity.

In 2023, WHO issued new conceptual guidance on “the five Cs” (Table S2A) to guide the strengthening of the national, regional and global operational systems of Health Emergency Preparedness, Response, and Resilience (HEPR).⁷ The purpose is to focus discussions around strengthening five core health emergency components. By focusing on these five Cs, countries can improve their SPAR scores, demonstrating enhanced readiness and resilience in managing health emergencies. In addition to 5 core investment areas, there is an overall umbrella with core functional requirements.⁸

Table S3A. The five “Cs” of health emergency prevention, preparedness, response and resilience (WHO, 2023)

| | HEPR SUBSYSTEM | LEVEL 2 |
|-----|------------------------------|---|
| C.0 | Core functional requirements | C.0.0 Overall Health Emergency Preparedness |
| C.1 | Collaborative Surveillance | C.1.0 Overall Collaborative Surveillance |
| | | C.1.1 Integrated disease, threat & vulnerability surveillance |
| | | C.1.2 Diagnostic and laboratory capacity for effective pathogen & genomic surveillance |
| | | C.1.3 Collaborative approaches for risk assessment, event detection & response monitoring |
| C.2 | Community Protection | C.2.0 Overall Community Protection |
| | | C.2.1 Community engagement, risk communication and infodemic management |
| | | C.2.2 Population & environmental public health interventions |
| | | C.2.3 Multisectoral action for social and economic protection |
| C.3 | Safe and Scalable Care | C.3.0 Overall Safe and Scalable Care |
| | | C.3.1 Scalable clinical care during emergencies |
| | | C.3.2 Protection of health workers and patients |
| | | C.3.3 Maintenance of essential health services |
| C.4 | Access to Countermeasures | C.4.0 Overall Access to Countermeasures |
| | | C.4.1 Fast-tracked research & development |
| | | C.4.2 Scalable manufacturing platforms |
| | | C.4.3 Coordinated supply chains & emergency distribution |
| C.5 | Emergency Coordination | C.5.0 Overall Emergency Coordination |
| | | C.5.1 Health emergency workforce |
| | | C.5.2 Health emergency preparedness, prevention and resilience |
| | | C.5.3 Health emergency alert and response coordination |

Costing Methods

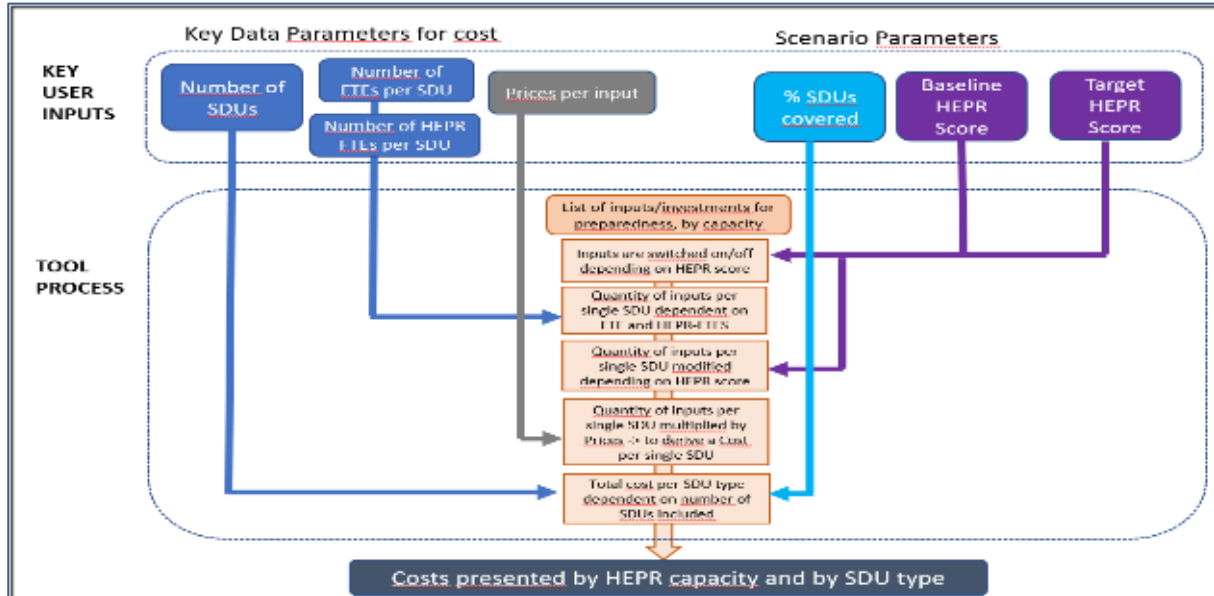
For the purpose of the work outlined here we focus on the five Cs. We used an existing costing tool developed by WHO,⁹ which links the HEPR capacity scores (SPAR or JEE) to the five Cs and to different investments. Costs are generated for preparedness and do not cover the full set of HEPR capacities and benchmarks. The approach and perspective taken in our analysis is financial costing, from the perspective of a public sector provider.

Figure S3A illustrates the model parameters and processes. The tool links the increase in preparedness capacity (score) to a default set of investments that should be incurred at different levels of the health system, ranging from community level to national level institutions (here referred to as Service Delivery Units (SDUs), see section below for a list of SDU types). Each investment reflects a certain type of input, with a quantity multiplied by a price, and is linked to a specific capacity.¹⁰

Key parameters inputted by the user are the number of SDUs, the number of full time equivalent (FTE) workforce based at each average SDU, the share of workforce that support preparedness full-time at each SDU level ("HEPR FTEs"),¹¹ and the prices per input.

Additional user inputs that were used to build scenarios are: the percentage (%) share of SDUs at which to implement PPR-specific activities/inputs, and the modelled shift in HEPR capacity scores (baseline and target).

Figure S3A. Costing tool key data and process for calculations



Note: SDUs Service Delivery Units, FTE Full Time Equivalent workforce, HEPR FTEs Full Time Equivalent workforce for Health emergency preparedness and response.

Cost inputs are included in the tool and linked to each capacity score and SDU platform. Quantities per SDU are calculated based on (i) a standard quantity of input per SDU type, (ii) an on/off parameter to indicate whether the input should be considered at the specific HEPR capacity level being costed, (iii) an adjustment of the quantity (intensity of activities/investments), depending on the HEPR score. The cost structure will thus change as a country is modelled to move up levels in the HEPR scores. The cost per average SDU is then multiplied by the total number of SDUs included in the costing. This gives a normative cost that is based on the standard set of assumptions for investment, by type of capacity.

The investments cover:

WORKFORCE:

- Wages¹² for specific numbers of workforce supporting PPR activities: (i) specialized workforce (e.g., epidemiologists), (ii) mid-level skilled workers, e.g., laboratory assistant, administrative assistant, data entry clerk, information technology specialist; and (iii) low skilled workforce
- Incentive payment for community health workers
- Travel costs to attend meetings abroad and in-country

TRAINING:

- Per diem for supervisor/trainer and for attendees
- Other training expenditures including venue, refreshments, etc.

MEETINGS:

- Per diem for attendees
- Other meeting expenditures including venue, refreshments, etc.

CONTRACTS:

- Contracts for technical advisory consultants
- Contracts for IT and communication services (internet, cellular data plans, etc), Laboratory transport, electricity, office space, software, cloud surveillance data storage.

SUPPLIES:

- Medical supplies – Lab; Medical supplies – PPE, vector control, vaccines,

CAPITAL:

- Digital/IT Equipment: laptops, cellphones, computer systems, internet modems, radios, solar powerbanks etc
- Medical equipment: Oxygen, Patient Monitoring set-up,
- Lab infrastructure and equipment: Lab waste management, GenExpert machine, Refrigerator, microscopes, centrifuge, incubator, etc.
- Office equipment: desk, chairs, etc
- Scalable infrastructure (e.g., isolation units) for essential health services
- Infrastructure – EOC: vehicles, motorcycles.
- Infrastructure - WASH and IPC: water, sanitation and waste management at hospitals.

These investments contribute toward the following capacities:

1. competent authorities: planning, risk analysis, coordination, monitoring and evaluation
2. equipping hospitals and health-care providers (public and/or private):
3. trained laboratory staff, public health officials and (public and/or private) local health-care workers:
4. expanding testing capacity at public and private laboratories.

As an example, when the score for “C 1.2 Diagnostic and laboratory capacity for effective pathogen & genomic surveillance” is set to increase from 2 to 3, a set of inputs are included for PPR cost at a PHC facility, including lab infrastructure maintenance, laboratory transport costs, medical supplies, and laboratory equipment. The inclusion or exclusion of certain inputs depends on the capacity score. A multiplier is applied that adjusts the quantity of inputs required (to achieve a higher capacity level will require a higher quantity of inputs).¹³

Illustrative country costs

We developed estimates for three country archetypes: one low- income country and two lower-middle income countries, as shown in Table S3B, using local price data. Using country archetypes, we aim to illustrate and explore the costs of investment in different health system structures. We do not extrapolate these to global costs, as that would require additional information on structures across countries, so this work should be considered as illustrative only. The input assumptions draw on existing data from countries but do not represent any particular country.

Table S3B. Country archetypes used in cost estimation exercise

| COUNTRY TYPOLOGY | DESCRIPTION | HEALTH EXPENDITURE PROFILE | DOMESTIC GENERAL GOVERNMENT HEALTH EXPENDITURE PER CAPITA |
|---|--|---|---|
| Type 1: Weak health system LIC | Low-income country in Africa with significant health system challenges. The health system and HEPR strategy is heavily reliant on community health workers. | Around 4% GDP spent on health. Medium levels of out-of-pocket spending (30-40%). Significant external funding (40-50% of total health spending). Low government spending (15-20%) as share of total health expenditure. | USD 5 |
| Type 2: Weak health system LMIC | Lower middle-income country in Africa with significant health system challenges. Primary health care suffers from poor investment and lack of accessibility. | Around 4% GDP spent on health. Health expenditure is driven primarily by large out of pocket expenditure (70-80% of total health expenditure). Low government spending (15-20% as share of total health expenditure). | USD 15 |
| Type 3: Strong health system LMIC | Lower middle-income country in Asia where the starting point is a more robust health system. Facilities and health workforce are readily available. | Around 4% GDP spent on health. Medium levels of out-of-pocket expenditure (30-40%) and government spending at around 40-50% of total current health expenditure. | USD 60 |

The parameters used to vary the intensity of investments across scenarios were (i) the percentage (%) share of Service Delivery Units (SDUs) at which to implement PPR activities/inputs, and (ii) the modelled shift in capacity from 1 to 5 (baseline and target scores). By varying these parameters, we were able to derive different scenarios and related costs.

The costs for preparedness are estimated at all levels of the health system (Table S3C). In reality, countries may choose to universally invest across all facilities or to select a set of representative health facilities at which to build capacity. Given that LMICs face severe resource constraints, we did not consider a universal scenario where all (100%) health facilities are supported to strengthen PPR capacity.

We modelled two scenarios for the intensity of investment, each covering a share of SDUs:

- one **moderate scenario** where 10% of health facilities are strengthened to provide a foundational network for health emergencies, ensuring that in the event of a crisis, a basic response can be mounted. In addition, 100% of provincial health offices are included as well as 100% of national-level costs.
- a second, **expanded scenario**, where capacity is strengthened at 30% of primary level facilities, along with the majority (80%) of district and province level facilities, and 100% of national institutions.

The second scenario would require higher levels of investment (as more CHWs and facilities are strengthened), but would also enhance resilience and expand the country's capacity to respond more effectively to emergencies. The assumption around the percentage (%) share of SDUs included in the costing is the only parameter that we varied between the moderate and expanded scenarios. Other parameters remain the same.

Table S3C: Service Delivery units used in the HEPR costing tool, and scenario assumptions ¹⁴

| SERVICE DELIVERY UNIT (SDU) | SERVICE DELIVERY LEVEL | IMPORTANT PPR FUNCTIONS | SHARE OF SDUS, BY SCENARIO | |
|------------------------------------|------------------------|--|----------------------------|----------|
| | | | MODERATE | EXPANDED |
| Community Worker | Local | Frontline surveillance, risk communication, trust building. | 10% | 30% |
| Primary Health Post / Center | Local | Early detection, case management, continuity of essential services. | 10% | 30% |
| District Health Office | District | Local coordination, district level surveillance, logistics, and surge mobilisation. | 10% | 80% |
| District Health Center | District | Intermediate clinical care, outbreak management. | 10% | 80% |
| Provincial Hospital | Provincial | Critical care, isolation capacity, surge capacity, infection prevention and control. | 10% | 80% |
| Provincial Health Office | Provincial | Subnational emergency planning, provincial surveillance, coordination, and multisector integration. | 100% | 100% |
| National Laboratory | National | Core diagnostics, genomic surveillance, quality assurance. | 100% | 100% |
| National Regulatory Agency | National | Oversight of diagnostics, vaccines, therapeutics, and emergency authorisations. | 100% | 100% |
| National Public Health Authorities | National | Risk monitoring, Emergency Operation Centers (EOCs), workforce training, IHR coordination, simulation/exercises. | 100% | 100% |

The estimated costs represent the investments needed to shift from one level of performance (score) to the next. For the purpose of analysis, we designed generic scenarios for the three country archetypes, where we shift all scores up one level at a time.

There are thus eight scenarios generated for each country typology; with 24 scenarios in total:

- 3 country typologies;
- 4 shifts in scores (from 1 to 2, from 2 to 3, from 3 to 4, and from 4 to 5); and
- a moderate and an expanded scenario, in terms of the % SDU coverage (Table S3C).

While the tool includes default quantity assumptions for inputs, we configured the files to reflect country-specific data for the existing number of health facilities (country statistics), the current population size (UN population data), and the estimated number of full time equivalent (FTE) health workers posted at each type of SDU (information available from a recent WHO study).¹⁵

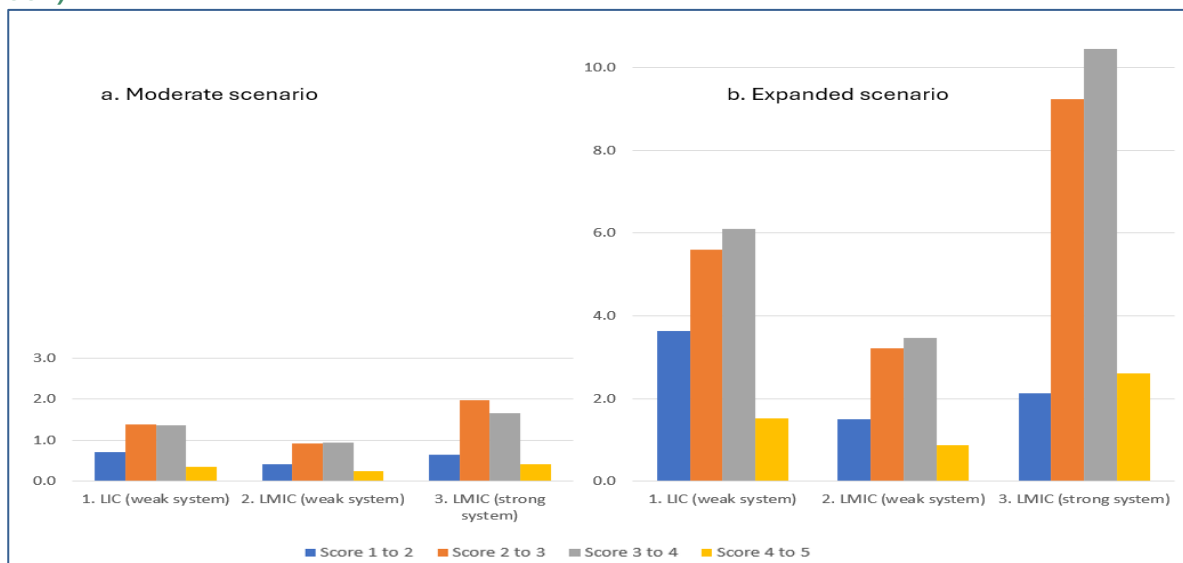
The country types were parameterised using price data from actual countries (one LIC, one LMIC from Africa, one LMIC from Asia), with different levels of resource availability. In our application of the model, we replaced the generic default prices with country-specific price estimates where available. Most default prices were kept for tradeable goods e.g., syringes, rodenticides, etc. Prices were adjusted for categories where we had access to country-specific price data and for inputs which were cost drivers, specifically wages (salaries) and per diem costs for attending meetings and doing supervision.⁶⁶

⁶⁶ Costs are assumed to reflect 2023 prices but should be interpreted as indicative. Prices for ICT goods were updated based on the ITU database (ITU ICT Price Baskets, historical data series, Mar 2024 release).

Results: PPR Cost estimates by level of preparedness score/capacity

Figure S3B shows the modelled additional cost of moving from one level of capacity score to the next, higher level of preparedness. It presents the estimated cost of one year's investment, with capital and recurrent cost combined. The cost of building preparedness capacity varies considerably by country context and health system, the baseline score and target score, and the coverage (moderate or expanded) of health sector institutions that will be equipped. The greatest additional investment is needed to move from a score 2 to 3 and/or from 3 to 4. This level of score is the current status of most LMICs.

Figure S3B: Modelled investment need associated with increasing PPR capacity scores (per capita USD)



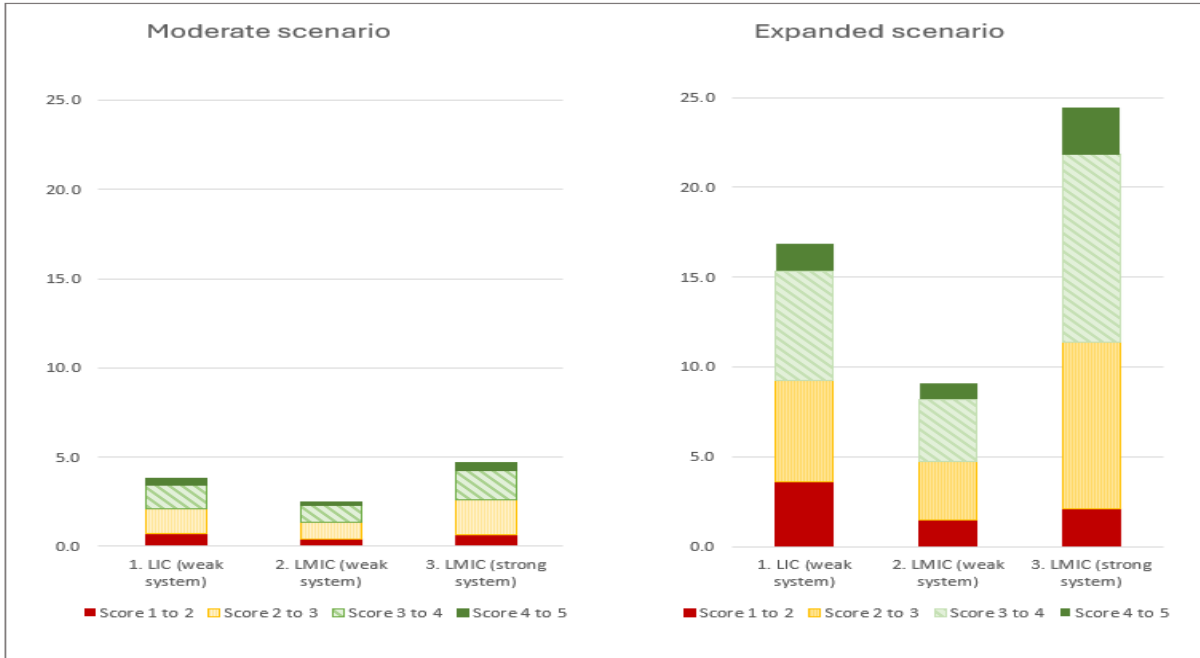
For example, in the modest scenario, a Fragile LIC setting would require spending around USD 1.5 per capita advance from a score 2 to reach score 3. (Figure 3SB). Out of the three archetype countries, costs are highest in country type 3 (LMIC with strong health system) primarily because prices are generally higher in this setting, and also because of a larger network of public health facilities where investments are modelled, and less reliance on community based approaches. **Estimated costs are higher in the weak LIC setting (country type 1) than in the weak LMIC setting (country type 2) because of the greater reliance on community workforce and the need to equip and train them, rather than relying on existing health infrastructure.**

The HEPR costing tool is designed to calculate the additional cost of increasing HEPR scores from baseline to target level. Thus, in order to derive the total costs for a full HEPR investment scenario going from a score 1 to a score 5, we summed the scores across all 4 levels. Using this approach, we estimate that total costs for advancing from level 1 to 5 range from USD 2.5 to 4.7 for the moderate scenario,¹⁶ and from USD 9.1 to 24.4 per capita for the expanded investment scenario. It should be noted that these costs combine capital and recurrent costs. Sustained investments over time would be lower, once capital investments have been made. This points to the critical importance of countries mapping out their own investment path to assess annual budgetary needs for PPR.

Based on self-reported scores in e-SPAR for 20 low-income countries and 19 lower middle-income countries, many countries currently rate their critical capacities at level 2 or 3 (for example, IHR

coordination and lab capacity is rated at level 3 on average, whilst human resources for HEPR and Infection Prevention and Control are on average rated as level 2).¹⁷ Typical investment needs at level 3 is roughly USD 1.5-2.7 in the moderate scenario, and USD 5-11 in the expanded scenario.¹⁸

Figure S3C. Total investment need by country typology (per capita USD)



Note: total investment need is calculated by adding the costs shown by level in Figure S3B

Results: PPR Cost estimates by type of preparedness capacity

Figure S3D and S3E show in greater detail how the costs in the different phases along the investment path relate to the different PPR capacities. Across all settings, costs are driven by investments for c0 Overall Health Emergency Preparedness, c1 Collaborative Surveillance, and c3 Safe and Scalable Care.

Figure S3D: Preparedness Investment Cost by PPR Capacity*, Moderate scenario, by shift in PPR capacity score (per capita USD)

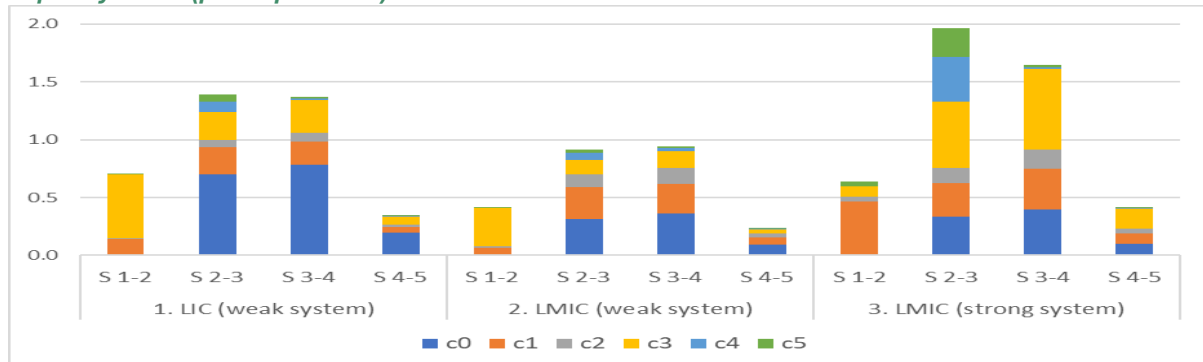
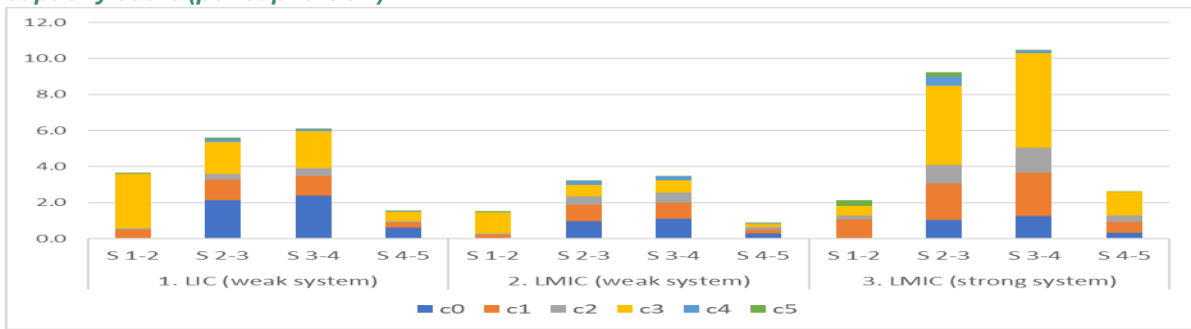


Figure S3E: Preparedness Investment Cost by PPR Capacity*, Expanded scenario, by shift in PPR capacity score (per capita USD)



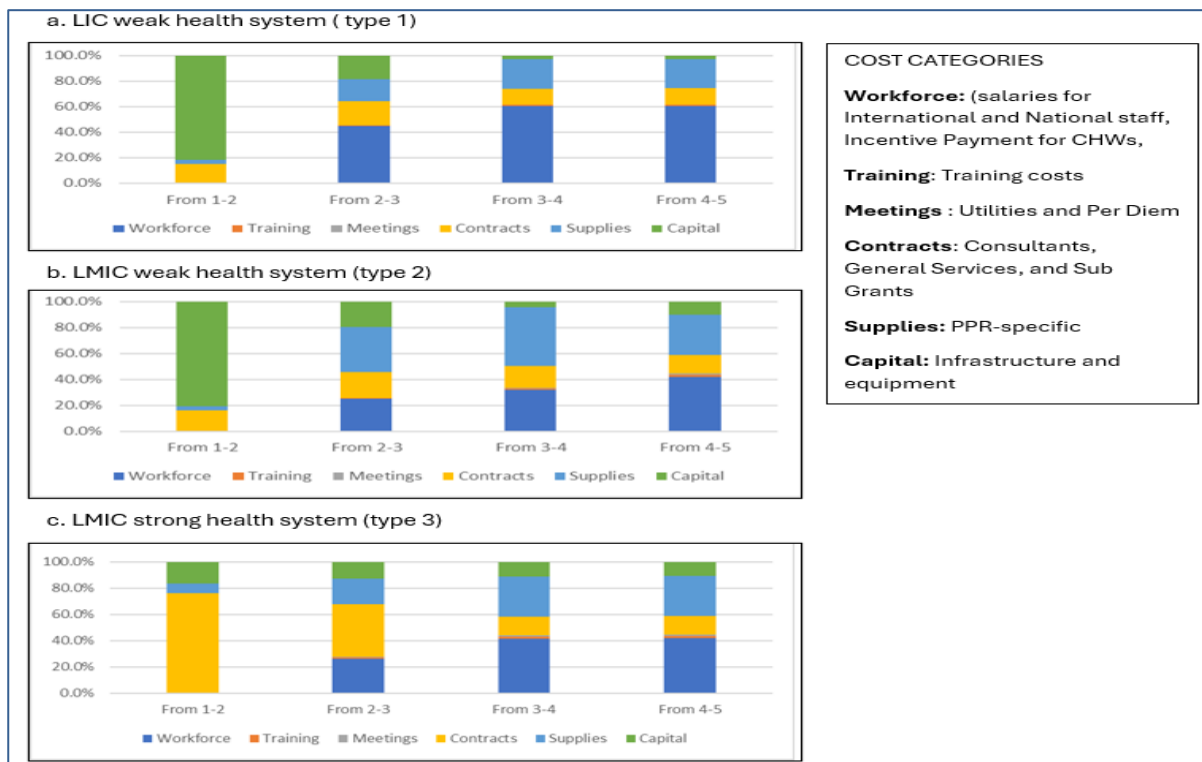
* C.0 Core SDU functions, C.1 Collaborative Surveillance, C.2 Community protection, C.3 Safe and Scalable Care, C.4 Access to counter measures, C.5 Emergency co-ordination. Note: estimates combine capital costs with recurrent costs.

The analysis confirms that the specific cost drivers for PPR investments will depend on the specific context in each setting, and how the health system is set up, notably the number of health facilities and health workers per capita.

Results: Cost estimates by categories of cost

As shown in Table S3D and Figure S3F, cost drivers vary across settings. Capital is initially an important cost driver in the first phases of investment (Level 1 to level 2) in the countries with poor health systems, but at level 2 and above the significant cost drivers are the workforce, but also supplies. Workforce and supplies become the largest cost drivers at the higher levels of capacity. The cost breakdown is similar in the moderate and expanded scenarios (only moderate scenario shown here).

Figure S3F. Additional cost for advancing PPR, by capacity level and cost category (moderate scenario)



The variation across settings is driven by the health system setup that is modelled (e.g., a system largely dependent on community health workers as in our archetype LIC (type 1), versus a more facility-based system as in our robust health system LMIC archetype (3). The costing approach applies different quantity assumptions to the different levels of SDU which explains the large differences between the country archetype scenarios.

Table S3D: Estimated capital and recurrent costs per capita for three country scenarios (USD)

| | MODERATE SCENARIO | | | | EXPANDED SCENARIO | | | |
|---|-------------------|--------|--------|--------|-------------------|--------|--------|--------|
| | 1 to 2 | 2 to 3 | 3 to 4 | 4 to 5 | 1 to 2 | 2 to 3 | 3 to 4 | 4 to 5 |
| Country type 1 (LIC weak health system) | | | | | | | | |
| Capital | 0.7 | 0.3 | 0.0 | 0.0 | 3.6 | 1.1 | 0.3 | 0.1 |
| Recurrent | 0.2 | 1.1 | 1.2 | 0.3 | 0.5 | 4.5 | 5.6 | 1.4 |
| Country type 2 (LMIC weak health system) | | | | | | | | |
| Capital | 0.3 | 0.2 | 0.0 | 0.0 | 1.2 | 0.8 | 0.3 | 0.1 |
| Recurrent | 0.1 | 0.7 | 0.9 | 0.2 | 0.3 | 2.5 | 3.2 | 0.8 |
| Country type 3 (LMIC strong health system) | | | | | | | | |
| Capital | 0.1 | 0.3 | 0.2 | 0.0 | 0.6 | 1.8 | - | 0.3 |
| Recurrent | 0.5 | 1.7 | 1.5 | 0.4 | 1.5 | 7.4 | 10.5 | 2.3 |

The key message here is that countries will need to examine their own strategies for their own local context to assess which strategies will be most feasible for their setting. They will also need to examine how the need for capital vs recurrent investments vary across PPR scores.

In our model, workforce is a significant cost driver for PPR, along with supplies for expanded testing (Figure S3F). The health workforce gap in LMICs is a critical global challenge, as projections indicate a shortfall of 10 million health and care workers.¹⁹ It should be noted that the HEPR costing tool estimated costs for workforce primarily relate to training and supervision activities. The share of salary costs is low, amounting to about 2-3% of the total PPR-estimated costs in our scenarios. However, the costing assumes that health workforce is in place and geographically placed to support PPR activities. This points to the need to consider preparedness activities costing within a broader context of national health workforce planning and distribution.

Investments in PPR as part of broader health sector investments

Box S3A. Rationale used for tagging PPR investments as PPR-specific or PPR/UHC/shared

Rationale: While the investments costed for PPR are not disease-specific, many investments will have additional benefit for infectious diseases such as TB, HIV (e.g., GeneXpert machines). At the same time, it is important to highlight specific investments for emergency preparedness that otherwise might not get funded.

Approach: we identified which cost elements in the WHO HEPR costing tool could be considered as PPR-specific, versus cost inputs that would have larger shared benefits for UHC.

| Type of resource | Examples of PPR-specific investments | Examples of PPR/UHC – shared investments |
|------------------|--|--|
| Workforce | 5% of Staff working at national laboratories, national regulatory agencies, and national public health authorities | Financial incentives provided to CHWs to support community engagement and infodemic management, surveillance, and provide scalable clinical care during emergencies |
| Training | Per Diem for supervisor/trainer for activities related to Health emergency alert and response coordination (C5) | Training expenditures, incl. approximate cost of stationery, refreshments, other incidentals, and venue, excl. Per Diem; linked to Scalable manufacturing platforms (C4) |
| Meetings | Meetings linked to Overall Emergency Coordination (C5) | Meeting expenditures linked to Countermeasures (C4) |
| Contracts | Service contracts for Laboratory transport | Technical consultants for development of plans and assessments linked to Collaborative surveillance (C1) |
| Supplies | PPE kit (face shield, gloves, gown, mask, plastic boots) | Soap, hand sanitizer, insecticides (e.g., larvicide) |
| Capital | Isolation unit, Quarantine unit. | GenExpert machine, Waste Management, Water and Sanitation |

Many countries remain unprepared for future pandemics due to underfunded health systems, unequal distribution of resources, and a lack of political will and sustained investment in public health infrastructure.

Joint PPR and UHC investment

Much of the investment that improves PPR at the same time strengthens overall health system performance. Integrating health emergency readiness within routine health services fulfils the dual needs of service delivery as well as allowing for rapid responses to emergencies, building health system resilience in both aspects. Investments in integrated data systems and national public health institutes supports nationally coordination processes not just for preparedness but for health service delivery overall. Enhanced community engagement will strengthen community-led response and build trust in governing institutions. The investments for PPR also consider a digitalized health information approach and will support the broader digitalisation of health information systems.

At the same time, there are certain investments that are specific to PPR, in that their sole purpose is PPR strengthening. To shed greater light on this, we identified which cost elements in the WHO HEPR costing tool could be considered as PPR-specific, versus cost elements that would be

considered to have larger shared benefits for health systems and UHC (Box S3A). Cost results are presented accordingly as PPR-specific or PPR/UHC-shared. We estimate that around 85% of the costs spend to strengthen PPR capacity will have co-benefits for the broader health system and other UHC objectives. These shares vary across country archetypes, HEPR score shifts, and by scenario (Table S3E).

Table S3E: PPR-specific costs and PPR investments with broader benefits for health systems and UHC

| SCENARIO | MODERATE SCENARIO | | | | | EXPANDED SCENARIO | | | | |
|---|-------------------|------------|------------|------------|------------|-------------------|------------|-------------|------------|-------------|
| HEPR Score | 1 to 2 | 2 to 3 | 3 to 4 | 4 to 5 | 1 to 5* | 1 to 2 | 2 to 3 | 3 to 4 | 4 to 5 | 1 to 5* |
| Country type 1 (LIC with weak health system) | | | | | | | | | | |
| USD per capita cost estimates | | | | | | | | | | |
| PPR/UHC shared | 0.7 | 1.1 | 1.0 | 0.3 | 3.1 | 3.8 | 4.5 | 4.6 | 1.1 | 14.1 |
| PPR-specific | 0.1 | 0.3 | 0.3 | 0.1 | 0.7 | 0.2 | 1.1 | 1.3 | 0.3 | 2.9 |
| Sum | 0.8 | 1.4 | 1.3 | 0.3 | 3.8 | 4.0 | 5.6 | 5.9 | 1.5 | 16.9 |
| Percentage shares | | | | | | | | | | |
| PPR/UHC shared | 87% | 81% | 79% | 79% | 81% | 94% | 81% | 78% | 78% | 83% |
| PPR-specific | 13% | 19% | 21% | 21% | 19% | 6% | 19% | 22% | 22% | 17% |
| Country type 2 (LMIC with weak health system) | | | | | | | | | | |
| USD per capita cost estimates | | | | | | | | | | |
| PPR/UHC shared | 0.4 | 0.8 | 0.8 | 0.2 | 2.2 | 1.3 | 2.7 | 2.9 | 0.7 | 7.7 |
| PPR-specific | 0.1 | 0.1 | 0.1 | 0.0 | 0.3 | 0.2 | 0.5 | 0.6 | 0.1 | 1.4 |
| Sum | 0.4 | 0.9 | 0.9 | 0.2 | 2.5 | 1.5 | 3.2 | 3.5 | 0.9 | 9.1 |
| Percentage shares | | | | | | | | | | |
| PPR/UHC shared | 86% | 87% | 86% | 87% | 86% | 89% | 85% | 83% | 83% | 85% |
| PPR-specific | 14% | 13% | 14% | 13% | 14% | 11% | 15% | 17% | 17% | 15% |
| Country type 3 (LMIC with strong health system) | | | | | | | | | | |
| USD per capita cost estimates | | | | | | | | | | |
| PPR/UHC shared | 0.2 | 1.5 | 1.4 | 0.4 | 3.5 | 1.2 | 7.8 | 8.9 | 2.2 | 20.1 |
| PPR-specific | 0.5 | 0.4 | 0.2 | 0.1 | 1.2 | 0.9 | 1.5 | 1.6 | 0.4 | 4.4 |
| Sum | 0.6 | 2.0 | 1.6 | 0.4 | 4.7 | 2.1 | 9.2 | 10.5 | 2.6 | 24.4 |
| Percentage shares | | | | | | | | | | |
| PPR/UHC shared | 30% | 79% | 85% | 86% | 75% | 57% | 84% | 85% | 85% | 82% |
| PPR-specific | 70% | 21% | 15% | 14% | 25% | 43% | 16% | 15% | 15% | 18% |

*Cost for 1 to 5 computed as the sum of score shifts

PPR spending as a proportion of UHC spending

In order to compare the PPR scenario costs with the estimated costs for expanding health systems towards universal coverage across LMICs, we accessed data from the WHO health SDG price tag analysis (henceforth referred to as GHSPT, for Global Health Sector price tag).²⁰

The GHSPT has two scenarios. One progress scenario (moderate) and one ambitious scenario (expanded). Table S3F compares the progress (moderate) GHSPT scenario with the moderate PPR investment cost scenario, and likewise compares the ambitious UHC scenario with the expanded PPR cost scenario.

Table S3F. Modelled costs for Preparedness and estimated Global Health System/UHC ⁶⁷ costs

| | COUNTRY TYPE | TYPE 1. LIC (WEAK HEALTH SYSTEM) | | TYPE 2. LMIC (WEAK HEALTH SYSTEM) | | TYPE 3. LMIC (STRONG HEALTH SYSTEM) | |
|---------------------|---|----------------------------------|-------------------|-----------------------------------|-------------------|-------------------------------------|-------------------|
| | | Moderate scenario | Expanded scenario | Moderate scenario | Expanded scenario | Moderate scenario | Expanded scenario |
| | Scenario | | | | | | |
| Costs ²¹ | a) PPR estimated costs (PPR-specific + PPR/UHC shared) | 3.8 | 16.9 | 2.5 | 9.1 | 4.7 | 24.4 |
| | b) PPR-specific estimated costs | 0.7 | 2.9 | 0.3 | 1.4 | 1.2 | 4.4 |
| | c) Previously estimated UHC/health systems investment needs | 90 | 110 | 130 | 150 | 130 | 150 |
| | d) Total PPR+UHC costs (= b + c) | 91 | 113 | 130 | 151 | 131 | 154 |

To illustrate the relation between the PPR costs and overall health sector investment needs, we added the PPR-specific cost and the previous UHC/health systems cost estimates as shown in Table S3J.

It should be noted that the costs shown here for PPR+UHC are likely underestimates as they do not cover all investments required for expanding health system capacity. Notably they exclude the cost of expanding laboratory capacity in LMICs.²² The PPR-specific costs presented here focus on the 5Cs and emergency preparedness in the health sector. They do not cover costs across other sectors.

PPR costs as a proportion of current health expenditure

We estimate that the costs for PPR as % share of current Domestic Government Health Expenditure for a modest investment scenario would range from 8 % -76%, whereas the cost for an expanded scenario would require between 41% and 339% of as % current Domestic Government Health Expenditure (Table S3G). This highlights the need for continued external assistance and prioritisation of investments in these very resource constrained settings.

Table S3G. Modelled costs for Preparedness as a share of current Domestic Government Health Expenditure

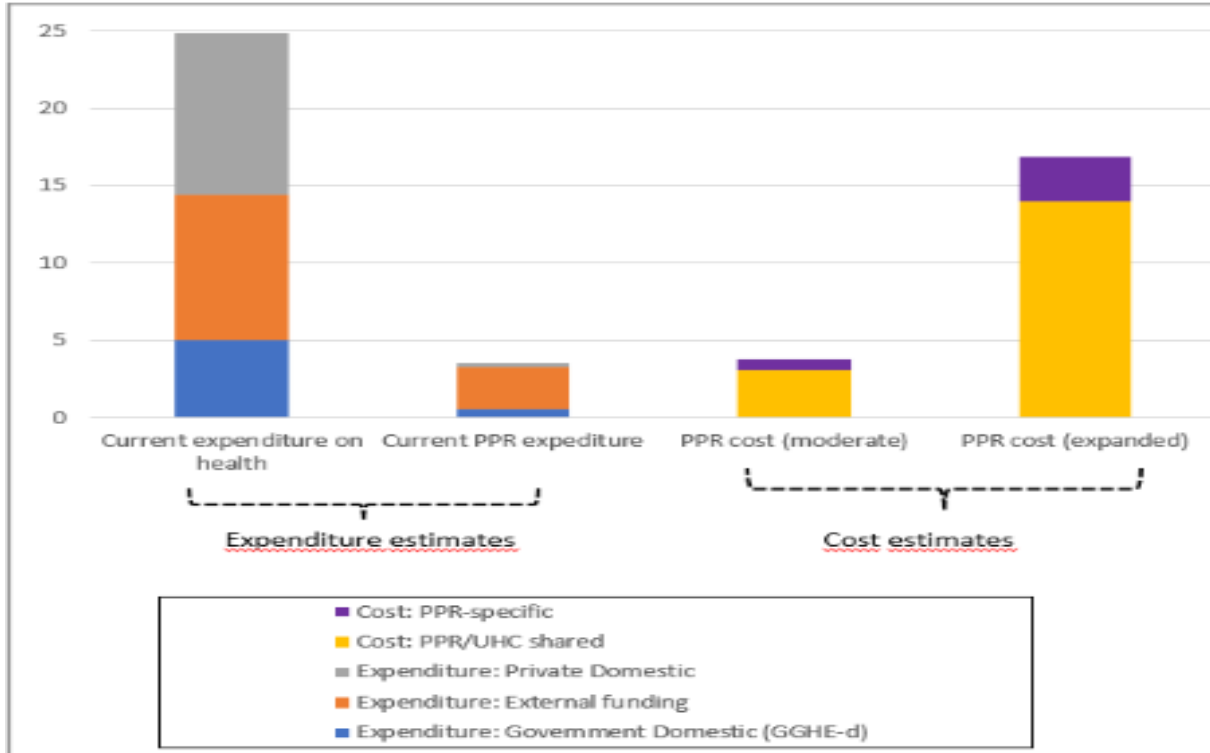
| | COUNTRY TYPE | TYPE 1. LIC (WEAK HEALTH SYSTEM) | | TYPE 2. LMIC (WEAK HEALTH SYSTEM) | | TYPE 3. LMIC (STRONG HEALTH SYSTEM) | |
|----------------------------------|---|----------------------------------|-------------------|-----------------------------------|-------------------|-------------------------------------|-------------------|
| | | Moderate scenario | Expanded scenario | Moderate scenario | Expanded scenario | Moderate scenario | Expanded scenario |
| Health expenditure ²³ | a) Total Current Health Expenditure (CHE) | 25.0 | 25.0 | 90.0 | 90.0 | 150.0 | 150.0 |
| | b) Domestic Government Health Expenditure | 5.0 | 5.0 | 15.0 | 15.0 | 60.0 | 60.0 |
| Costs ²⁴ | c) PPR estimated costs | 3.8 | 16.9 | 2.5 | 9.1 | 4.7 | 24.4 |
| Financing implications | d) Funding needs for PPR as % of current Domestic Government Health Expenditure (d = c / b) | 76% | 339% | 17% | 60% | 8% | 41% |

Figure S3I is an illustrative example for a low-income setting, showing that estimated PPR costs are close to and/or exceed the current total government health expenditure envelope. Estimated current expenditure on PPR is roughly the same amount as the moderate PPR cost scenario

⁶⁷ Note: costs for UHC as shown here are indicative and presented for illustrative purposes only. Countries should undertake a context-specific assessment of their investment needs. Future global work should include an update of the previously estimated costs for UHC/health systems investment as published in 2017 (USD2014).

(around USD 3 per capita), but the elements included differ. The PPR-costing includes activities targeting the 5C capacities, whereas the PPR expenditure largely capture immunisation and surveillance.

Figure S3I. PPR estimated health sector costs compared to current health expenditure, (country Type 1).



Notes to Figure: (i) Current expenditure on health is based on data for an indicative LIC, and excludes capital investment. (ii) Current PPR expenditure is based on OECD (2025, <https://dx.doi.org/10.1787/166d7c57-en>) taking the estimated average per capita expenditure on PPR of USD3.5 in low income countries, of which 78% from external sources. (iii) cost estimates derived from author analysis, include both recurrent and capital investment – the latter representing about 12-25% of PPR costs in LMICs and 30% of PPR costs in the LIC archetype.

7.4. Appendix 4: Co-benefits of collaborative surveillance

We illustrate the co-benefits approach below. Fig. 3A illustrates the prioritisation of a high-cost pandemic PPR intervention within current budget, that would imply that some health interventions that are more cost-effective go unfunded, with potential health losses.

Figure 3A. Bookshelves of health sector resource allocation

Note: The height of each book indicates the intervention’s effectiveness (health gains, vertical axis), while its thickness reflects the share of budget it may consume (cost, horizontal axis). The vertical black line represents the health sector budget constraint. Books on the left-hand side of the budget constraint are health interventions that may be paid for by the health sector because they deliver more health per dollar spent (above threshold). Left panel: the yellow book is a pandemic PPR intervention. On the right-hand side of the budget constraint, green and dark purple books are other health interventions that can no longer be funded. The black area above the yellow book represents the health loss from diverting funding from these more cost-effective interventions.

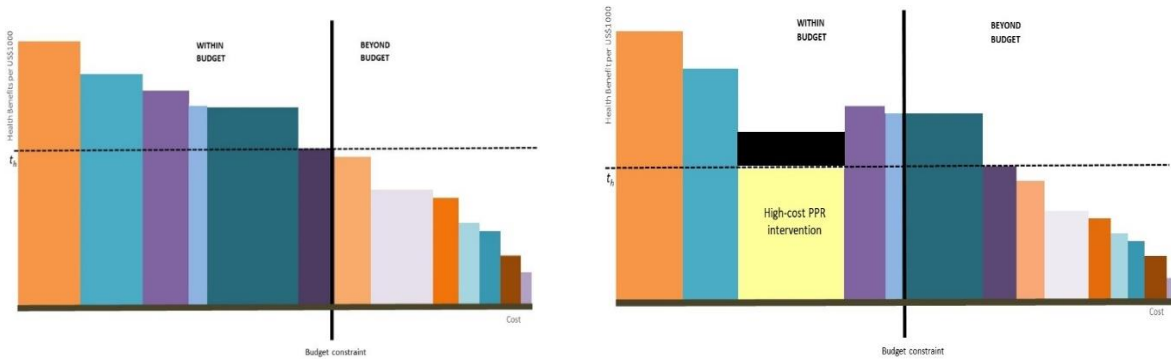
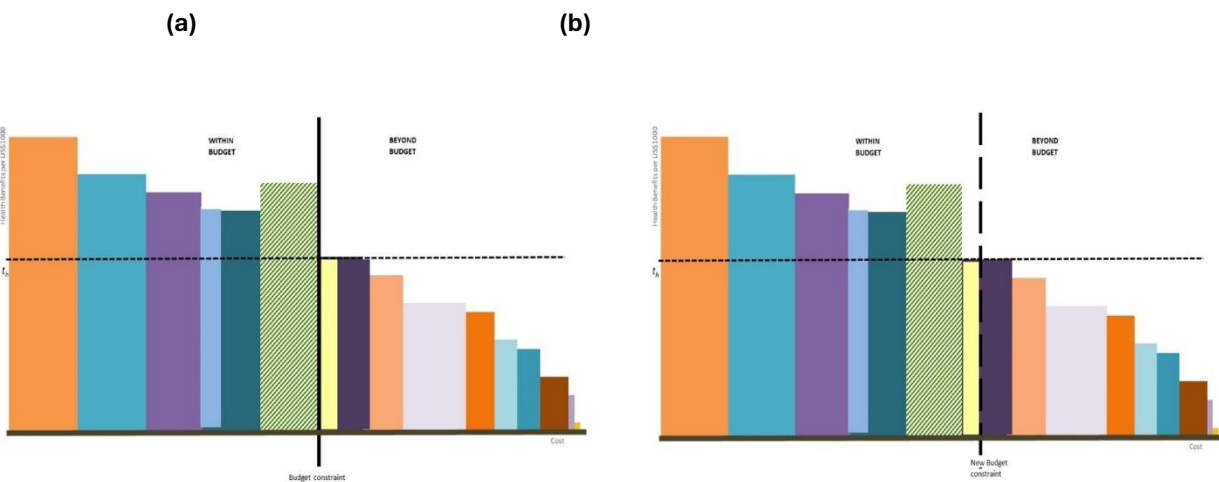


Figure 3B Bookshelf of health sector resource allocation with pandemic PPR investments

Note: the green book is an intervention for endemic infectious diseases only, such as surveillance. The striped book is a joint intervention that benefit both pandemic PPR and endemic infectious diseases, such as collaborative surveillance. The yellow book is a collaborative surveillance intervention for pandemic PPR only.

- (a) Interventions within current budget constraint
- (b) Interventions with additional health sector budget



Value for money of collaborative surveillance

We explored whether it was possible to identify a set of ‘best buys’ using a co-benefit approach, incorporating identification of key levers to improve technical efficiency for collaborative surveillance. Collaborative surveillance is defined as ‘a core public health function responsible for identifying, collecting, connecting, synthesising, analysing, assessing, interpreting, and generating a wide range of information for actionable insights and disseminating these for informed and effective decision making to protect and improve the health of populations.’⁶⁸ Interventions include building on underlying platforms employing digital tools, technical partnerships and networks, data integration and systems enhancements (which could include areas such as genomics, wastewater surveillance or improving diagnostic systems).. See **Annex 3** for a summary of studies.

Surveillance plays a dual role in health security: it is critical for early detection and rapid response to emerging pandemic or epidemic-prone pathogens at national, regional and global levels, and it also strengthens the control and management of endemic infectious diseases. However, declining funding and the de-prioritisation of pandemic-related surveillance during inter-pandemic periods have revealed the vulnerability of these systems. Integrating pandemic surveillance into routine health system functions and strengthening surveillance infrastructure more broadly are the main approaches.⁶⁹ Even while additional investment may be aimed at ensuring surveillance systems is effective during health emergencies, additional investment may also benefit existing infectious disease control.

Despite sizeable investments, there is little evidence of the value for money of collaborative surveillance interventions.^{70 71} This applies to both new approaches that may need to be scaled (for example genomics) and the investment in strengthening of underlying platforms (laboratory systems), where these are currently underperforming. However, most of the literature on surveillance focuses on the value for money of surveillance of single diseases. The assessment of value for money often ignores the interconnected overlapping nature of surveillance activities.⁷² For example, laboratory networks involve significant capital investment and high initial implementation and scale-up costs, networks that are also critical for sentinel surveillance⁷³. However, these broader benefits are rarely considered.⁷⁴ Most of the literature focusses on endemic infectious disease, with only 2% of the 25,000 cost-effectiveness ratios available in the Tufts-CEVR CEA and Global Health CEA Registries relate to disease outbreak and/or prevention strategies specifically.⁷⁵ These studies tend to focus on response such as medical or vaccine interventions in high income settings. In contrast, the opportunity costs of implementing and

⁶⁸ United Nations, "United Nations Terminology Database (UNTERM)," [Online]. Available: <https://unterm.un.org/>

⁶⁹ [covid-19_global-risk-assessment_final\(1\).pdf](#)

⁷⁰ [Strategic-Investment-in-Surveillance-for-Pandemic-Preparedness-Policy-Paper.pdf](#).

⁷¹ in relation to core surveillance activities including laboratory networks, sentinel surveillance, notifiable disease surveillance and health facility event-based surveillance, based on WHO’s Mosaic Framework.

⁷² [Strategic-Investment-in-Surveillance-for-Pandemic-Preparedness-Policy-Paper.pdf](#)

⁷³ CGDEV

⁷⁴ [Strategic-Investment-in-Surveillance-for-Pandemic-Preparedness-Policy-Paper.pdf](#)

⁷⁵ [The cost-effectiveness of outbreak responses: Considerations in the COVID-19 era - Center for the Evaluation of Value and Risk in Health](#)

maintaining outbreak control activities within health systems are rarely assessed, and for surveillance specifically, cost-effectiveness analyses are scarce.⁷⁶

Where evidence exists, **the lack of standardised methods also complicates comparisons** across systems and is not conducive to a co-benefit approach. The literature is often qualitative⁷⁷ or mixes different quantitative metrics, such as allocative (cost per unit of health benefit or cost-effectiveness) and technical efficiency measures (cost per case detected of different systems, or cost per death averted (which excludes morbidity), making it difficult to draw conclusions. Surveillance and pandemic response which are closely intertwined are rarely evaluated together. Yet the benefits of surveillance systems are dependent on response and the costs of response on the surveillance system.

There is however evidence on the cost-effectiveness of some of collaborative surveillance components, particularly the strengthening of underlying systems. There are numerous studies of even relatively high-cost diagnostic methods for infectious diseases like tuberculosis and HIV, along with digital tools like mHealth for maternal and child health have been found to be cost-effective, consistently falling below a common GDP per capita threshold in relevant countries. Likewise, broad-based detection strategies for diseases like Dengue fever and HIV have been found cost-effective in similar settings.^{78,79} none of these studies informs pandemic preparedness specifically, they provide insight into the drivers of value for money.

Best buys and cost-effectiveness of the diagnostic element of surveillance are likely to be highly context specific, depending on the local disease mix, screening, pathways of care, technology prices, geography, capacity and infrastructure. Drivers include the cost of diagnostic cartridges, equipment placement, screening algorithms, the balance between passive and more active forms of case finding, and the pathway of care⁸⁰. The underlying relationship between costs and sensitivity and specificity of diagnostics/ case identification is critical. Lower cost tests may either identify less cases or generate high additional costs if they over-identify cases. Equipment placement is key to utilisation of high-cost equipment. Where high-cost equipment can be shared between diseases, that may substantially improve cost-effectiveness. Screening algorithms are fundamental to determining the extent to which tests are efficiently used in populations with high probabilities of disease (dependent on symptoms). Critical is the pathway of care, if there is high drop-off for example, or a slow response to identifying a case post identification the benefits of case identification and diagnosis can be substantially reduced.

Different methods of contact tracing also have variable cost-effectiveness; and access and demand can substantially impact the cost-effectiveness of case finding. The value for money of collaborative surveillance will depend on the actions taking after cases are found. Contact

⁷⁶ [The cost-effectiveness of outbreak responses: Considerations in the COVID-19 era - Center for the Evaluation of Value and Risk in Health](#)

⁷⁷ [Strategic-Investment-in-Surveillance-for-Pandemic-Preparedness-Policy-Paper.pdf](#) + Berlin Hub CS review slides.

⁷⁸ Gomez GB, Mudzengi DL, Bozzani F, Menzies NA, Vassall A. Estimating Cost Functions for Resource Allocation Using Transmission Models: A Case Study of Tuberculosis Case Finding in South Africa. *Value Health*. 2020 Dec;23(12):1606-1612. doi: 10.1016/j.jval.2020.08.2096.

⁷⁹ Vassall A, Mangham-Jefferies L, Gomez GB, Pitt C, Foster N. Incorporating Demand and Supply Constraints into Economic Evaluations in Low-Income and Middle-Income Countries. *Health Econ*. 2016 Feb;25 Suppl 1(Suppl Suppl 1):95-115. doi: 10.1002/hec.3306. Epub 2016 Jan 19.

⁸⁰ Hsiang E, Little KM, Haguma P, Hanrahan CF, Katamba A, Cattamanchi A, Davis JL, Vassall A, Dowdy D. Higher cost of implementing Xpert[®] MTB/RIF in Ugandan peripheral settings: implications for cost-effectiveness. *Int J Tuberc Lung Dis*. 2016 Sep;20(9):1212-8. doi: 10.5588/ijtld.16.0200. PMID: 27510248; PMCID: PMC5018405.

tracing is primary means of controlling several endemic infectious diseases such as TB, HIV and STDs. In the case of small outbreaks, cost of contact tracing may be low and contact tracing may prevent substantial costs if a disease were left to spread. Its cost-effectiveness substantially varies by the way in which it is done and pathogen characteristics⁸¹ However, contact tracing at population level may incur substantial expenditures⁸² – as it is labour intensive, and how and when it is deployed can substantially impact value for money.

Integrating surveillance systems so they jointly respond to multiple pathogens is likely to bring additional value for money. Leveraging routine diagnostic infrastructure and capacities to support novel pathogen surveillance through an “Always On system” approach offers a promising way to avoid the inefficiencies of developing and maintaining parallel systems.⁸³ During the COVID-19 pandemic, several countries effectively pivoted their strong diagnostic capacities such as GeneXpert for tuberculosis to test SARS-COV-2 and other respiratory pathogens.⁸⁴ Just as they were repurposed to respond to the COVID-19 pandemic, these platforms can be adapted for future disease outbreaks.⁸⁵ More generally, integrated disease surveillance systems have proven highly cost-effective in managing outbreaks in low-income settings – for example, in controlling meningitis outbreaks. In contrast, investments in surveillance capacity for specific pathogens risk duplication and failure to address local disease priorities.⁸⁶ During the COVID-19 pandemic, investments were channelled through fragmented surveillance projects without adding value in building new or complementary capacities in critical areas.⁸⁷ This suggests that enhancing collaborative surveillance more broadly may potentially not only add benefits in terms of the prevention of the escalation of emergencies, but also improve efficiency in existing systems.

Improved digital and data systems for collaborative surveillance may improve technical efficiency. For example, investment in harmonising and improving routine data systems for integrated disease surveillance system in Burkina Faso has shown to improve 15% to 44% efficiency in reducing meningitis cases and deaths. Careful consideration of modalities/technology of screening and testing may yield high efficiency gains. For example, implementing improved and systematic testing for cholera in 35 African countries, rather than relying on traditional clinical methods for diagnosis, can increase the efficiency of oral cholera vaccine use in outbreak settings by over 134% (Annex 4). Technological innovations, such as telemedicine, remote and AI-based tracking and monitoring, mobile-based healthcare practices, and the use of improved and efficient transport systems like drones, can enhance the efficiency of healthcare systems during a pandemic. For example, the use of drones and other new technologies in diagnosing, testing and treating tuberculosis in Madagascar and the use of mHealth in India have shown to improve the technical efficiency.

⁸¹ Cavany SM, Vynnycky E, Anderson CS, Maguire H, Sandmann F, Thomas HL, White RG, Sumner T. Should NICE reconsider the 2016 UK guidelines on TB contact tracing? A cost-effectiveness analysis of contact investigations in London. *Thorax*. 2019 Feb;74(2):185-193. doi: 10.1136/thoraxjnl-2018-211662.

⁸² Torres-Rueda S, Sweeney S, Bozzani F, Naylor NR, Baker T, Pearson C, Eggo R, Procter SR, Davies N, Quaife M, Kitson N, Keogh-Brown MR, Jensen HT, Saadi N, Khan M, Huda M, Kairu A, Zaidi R, Barasa E, Jit M, Vassall A. Stark choices: exploring health sector costs of policy responses to COVID-19 in low-income and middle-income countries. *BMJ Glob Health*. 2021 Dec;6(12):e005759. doi: 10.1136/bmjgh-2021-005759.

⁸³ DCP4

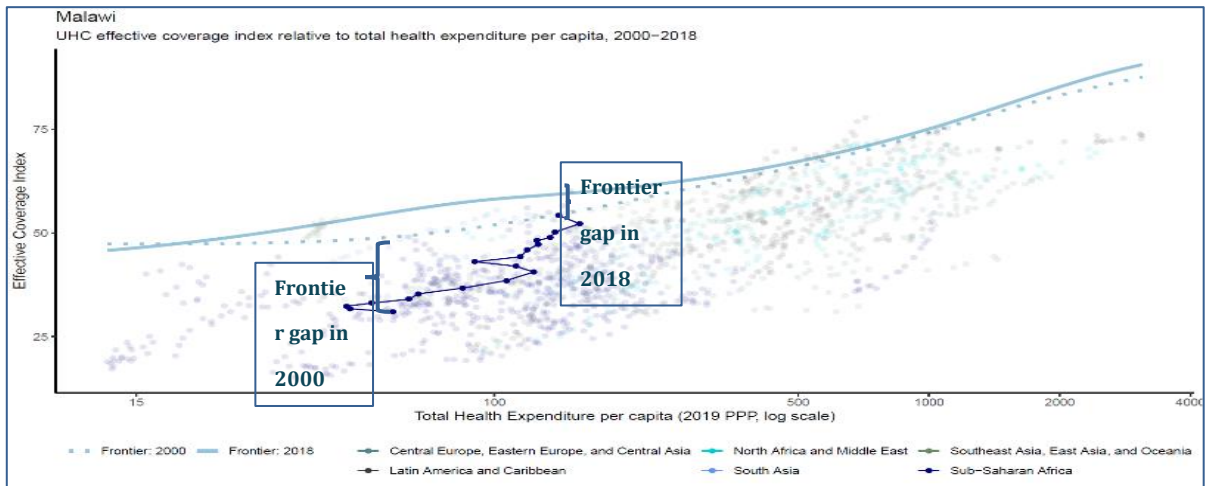
⁸⁴ [Leveraging tuberculosis programs for future pandemic preparedness: A retrospective look on COVID-19 - PubMed](#)

⁸⁵ [Strengthening diagnostic capacity in Africa as a key pillar of public health and pandemic preparedness](#)

⁸⁶ [Strengthening diagnostic capacity in Africa as a key pillar of public health and pandemic preparedness](#)

⁸⁷ [Strengthening diagnostic capacity in Africa as a key pillar of public health and pandemic preparedness](#)

Fig. S4A Plot of all countries over 2000-2018 effective coverage of UHC services against total health expenditure



Note: the figure illustrates the frontier and shows the pathway of one country over time, which increased efficiency and spending at the same time

Rapid review of surveillance literature: cost-effectiveness

| AUTHOR, DATE | REGION (COUNTRY) | INCOME LEVEL | DISEASE | EPI DATA | INTERVENTION | COMPARATOR | COST PER CASE DIAGNOSED (\$2023) | CE RATIOS ^{88*} (USD 2023) |
|--|--------------------|--------------|------------|--|---|---|----------------------------------|---|
| Integration of data systems | | | | | | | | |
| Somda et al., 2010 ⁸⁹ | AFR (Burkina Faso) | Low | Meningitis | Outbreak (defined threshold >10 cases per 100,000) | Integrated disease surveillance and prevention | Routine data systems | USD 25.62 | USD 3.49 per DALY averted |
| | AFR (Burkina Faso) | Low | Meningitis | Outbreak, (defined threshold >10 cases per 100,000) and the largest outbreak excluded) | Integrated disease surveillance and prevention | Routine data systems | USD 294.98 | USD 8,79 per DALY averted |
| Diagnostics & testing methods | | | | | | | | |
| Al Abri et al., 2021 ⁹⁰ | EMRO (Oman) | High | TB | Outbreak/ Endemic < 6 cases per 100,000 pop | QuantiFERON-TB Gold Plus (QFT) with 3-month TB treatment with two drugs | QFT with 4-month TB treatment with one drug | USD 11.09 | USD 3337 per QALY gained |
| Barker et al., 2023 ⁹¹ | WPRO (Malaysia) | Upper-Middle | TB | Endemic, 17% latent TB infection prev. | QuantiFERON-TB Gold Plus test | tuberculin skin test (TST) | | Dominated (-20.16 incremental cost, -0.01 QALY) |
| Foster et al., 2021 ⁹² | AFR (South Africa) | Upper-Middle | TB | Endemic, 13% | Various strategies for improving access to TB diagnosis pathway using Xpert testing | Routine Xpert testing | USD 117.80 to USD 182.26 | USD 22.20 to USD 50.60 per DALY averted |
| Shweta, M et al. ⁹³ | AMR (Canada) | High | HIV | Endemic, 6 per 100,000 (2023 inc.) | Point of care testing | Lab testing | | Dominant (-CAD\$885 million), 5000 QALY gained |
| Shweta, M et al. | AMR (Canada) | H | HIV | Endemic, 6 per 100,000 (2023 inc.) | Point of care testing | Self-testing | | USD 42,827 per QALY gained |
| Bahrainwala et al. 2020 ⁹⁴ | AFR (Madagascar) | L | TB | Endemic, 250 per 100,000 | DrOTS (active case finding, use of drones for sample | DOTS therapy (passive case finding, self-reporting, | \$1365.95 | USD 206.29 per DALY averted |

⁸⁸ *converted health outcomes to estimated DALY; all data in US\$2023 recalculated

⁸⁹ [Modeling the Cost-Effectiveness of the Integrated Disease Surveillance and Response \(IDSR\) System: Meningitis in Burkina Faso | PLOS One](#)

⁹⁰ Cost-effectiveness of IGRA/QFT-Plus for TB screening of migrants in Oman - International Journal of Infectious Diseases

⁹¹ A cost-effectiveness evaluation of latent tuberculosis infection screening of a migrant population in Malaysia | Scientific Reports

⁹² Strengthening health systems to improve the value of tuberculosis diagnostics in South Africa: A cost and cost-effectiveness analysis - PMC

⁹³ Estimated cost-effectiveness of point-of-care testing in community pharmacies vs. self-testing and standard laboratory testing for HIV - PubMed

⁹⁴ Drones and digital adherence monitoring for community-based tuberculosis control in remote Madagascar: A cost-effectiveness analysis - PubMed

| AUTHOR, DATE | REGION (COUNTRY) | INCOME LEVEL | DISEASE | EPI DATA | INTERVENTION | COMPARATOR | COST PER CASE DIAGNOSED (\$2023) | CE RATIOS ^{88*} (USD 2023) |
|---------------------------------------|------------------|--------------|---------|---|--|--|----------------------------------|---|
| | | | | | transport, GeneXpert diag, drone, evriMED™ device and tracker system-based treatment and follow-up); | smear microscopy and treatment at health facility) | | |
| Bahrainwala et al. 2020 ⁹⁵ | AFR (Madagascar) | L | TB | Endemic, 250 per 100,000 | DOTS with evriMED™ device (technological innovation) | DOTS | \$337.98 | USD39.63 per DALY averted |
| Bahrainwala et al. 2020 | AFR (Madagascar) | L | TB | Endemic, 250 per 100,000 | DrOTS without drones | DOTS | \$467.35 | USD 109.55 per DALY averted |
| Bahrainwala et al. 2020 | AFR (Madagascar) | L | TB | Endemic, 250 per 100,000 | DOTS with drones | DOTS | \$1164.29 | USD 258.73 per DALY averted |
| Pinja et al ⁹⁶ | SEAR (India) | Lower M | PHC | maternal mortality ratio 366 per 100,000 live births; infant mortality 80 deaths per 1000 live births | mHealth | routine care (no mHealth) | \$296.69 | USD 253.42 per DALY averted (166.89-360.97) |

⁹⁵ Drones and digital adherence monitoring for community-based tuberculosis control in remote Madagascar: A cost-effectiveness analysis - PubMed

⁹⁶ Cost effectiveness of mHealth intervention by community health workers for reducing maternal and newborn mortality in rural Uttar Pradesh, India - PMC

Rapid review of surveillance literature: Technical efficiency

| AUTHOR, DATE | REGION (COUNTRY) | INCOME LEVEL | DISEASE | EPI DATA | INTERVENTION | COMPARATOR | TECHNICAL EFFICIENCY PARAMETER | MARGINAL COSTS IN USD2023 | EFFICIENCY GAINS |
|--------------------------------------|--------------------|--------------|--------------|---|---|--|---------------------------------|---------------------------|------------------|
| Somda et al., 2010 ¹ | AFR (Burkina Faso) | Low | Meningitis | Outbreak (defined threshold >10 cases per 100,000) | Integrated disease surveillance and prevention | Routine data systems | Cumulative meningitis cases | USD 38.01 per case | 20.33% |
| Somda et al., 2010 | AFR (Burkina Faso) | Low | Meningitis | Outbreak (defined threshold >10 cases per 100,000) | Integrated disease surveillance and prevention | Routine data systems | Cumulative meningitis deaths | USD 132.22 per death | 43.48% |
| Somda et al., 2010 | AFR (Burkina Faso) | Low | Meningitis | Outbreak (defined threshold >10 cases per 100,000) | Integrated disease surveillance and prevention | Routine data systems | Time to peak outbreaks in weeks | NA | 33.33% |
| Somda et al., 2010 | AFR (Burkina Faso) | Low | Meningitis | Outbreak, (defined threshold >10 cases per 100,000) and the largest outbreak excluded) | Integrated disease surveillance and prevention | Routine data systems | Cumulative meningitis cases | USD 161.97 per case | 15.48% |
| Somda et al., 2010 | AFR (Burkina Faso) | Low | Meningitis | Outbreak, (defined threshold >10 cases per 100,000) and the largest outbreak excluded) | Integrated disease surveillance and prevention | Routine data systems | Cumulative meningitis deaths | USD 434.69 per deaths | 38.10% |
| Somda et al., 2010 | AFR (Burkina Faso) | Low | Meningitis | Outbreak, (defined threshold >10 cases per 100,000) and the largest outbreak excluded) | Integrated disease surveillance and prevention | Routine data systems | Time to peak outbreaks in weeks | NA | 33.33% |
| Bahrainwala et al. 2020 ² | AFR (Madagascar) | Low | Tuberculosis | Endemic, 250 per 100,000 | DrOTS (active case finding, use of drones for sample transport, GeneXpert diag, drone, evriMED™ device and tracker system-based treatment and follow-up); | DOTS therapy (passive case finding, self-reporting, smear microscopy and treatment at health facility) | Tuberculosis cases diagnosed | USD 903.23 | 61.23% |
| Bahrainwala et al. 2020 | AFR (Madagascar) | Low | Tuberculosis | Endemic, 250 per 100,000 | DrOTS | DOTS | Tuberculosis deaths averted | NA | 62.89% |
| Bahrainwala et al. 2020 | AFR (Madagascar) | Low | Tuberculosis | Endemic, 250 per 100,000 | DOTS with evriMED™ device | DOTS | Tuberculosis cases diagnosed | USD 9.32 | 0.00% |

¹ Modeling the Cost-Effectiveness of the Integrated Disease Surveillance and Response (IDSR) System: Meningitis in Burkina Faso | PLOS One

² Drones and digital adherence monitoring for community-based tuberculosis control in remote Madagascar: A cost-effectiveness analysis - PubMed

| AUTHOR, DATE | REGION (COUNTRY) | INCOME LEVEL | DISEASE | EPI DATA | INTER-VENTION | COM-PARATOR | TECHNICAL EFFICIENCY PARAMETER | MARGINAL COSTS IN USD2023 | EFFICIENCY GAINS |
|--------------------------|---------------------|------------------------|---------------------------|---|--|---|-----------------------------------|---------------------------|------------------|
| | | | | | (technological innovation) | | | | |
| Bahrainwala et al. 2020 | AFR (Madagascar) | Low | Tuberculosis | Endemic, 250 per 100,000 | DOTS with evriMED™ device (technological innovation) | DOTS | Tuberculosis deaths averted | NA | 2.73% |
| Bahrainwala et al. 2020 | AFR (Madagascar) | Low | Tuberculosis | Endemic, 250 per 100,000 | DrOTS without drones | DOTS | Tuberculosis cases diagnosed | USD 129.37 | 11.54% |
| Bahrainwala et al. 2020 | AFR (Madagascar) | Low | Tuberculosis | Endemic, 250 per 100,000 | DrOTS without drones | DOTS | Tuberculosis deaths averted | NA | 15.63% |
| Bahrainwala et al. 2020 | AFR (Madagascar) | Low | Tuberculosis | Endemic, 250 per 100,000 | DOTS with drones | DOTS | Tuberculosis cases diagnosed | USD 36.13 | 29.77% |
| Bahrainwala et al. 2020 | AFR (Madagascar) | Low | Tuberculosis | Endemic, 250 per 100,000 | DOTS with drones | DOTS | Tuberculosis deaths averted | NA | 40.23% |
| Pinja et al ¹ | SEAR (India) | Lower Middle | Maternal and child health | maternal mortality ratio 366 per 100,000 live births; infant mortality 80 deaths per 1000 live births | mHealth | routine care (no mHealth) | Maternal illness episodes averted | \$296.69 | 9.12% |
| Pinja et al | SEAR (India) | Lower M | Maternal and child health | | mHealth | routine care (no mHealth) | Neonatal illness episodes averted | \$296.69 | 1.92% |
| Pinja et al | SEAR (India) | Lower M | Maternal and child health | | mHealth | routine care (no mHealth) | Maternal deaths averted | \$7,250.35 | 0.32% |
| Pinja et al | SEAR (India) | Lower M | Maternal and child health | | mHealth | routine care (no mHealth) | Neonatal deaths averted | \$7,250.35 | 6.89% |
| Xu.et. al ² | AFRO (35 countries) | Lower and Lower middle | Cholera | Outbreak, incidence threshold of 1/10,000 per year | Systematic testing for cholera and targeted oral cholera vaccine | Clinical definition for suspected cholera and targeted oral cholera vaccine | Oral cholera vaccine use | \$631 | 134% |
| Xu.et. al | AFRO (35 countries) | Lower and Lower middle | Cholera | Outbreak, incidence threshold of 2/10,000 per year | Systematic testing for cholera and targeted oral cholera vaccine | Clinical definition for suspected cholera and targeted oral cholera vaccine | Oral cholera vaccine use | \$587 | 147% |
| Xu.et. al | AFRO (35 countries) | Lower and Lower middle | Cholera | Outbreak, incidence threshold of 10/10,000 per year | Systematic testing for cholera and targeted oral cholera vaccine | Clinical definition for suspected cholera and targeted oral cholera vaccine | Oral cholera vaccine use | \$248 | 156% |
| Xu.et. al | AFRO (35 countries) | Lower and | Cholera | Outbreak, incidence | Systematic testing for | Clinical definition for | Oral cholera vaccine use | \$631 | 134% |

¹ Cost effectiveness of mHealth intervention by community health workers for reducing maternal and newborn mortality in rural Uttar Pradesh, India - PMC

² Enhanced cholera surveillance to improve vaccination campaign efficiency. *Nat Med* 30, 1104–1110 (2024).

| AUTHOR, DATE | REGION (COUNTRY) | INCOME LEVEL | DISEASE | EPI DATA | INTER-VENTION | COM-PARATOR | TECHNICAL EFFICIENCY PARAMETER | MARGINAL COSTS IN USD2023 | EFFICIENCY GAINS |
|--------------|------------------|--------------|---------|--------------------------------|---|---|--------------------------------|---------------------------|------------------|
| | | Lower middle | | threshold of 1/10,000 per year | cholera and targeted oral cholera vaccine | suspected cholera and targeted oral cholera vaccine | | | |

7.5. Appendix 5: Supplementary material health financing

Table S5A. Key PFM adjustments to enhance system response

| | |
|---------------------------|---|
| BUDGET FORMULATION | Regulate contingency funds and develop SOP for Extra-Budgetary Funds |
| | Set up budget prioritisation framework |
| | Accelerate budget structure (e.g., Program-Based Budgeting) reform to enable more flexible re-allocations |
| BUDGET EXECUTION | Update emergency spending protocols |
| | Update emergency procurement protocols |
| | Refine budgetary transfer modalities for subnational levels |
| | Consider adjustments to provider payment and contracting modalities |
| BUDGET OVERSIGHT | Adjust financial reporting system to incorporate response spending |
| | Set up procedures for comprehensive financial monitoring (including off-budget funding sources) |
| | Establish SOP for real-time auditing |

Source: authors, adapted from <https://www.who.int/publications/i/item/9789240052574>