The Cost of Selected Prison Health Services in Indonesia: HIV, Tuberculosis, and Drug Dependence Programmes

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REPORT

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Correspondence to:

Arie Rahadi, Ph.D.
☏ : +62 811 220 2240
✉ : arie.rahadi@atmajaya.ac.id

Foreword

Costing a health programme is the first crucial step in resource planning and budgeting. An important condition that we must satisfy for a health intervention to be effective is that it receives adequate resource inputs to match the target and scale at which it reaches the maximum number of people at risk. These resource inputs need to be identified, measured, and valued to evidentiarily and reliably inform budgeting. During my career I have witnessed many lost public health opportunities due to uninformed budgeting decision with gross underestimation of a programme value (likely to be suboptimal when implemented) or its overestimation (likely to be rejected at first proposal) as the end result. Knowing the size of a health problem or the burden of a disease in a population is a futile exercise by itself if there exists no attempt to gauge the size of the resources needed towards a concrete plan of action.

This report showcases the cost and budget estimates for selected health care programmes in Indonesia's prisons, namely for HIV, tuberculosis, and drug rehabilitation. These three diseases have affected the lives of many and even more so for persons who are incarcerated (PWI) who face the stark reality of not having the quality of care comparable to that outside the prison confines. By the same token, we must not forget the strategic position that the penitentiary system holds to care for those who would otherwise have no means to obtain essential health services in the mainstream public health system. The results of the study conducted in this report offer a road map of how much we would gain from an investment option in prison health.

For the first time in our long-term collaboration with the Directorate General of Corrections (DGC) of the Ministry of Laws and Human Rights Republic of Indonesia, we managed to provide an economic reasoning to strengthen the concurrent development of the key actions exemplified in relevant National Action Plans 2020-2024 of DGC. By explicitly comparing the strategies at current programme coverage and optimal (90%) coverage either since 2020 or as a targeted coverage in 2024 in a linear growth rate, policy makers can have a sense of return on investment with respect to these strategy options. The intent of such an undertaking then is not to prescribe a course of action but to assist in policy making by presenting a range of plausible options as transparently as possible and using the best available evidence that we have at the moment.

In the realms of economics, no one escapes the consequence of (not) choosing one over the others. Resources allocated to one strategy option may limit proportionally the amount of allocations to other prison health care programmes or to other DGC domains and beyond. Additionally, a programme shift to a particular strategy option may reduce the attractiveness of the other, more effective alternatives as the cost of shifting further outweighs the incremental gains in health as programme coverage is approaching optimality.

The study findings project nearly IDR 155 billion in annual investment to support the three programmes at optimal coverage, or about more than twice the estimates for current coverage. About IDR 25 billion of which is expected to fund blanket screening and diagnosis programmes. Some potential gains in efficiency can be made by differentiating screening and diagnosis strategies by prison types, thereby freeing a portion of sunk costs from testing low-risk PWI for an active investment in treatment programmes.

I am optimistic that the study will represent a milestone in our enduring advocacy effort with DGC for better prison health. Ten years down the road we may look back on this very moment and feel glad to be a part of this process. I thank DGC for our lasting partnership and look forward to more avenues of strategic collaboration in the future. I also thank the consultant and others who took part in making this study possible.

Evidence-informed advocacy lies at the core of what many of us do on a daily basis. This report can fuel the momentum needed to promote equitable health for PWI, which I encourage to consider as a reference document in future policy discussions on prison health in Indonesia.

Collie F. Brown
UNODC Country Manager and Liaison to ASEAN

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List of abbreviations

AIDS	=	Acquired immune deficiency syndrome
ART	=	Antiretroviral treatment
BIA	=	Budget impact analysis
CEA	=	Cost-effectiveness analysis
DALY	=	Disability-adjusted life years
DD	=	Drug dependence
DDR	=	Drug dependence rehabilitation
DGC	=	Directorate General of Corrections
HIV	=	Human immunodeficiency virus
HR	=	Hazard ratio
IDR	=	Indonesian Rupiah
INA-CBG	=	Indonesia Case Base Groups
MOH	=	Ministry of Health
MSH	=	Management Sciences for Health
NAP	=	National action plan
OI	=	Opportunistic infection
TB	=	Tuberculosis
UNODC	=	United Nations Office on Drugs and Crime
WHO	=	World Health Organization

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Executive summary

Prison health is often neglected in the absence of a policy framework to reconcile the correctional system into the larger public health system. In the recent years, pressure has mounted to improve prison health in Indonesia. However, funding allocations have not been adequate to implement health programmes for persons who are incarcerated (PWI) as effectively and as efficiently as those found in community settings. Prison health is an integral component of the public health system, which provides access to care to vulnerable populations who have little or no means of obtaining care from community health services.

The Directorate General of Corrections of the Ministry of Laws and Human Rights (DGC) acknowledges that strategic information on resource needs for priority diseases is the first step to advance prison health. Two thousand nineteen marks the end of the quinquennial National Action Plan (NAP). Planning for resource requirements for the 2020-2024 period is a critical first step to advocate for needs-based budget allocations for prison health. In collaboration with the United Nations Office on Drugs and Crime (UNODC), Programme Office of Indonesia, DGC conducted a prison costing study for this purpose in three priority disease areas: HIV, tuberculosis (TB), and drug dependence (DD). This report presents the results of this study.

A budget impact analysis (BIA) was performed to assess the costs and health outcomes of three competing strategies: current (HIV, TB, and DD treatment coverage at the 2018 level), gradual improvement (increased treatment coverage from the current level to 90% by 2024), and optimal improvement (constant 90% treatment coverage throughout the entire 2020-2024 period). Cost and resource utilization data were collected from interviews at two all-male prison sites in Jakarta and DGC and from existing costing studies, where relevant. The effectiveness of a strategy was assessed as reduction in morbidity and mortality summarized as disability-adjusted life years (DALYs). A health sector perspective was adopted in calculating programme costs. A fixed increase in the prison population was assumed and the cost of health screening and diagnosis associated with the three diseases for PWI new entrants was additionally calculated.

At current treatment coverage, approximately IDR 49.62 billion was spent annually for three programmes of which HIV - at 51% coverage - received the highest spending share in comparison to TB (10% coverage, 4% share) and DD (0.3% coverage, 0.2% share). Targeting a gradual improvement in coverage to 90% by 2024 requires an annual investment of IDR 56.31 billion with a substantial reduction in DALYs (31,968 units) compared to the current strategy (11,149 units). An immediate increase to 90% coverage and maintaining it throughout the NAP period would cost IDR 129.55 billion annually with a relatively modest reduction in DALYs (44,623 units) compared to the gradual strategy at more than twice of its annual cost. An additional investment of IDR

23.80 billion per annum is required to match the need for health screening and diagnosis to all PWI new entrants of which about 94% would be spent on PWI who have no HIV, TB, and DD. Choosing the more affordable gradual improvement now would reduce the attractiveness of optimal improvement as the next best strategy due to the limit in additional quantities of DALY reduction that can be achieved with optimal treatment coverage.

It is important that policy makers pay attention to this trade-off of affordability and optimality in deciding on the budget allocation for prison health. Promoting service innovations in prison health will produce efficiency gains that will favorably alter the cost profile of the next best strategy when due for adoption. Another potential source of efficiency gains is to economize on health screening and diagnosis of PWI new entrants, with differentiated models of blanket and targeted screening by prison characteristics (e.g., blanket health screening only in narcotic prisons). A differentiated screening model can free up a sizable portion of fixed investment dedicated to mass health screening to be reallocated to treatment programmes.

Improving prison health requires a multisectoral effort, and the BIA results from this study are expected to inform future budget allocations for prison health and broader public health system in Indonesia. Funding should be the next step in policy discussions, prioritizing the type of modality to best allocate resources for prison health.

1. Background

The disconnect of prison health from the general public health system is the key feature responsible for the disproportionate health problems seen among persons who are incarcerated (PWI) in many countries [1, 2]. Prison health is one of the critical issues in contemporary public health system of Indonesia due to overcrowding, drug use, and the high prevalence of sexually transmitted infections, including HIV, occurring in prison settings [3–5]. In 2018 an estimated 38% of all PWI entering the correctional system had a drug-related offence [6]. Despite this, treatment coverage remains suboptimal and the increasing trend in inflows into the correctional system from drug-related offences continues unabated. A drastic policy change is needed to divert PWI to a more health-oriented drug treatment.

Against this background environment, the Directorate General of Corrections of the Ministry of Laws and Human Rights (DGC) has been stepping up effort to strengthen prison health. The National Action Plan (NAP) for HIV Control and Drug Use has laid the foundation for multisectoral collaboration to scale up HIV and tuberculosis (TB) programming and reinvigorate care for drug dependence (DD) among PWI [7]. Despite this achievement in policy making, budget allocations remain stagnant and minimal for adequate in-prison health care. These allocations also do not align with the mainstream public health system in adopting innovations and effectively responding to the threat of emerging infectious diseases such as drug-resistant TB [8].

Accumulated evidence on Indonesia prison health services suggests that despite the heightened risk of in-prison morbidity and mortality, provision of effective care works to improve other health outcomes. PWI living with HIV can be expected to respond equivalently well to antiretroviral treatment (ART) as their community counterparts, which suggests that adequate levels of treatment adherence can be maintained in the penitentiary setting [9]. Interventions for drug dependence have been shown to be protective against in-prison mortality and encourage access to care for other health services on offer [5]. Findings from developed countries have highlighted the role of prison health as an opportunity to expand public health services to very hard-to-reach groups who would otherwise not have enrolled in the mainstream services in community settings [10–12].

Ultimately, there is a critical need to advocate for improved coverage of in-prison care. While this is the main issue to be addressed in the subsequent revision to sectoral NAPs for the 2020-2024 period, no less important is effort to document the size of the priority health problems and synchronize future resource allocations required to address these and inform budgeting. This is the goal of this costing study. DGC and the United Nations Office on Drugs and Crime, Country Office of Indonesia (UNODC) have collaborated to advance prison health in Indonesia. To support this effort, UNODC has commissioned a costing study for HIV and TB care and drug dependence rehabilitation

as the basis for programme budgeting. This document reports on the results of the costing study.

2. Objective

The ultimate objective of this study was to estimate the resource needs of prison health programmes in HIV, TB, and DD. In order to do this, a model-based study was conducted to explore the effectiveness and efficiency of alternative strategies to improve treatment coverage for the three diseases in question. The primary aim of this study was to calculate the total costs and health effects of the comparative strategies for improved prison health in these three disease areas to inform policy making. In this study, the programme unit costs were therefore calculated in the first step. Data on effectiveness and model inputs were then assembled to project the cost estimates for the 2020-2024 budget period.

3. Methods

3.1. Study design

A budget impact analysis (BIA) was performed to estimate the resource needs for prison health care in HIV/AIDS, TB, and DD for the 2020-2024 NAP period. BIA is an extension to cost-effectiveness analysis (CEA) and has an increasing prominence in economic evaluation to contextualize economic decision-making in a budget-constrained environment [13], which befalls virtually all economic actors. Similar to CEA, BIA utilizes inputs of quantities related to costs and effectiveness of a proposed strategy or an intervention, analyzed in modelling mechanics. What distinguishes BIA from CEA lies in its primary goal of estimating the total resource needs in budgetary terms rather than the average programme cost as in the latter for a given health objective (e.g., to reduce mortality of PWI by an *x* amount). Rather than evaluating whether a specified strategy is “worth doing” as in the CEA, BIA extends this information to assess if an optimal strategy, when being pursued, is affordable to the budget holder [13]. In terms of the data need, BIA additionally requires an estimate of future patient flows covered in the budget period and the unit costs of the budget holder.

Modelling analysis that underpins BIA describes costs and health outcomes in mutually exclusive compartments, or "health states", that define the strategies to be compared. The number of compartments will typically depend on the important health states to capture and/or sequela in the natural history of a disease that a proposed strategy aims to reduce or prevent from progressing. In summary, BIA provides a transparent method of budget estimation by using an explicit decision model for each strategy being compared so as to aid in a rational and optimal policy-making process. BIA also simultaneously assesses both costs and outcomes to demonstrate the total health benefit

from spending the indicated budget for each strategy. This is the key feature of BIA compared to other costing methods that disregard the health outcome estimation and therefore have a comparatively little value to indicate an optimal budget, given the constraint in its allocation size, that maximizes the population health.

3.2. Comparative strategies

A strategy in the context of BIA, broadly defined, is a course of action to which health resources are allocated in order to produce additional health gains [14]. Equivalently, a strategy denotes a "policy option", an "intervention group", or a "change in the standard practice"; and the implementation of a new strategy is expected to generate health gains in excess of what the current strategy can. In practice, more than one strategy to choose from can be available, and these strategies reflect a gradient of costs and the corresponding quantities of health benefits on which the decision to select a strategy in a budget-constrained environment is based (i.e., with a limitless budget the policy decision will almost always default to the most expensive strategy).

In the study, the following definitions are used to define care related to HIV, TB, and DD:

- HIV care: diagnosis of HIV, enrolment into routine, prophylactic care and ART, to outpatient and inpatient treatment of opportunistic infections and long-term care retention;
- TB care: diagnosis of TB, enrolment into routine, prophylactic care and anti-TB treatment, to outpatient and inpatient treatment and treatment completion; and
- Drug dependence rehabilitation (DDR): diagnosis of DD, enrolment into prison-based medical and social rehabilitation programme, modeled on standard therapeutic community programming.

The strategies proposed in the study were developed from combining the above care at varying levels of service coverage, and these are detailed as follows:

- Current strategy (status quo): this strategy reflects the current state of implementation of HIV and TB care and DDR in Indonesia prisons as being practiced now based on the latest available data on service coverage;
- Gradual strategy: this strategy targets a linear improvement in service coverage such that the optimal level, defined in this study as 90% coverage, of HIV care, TB care, and DDR will be attained by the final year of the budget period in year 2024;
- Optimal strategy: this strategy assumes an abrupt change in service coverage to a 90% level throughout the budget period for HIV care, TB care, and DDR; and
- Null strategy: the counterfactual baseline strategy of no HIV, TB, and DDR programmes against which the other strategies were compared to in order to

calculate the net health improvements (i.e., reduction in morbidity and mortality) for each of the other strategies [15]. This strategy assumes an unhindered natural history of the disease.

The two other strategies outlined in the Inception Report (i.e., HIV-TB-DDR at 60% and Optimal HIV-TB) were removed for a more focused analysis on the implications of optimal coverage in prison health related to these three diseases. In evaluating all three strategies, a background strategy of mass health screening upon entry into the penitentiary system was assumed and costed accordingly in the analysis. The current strategy also assumed receipt of routine clinical monitoring recommended in the international guideline for HIV and TB care but were not available at the time of writing this report [16,17].

3.3. Analytic model overview

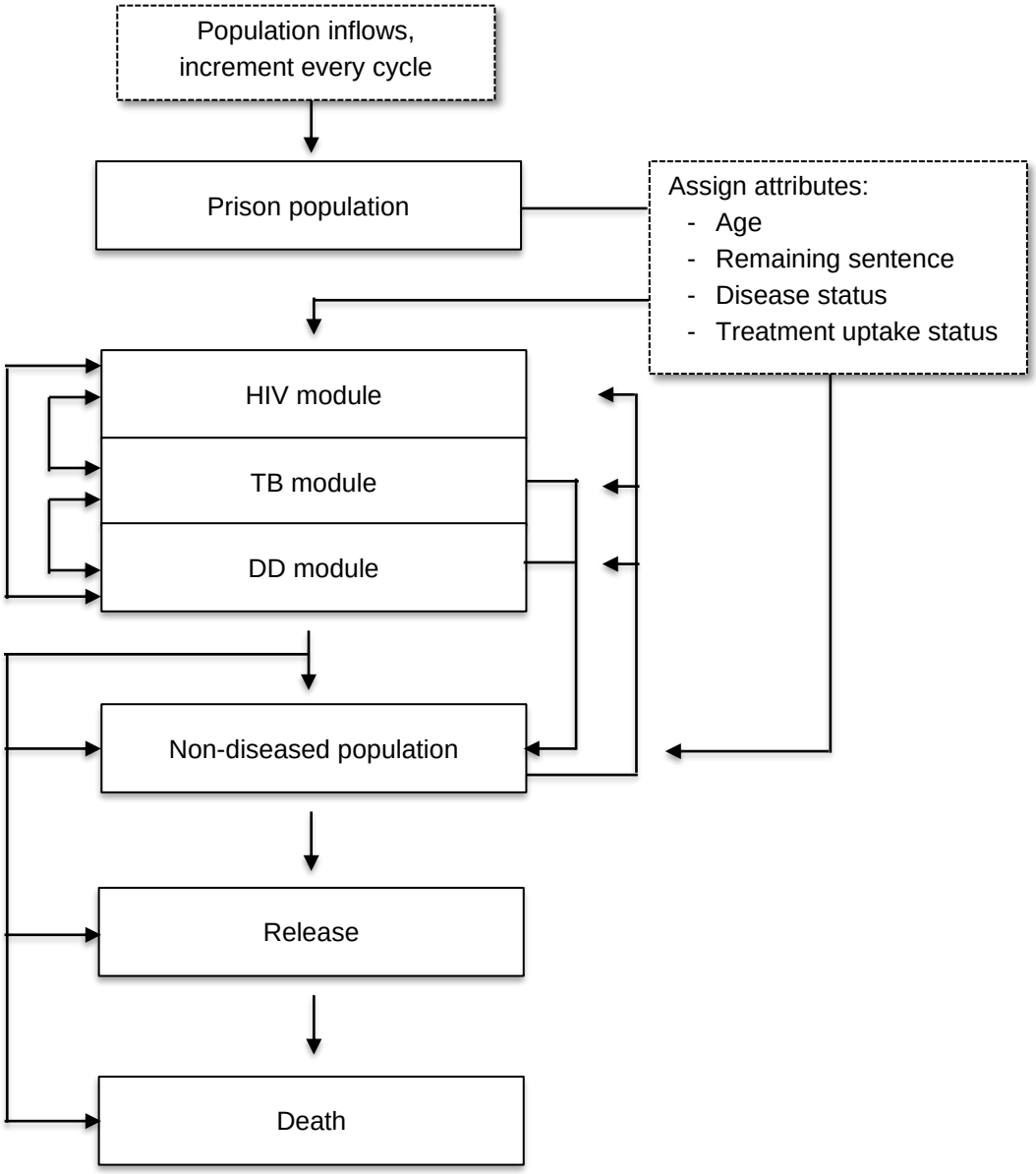
A schematic of the BIA model used in this study is presented in **Figure 1**. The model simulated individual PWI (microsimulation), taking a distribution of characteristics in age (range: 18—59 years), remaining sentence (in months), and disease and treatment uptake status (i.e., whether or not individual PWI who had HIV, TB, and/or DD enrolled in the care and treatment available). By their disease characteristics, individual PWI entered their corresponding state into the diseased (HIV, TB, and DD modules) or non-diseased or healthy state. Simulated PWI could transition between the disease areas (i.e., across the modules) to consider comorbidity and to the Non-diseased (except for those in the HIV module), Release (no longer in prison), and Death (background and disease-specific rates) states thereafter. All simulations were male, and no cost or health consequence was linked to biological or other differences by sex. Other key model features and BIA components are described in **Table 1**.

Comorbidities were handled in the disease module (**Figure 2**) in the following ways. Comorbidities were explicitly modeled in the TB and HIV modules. In the DD module, a comorbid condition would transition a simulated PWI to the TB or HIV module. The HIV module has the most exhaustive list of comorbidities: with TB, with DD, and with TB and DD. Only in the HIV module did the simulation not transition to the other diseased modules nor the Non-diseased state (i.e., effective ART does not fully restore health). Once in the HIV module, the simulation would change states to comorbid conditions (or not) until the time of release, death, or model termination after the five years of time horizon (five annual cycles) were completed.

3.4. Model parameters: cost and effectiveness data

Primary data collection on resource utilization rates was conducted in two prison sites in Jakarta (Prison Class I Cipinang, Detention Center Class I Cipinang) and at DGC.

Figure 1. BIA model structure



BIA = Budget impact analysis; DD = Drug dependence; HIV = Human immunodeficiency virus; TB = Tuberculosis.

Resource items used in respective programmes and the proportion of utilization were elicited during interviews with programme staff. DGC staff provided information on additional personnel time to supervise the programmes and the training needs. Resource utilization data were collected in a standard spreadsheet programme. A trained research assistant explained the purpose of the spreadsheet and assisted programme staff in filling out the required data in two or three visits to each site. Additionally, a three-day workshop on health economic evaluation was conducted as a medium of capacity building for DGC staff to better understand the costing process and for data coordination.

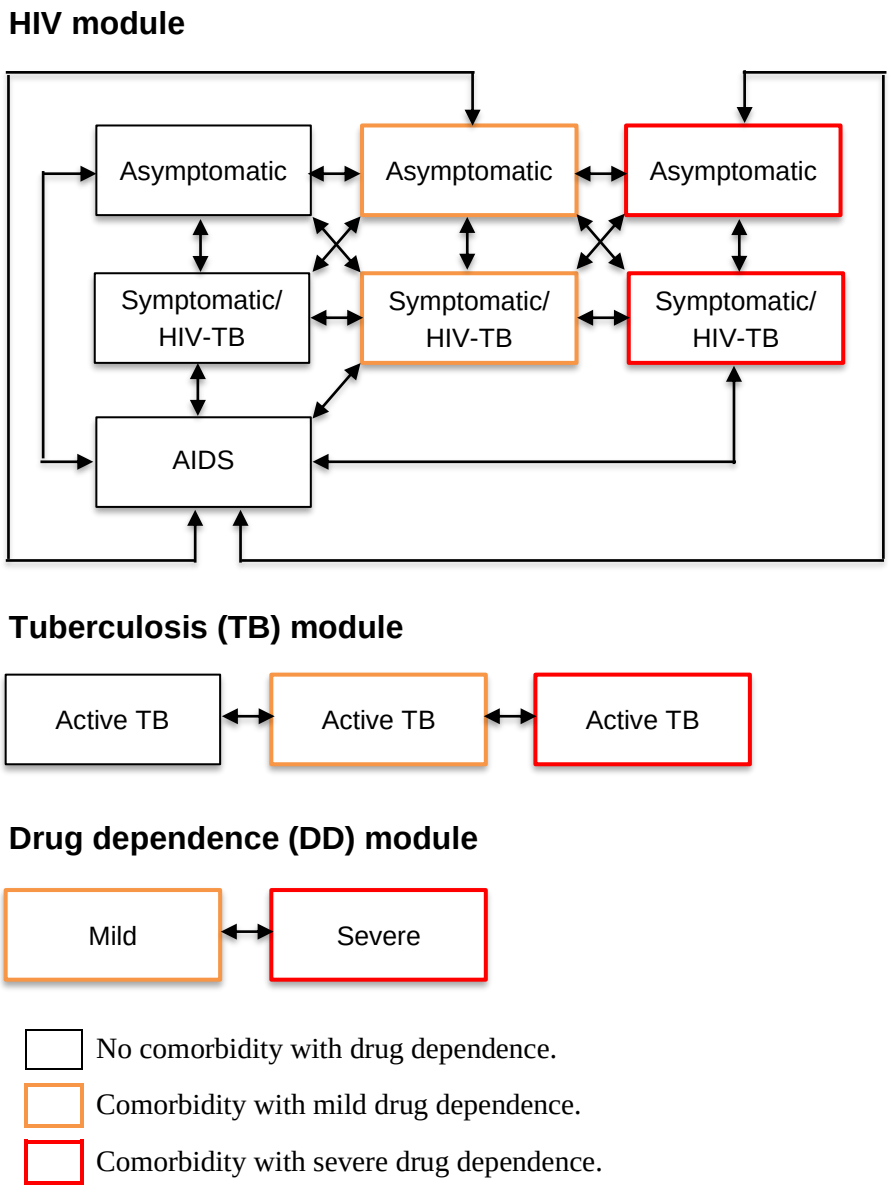
Table 1. Key model features and BIA components

No	Model feature	Description	Value / used in the model?
1	Cycle	The length of time in which simulated PWI stay in one state before transitioning to other states or back in the same state.	1 year
2	Discount rate	The annual rate at which future costs and health consequences are deducted to reflect the net present value of competing programmes. Not used in BIA because undiscounted costs describe the actual (financial) resource needs to be advocated in a future budget.	0%
3	Dynamic infection	Incorporation of the changing risk of infection due to increased contacts and overcrowding. Applicable to the three diseases under study and assuming that drug use is a social process (i.e., more PWI are susceptible to drug use as the number of drug-using PWI increase.	No
4	Dynamic population	Incorporation of inflows of new PWI entering the model (i.e., the size of the PWI cohort is not fixed). The annual number was predicted linearly from the available data and scaled to cycle duration.	Yes
5	Half-cycle correction	An assumption that events occur in the middle of the cycle period as opposed to on the first or final date. A standard approach in health economic evaluation.	Yes
6	Perspective	Defines the coverage of costs and health consequences depending on to whom the BIA results will be applicable (end-users).	Health sector (DGC + non-DGC)

No	Model feature	Description	Value / used in the model?
7	Reference year	The base year to inform initial programme conditions when the model starts and for conversion of costs accrued in all other years.	2018
8	Time horizon	The evaluation period. Simulated PWI will keep transitioning between states until release or death or the end of the evaluation period. Equal to the NAP or budget period.	5 years (5 cycles)
9	Trial type	Whether simulated PWI enter the model in series (i.e., one after another until death, release, or end of the evaluation period) or in parallel (i.e., simultaneous entry for all simulated PWI in the initial model state).	Serial trial

BIA = Budget impact analysis; DGC = Directorate General of Corrections; NAP = National Action Plan; PWI = Persons who are incarcerated.

Figure 2. BIA disease modules



AIDS = Acquired immune deficiency syndrome; BIA = Budget impact analysis; HIV = Human .
nodeficiency virus; TB = Tuberculosis.

In the next step, resource utilization was valued using the standard, prevailing prices for government agencies [18], where available, or from market prices or market proxies such as case-based groups of tariffs for medical services to estimate the cost of hospitalization [19]. The estimates were cross-referenced with those found in the literature and calibrated these unit costs to reflect a wider scope of essential goods and services that made up a resource item reported in these studies as necessary. Depreciation costs for land and building were obtained from previous costing studies for the same programme [20–22]. **Table 2** presents the unit costs of HIV, TB, and DD programmes in diagnosis and treatment calculated in this step for use in the BIA model.

Table 2. Programme unit cost, annual values (2018 IDR, '000)

Cost parameter	Mean	Min	Max	Distribution	Source
HIV Programme cost					
HIV diagnosis, screening	148,215	101,427	195,015	Gamma	Siregar [22], estimated from data
HIV-related hospitalization (episode)[a]	11,695,367	8,771,525	14,619,209	Gamma	INA-CBG [19]
ART programme, total	11,399,770	10,396,426	12,403,114	Gamma	
Personnel	1,630,563	1,222,922	2,038,204	Gamma	Estimated from data
Supplies	25,189	18,892	31,486	Gamma	Siregar [22], estimated from data
Equipment	39,424	29,568	49,280	Gamma	Siregar [22], estimated from data
First-line antiretroviral drugs	7,524,360	6,542,640	8,178,480	Gamma	Siregar [22], estimated from data
OI treatment, prophylaxis	1,114,798	863,099	1,393,498	Gamma	LKPP [18]
Diagnostics, monitoring	1,020,000	714,000	1,326,000	Gamma	Assumed
Training, supervision	8,597	6,488	10,746	Gamma	Estimated from data
Land, building	36,839	27,629	46,049	Gamma	Siregar [22]
TB programme cost					
TB diagnosis, screening	137,465	96,226	178,705	Gamma	Estimated from data
TB-related hospitalization (episode)[b]	10,403	7,802,913	13,004,855	Gamma	INA-CBG [19]
TB treatment programme, total	2,300,153	1,822,534	2,777,772	Gamma	
Personnel	1,359,647	951,753	1,767,541	Gamma	Estimated from data
Supplies	11,145	7,802	14,489	Gamma	MSH [21], estimated from data

Cost parameter	Mean	Min	Max	Distribution	Source
Equipment	18,156	12,709	23,603	Gamma	MSH [21], estimated from data
First-line anti-TB drugs	630,731	388,320	873,141	Gamma	LKPP [18]
Other drugs	121,378	84,965	157,791	Gamma	Estimated from data
Diagnostics, monitoring	132,245	92,462	172,049	Gamma	MSH [21], estimated from data
Training, supervision	8,597	6,018	11,176	Gamma	Estimated from data
Land, building	18,154	12,708	23,600	Gamma	MSH [21]
Drug rehabilitation programme cost					
Diagnosis, screening	182,536	136,902	228,170	Gamma	DGC [23], estimated from data
Drug-related hospitalization (episode)[c]	9,127,820	6,845,865	11,409,775	Gamma	INA-CBG [19]
Drug rehabilitation cost, total	2,058,669	1,659,396	2,457,942	Gamma	
Personnel	1,565,137	1,173,853	1,956,421	Gamma	Afriandi [20], DGC [23]
Supplies	32,263	24,197	40,329	Gamma	DGC [23]
Equipment	52,233	39,175	65,291	Gamma	Afriandi [20]
Other drugs	51,215	38,411	64,019	Gamma	DGC [23]
Diagnostics, monitoring	304,226	228,170	380,283	Gamma	Afriandi [20], DGC [23]
Training, supervision	8,597	6,448	10,746	Gamma	Estimated from data
Land, building	44,998	33,749	56,248	Gamma	Afriandi [20], estimated from data

ART = Antiretroviral treatment; DGC = Directorate General of Corrections; HIV = Human immunodeficiency virus; IDR = Indonesian Rupiah; INA-CBG = Indonesia Case Base Groups; LKPP = National Public Procurement Agency; MSH = Management Sciences for Health; OI = Opportunistic infection; TB = Tuberculosis.

Cost parameter	Mean	Min	Max	Distribution	Source

[a] Standard reimbursement rate for inpatient care related to severe HIV infection for Type A hospitals, averaging over the regional differences, plus an estimated cost of escort protection valued at five times local transport for two guards.

[b] Standard reimbursement rate for inpatient care related to severe bacterial and parasitological infections for Type A hospitals, averaging over the gional differences in pricing rates, plus an estimated cost of escort protection valued at five times local transport for two guards.

[c] Standard reimbursement rate for inpatient care related to severe abuse and dependence for other drugs for Type A hospitals, averaging over the regional differences in pricing rates, plus an estimated cost of escort protection valued at five times local transport for two guards.

Estimates from published meta-analyses and prospective studies were used to inform other key parameters when these were not available in DGC routine reports or administrative data.

The effectiveness of a strategy was measured in disability-adjusted life years (DALY). DALY is the standard metric of population health, which simultaneously captures the burden of morbidity and mortality attributable to a disease has two components, which are years of life lost (the number of years from the time of premature death due to a disease to the age of life expectancy) and years lived with disability (the number of years lived with suboptimal health due to a disease). DALY values range from 0 (full health) to 1 (equal to a death state), and all values in between indicate a reduction in health status by the amount of the disability weight from the disease in question. Comorbid conditions was assumed to have a multiplicative effect on health and calculated using the formula described in the WHO Technical Paper [24]. Key model parameters related to transition probabilities, effectiveness, and disability weights are described in **Table 3**.

3.5. Data analysis

The microsimulation model was programed in TreeAge Pro 2019 R2.1 (Williamstown, MA). Model outputs were saved in a standard spreadsheet programme and analyzed using statistical package Stata version 14.2 (College Station, TX) to compute the bootstrap bias-corrected standard errors and the corresponding 95% confidence intervals. Variability in the plausible range of parameter values for cost and DALY estimates was captured and averaged from 1,000 model runs, with each run taking random values from the specified parameter distribution in **Table 2** and **3**, in the probabilistic sensitivity analysis [25]. The main results are presented as annual total and average costs and reduction in DALYs. The cost estimates are differentiated incorporating all programme components (from personnel to land and building), limiting to major components (excluding personnel, training and supervision, and land and building), and drugs only (prophylactic, treatment, and other drugs). All costs were presented in 2018 IDR. Exchange rate conversion and inflation adjustments were applied for cost or price data expressed in other currencies or reported for the year other than this reference year [26,27].

Table 3. Key model parameters, annual values

Selected parameter	Mean	Min	Max	Distribution	Source
Model and population characteristics					
Time horizon (years)	5	-	-	-	
N cycle	5	-	-	-	
N initial cohort of PWI	278,135	-	-	-	
Initial age of PWI (years)	32.90	18.00	59.00	Triangular	Culbert [5], Sawitri [28]
Life expectancy in years (mortality risk), by age					WHO [29]
19-24 years	49.9 (0.009)	-	-	-	
25-29 years	45.3 (0.009)	-	-	-	
29-34 years	40.7 (0.011)	-	-	-	
34-39 years	36.1 (0.014)	-	-	-	
40-44 years	31.6 (0.020)	-	-	-	
44-49 years	27.2 (0.031)	-	-	-	
50-54 years	23.0 (0.048)	-	-	-	
54-59 years	19.0 (0.076)	-	-	-	
59-64 years	15.4 (0.126)	-	-	-	
Length of imprisonment (years)	5.00	0.25	29.00	Gamma	Sawitri [28]
Probability of release	0.04	0.03	0.06	Beta	Sawitri [28]
Estimated *N* PWI (person)					Estimated from [30]

Selected parameter	Mean	Min	Max	Distribution	Source
Year 2020	278,135	-	-	-	
Year 2021	297,432	-	-	-	
Year 2022	316,730	-	-	-	
Year 2023	336,028	-	-	-	
Year 2024	355,325	-	-	-	
Disease prevalence					
HIV	0.031	0.001	0.073	Beta	MOH [31]
TB	0.036	0.010	0.060	Beta	USAID [32]
Drug use/dependence	0.074	0.040	0.108	Beta	Sawitri [28]
HIV-TB coinfection	0.201	0.138	0.264	Beta	Gao [33]
Programme coverage					
Current ART coverage	0.510	-	-	-	Estimated from data
Current anti-TB coverage	0.100	-	-	-	Unpublished report
Current rehabilitation coverage	0.003	-	-	-	DGC [23]
Disease risk and treatment effect					
HR of progression to symptomatic and AIDS, treated	0.250	0.188	0.313	Beta	
Risk of HIV-related death, treated	0.128	0.085	0.285	Beta	Culbert [5], estimated from data

Selected parameter	Mean	Min	Max	Distribution	Source
HR of death in HIV-TB cohort, treated	1.100	0.900	1.300	Log-normal	Stratemans [34]
TB mortality (no HIV), treated	0.121	0.094	0.153	Beta	MOH [35]
HR of death due to TB, not treated	3.803	2.062	5.933	Log-normal	Unpublished report
Risk of TB recurrence	0.056	0.036	0.076	Beta	Romanowski [36]
TB cure rate, treated	0.480	0.360	0.600	Beta	DGC [37]
HR of TB cure, not treated	0.121	0.043	0.197	Beta	Legrand [38]
Death rate due to drug dependence (fatal overdose)	0.014	0.011	0.017	Beta	Mathers [39]
Relapse to drug use	0.400	0.250	0.550	Beta	Vanderplasschen [40]
Disability weight[a]					Salomon [41]
HIV, asymptomatic	0.078	0.052	0.111	Beta	
HIV, symptomatic with TB	0.408	0.274	0.549	Beta	
AIDS	0.582	0.406	0.743	Beta	
Active TB, no HIV infection	0.333	0.224	0.454	Beta	
Mild drug dependence[b]	0.079	0.051	0.114	Beta	
Moderate to severe dependence[b]	0.486	0.329	0.637	Beta	

AIDS = Acquired immune deficiency syndrome; ART = Antiretroviral treatment; DGC = Directorate General of Corrections; HIV = Human immunodeficiency virus; HR = Hazard ratio; MOH = Ministry of Health; PWI = Persons who are incarcerated; TB = Tuberculosis; WHO = World Health Organization; USAID = United States Agency for International Development.

[a] Disability weights from comorbid conditions assumed to have multiplicative effects and calculated by $1 - (1 - dw_1) \times (1 - dw_2)$ where dw_1 and dw_2

Selected parameter	Mean	Min	Max	Distribution	Source

respectively are the disability weight for one and another disease [24].

[b] Value corresponds to dependence on amphetamine-type stimulants, a class of drugs widely abused in Indonesia [42].

4. Results

4.1. Estimated population distribution

The BIA model projected a total of 39,217 PWI living with HIV (22%), infected by TB (26%), and/or having DD (52%) at the beginning of 2020, the first year of the budget period (**Table 4**). During the budget period, an estimated 2,721 PWI with at least one disease entered into the penitentiary system annually, with the same distribution of disease areas. The size of non-diseased PWI in whom the risk of having these diseases was absent was estimated to be 238,918 individuals at the beginning of 2020 with a subsequent annual entry rate of 16,577 PWI.

4.2. Screening and diagnosis costs

The annual mean cost of mass health screening programme in the diseased group was estimated to be IDR 1.49 billion. DD screening has the highest cost (IDR 541 million) although in proportion (36%) this amount is not too far different from HIV (34%) and TB screening (30%) (**Table 4**). The cost is fifteen-fold higher (IDR 22.3 billion) in the non-diseased group owing to their sheer size. Again, DD screening records the highest cost (IDR 8.70 billion) with a slightly larger proportion than observed in the diseased group (39%). HIV and TB screening claims a 32% and 29%, respectively, in the non-diseased group. The average screening cost was estimated to be IDR 454,000 per person-year for all three diseases combined.

4.3. Treatment costs

4.3.1. Current strategy

The current level of programme coverage reduced DALYs by 11,149 units per annum, on average, at a total annual cost of IDR 49.62 billion, inclusive of all programme components (**Table 4**). A lion share of health effects was attributed to the reduction of mortality and morbidity due to HIV and TB. DDR had only a meagre contribution to the DALY reduction (16 units) because of its nearly zero coverage in the current strategy. At an annual cost of IDR 47.62 billion, the share of HIV treatment cost was 96% of the total for the three diseases, incorporating all programme components. Limiting to major programme components, the mean cost was reduced by about 15% to IDR 42.65 billion. Drugs, valued overall at approximately IDR 36.60 billion, constituted about 71% of the total annual resource needs. The cost for HIV programmes had a very wide range of confidence interval that is about 10 times the lower limit, impacting on the precision of the estimates.

4.3.2. Gradual strategy

This strategy resulted in an annual reduction of 31,968 DALYs of which TB treatment contributed a 68% reduction in mortality and morbidity (**Table 4**). A shift to this strategy

Table 4. Population parameters and annual cost outputs (2018 IDR)

Parameter / strategy	Disease area			Total
	HIV	Tuberculosis	Drug dependence	
Population				
N PWI in 2020	8,622 (22%)	10,013 (26%)	20,582 (52%)	39,217
N annual entry with disease	598 (22%)	695 (26%)	1,428 (52%)	2,721
Screening and diagnosis[a]				
Total cost ('000)				
In diseased PWI	492,317	452,752	540,744	1,485,814
	(298,560 - 849,914)	(274,588 - 731,192)	(296,341 - 934,013)	(938,014 - 2,347,464)
In non-diseased PWI[b]	7,091,751	6,527,192	8,700,406	22,319,349
	(5,098,414 - 9,748,453)	(4,692,873 - 8,821,169)	(6,376,632 - 10,928,489)	(18,466,263 - 26,172,435)
Avg. screening cost	165	130	159	454
	(100 - 284)	(79 - 210)	(87 - 274)	(307 - 601)
Treatment				
Current strategy				
DALY reduction	5,965	5,184	16	11,149
	(708 - 27,328)	(2,601 - 10,973)	(3 - 50)	(4,518 - 28,847)
Total cost ('000)	47,619,990	1,914,365	83,904	49,618,259

Parameter / strategy	Disease area			Total
	HIV	Tuberculosis	Drug dependence	
	(13,945,623 - 144,201,728)	(1,042,483 - 3,880,972)	(48,468 - 144,259)	(15,618,521 - 146,946,944)
Total cost, major compo-	41,063,702	1,569,606	20,392	42,653,700
nents ('000)[c]	(12,042,646 - 124,310,624)	(851,497 - 3,123,004)	(11,564 - 34,618)	(13,257,678 - 127,964,768)
Total cost, drugs ('000)	34,437,448	625,806	2,027	33,065,281
	(10,151,279 - 101,786,904)	(340,788 - 1,268,689)	(1,141 - 3,557)	(10,667,278 - 102,953,704)
Gradual coverage				
DALY reduction	8,572	21,650	1,745	31,968
	(974 - 42,838)	(11,091 - 46,543)	(771 - 3,125)	(17,611 - 67,056)
Total cost ('000)	50,870,902	3,104,059	2,339,582	56,314,547
	(14,233,726 - 149,807,072)	(1,656,912 - 6,193,154)	(1,405,171 - 3,895,670)	(19,276,832 - 157,292,240)
Total cost, major compo-	43,867,446	2,447,481	471,753	46,787,040
nents ('000)[c]	(12,263,615 - 131,386,440)	(1,301,113 - 4,931,578)	(282,759 - 774,328)	(14,991,254 - 135,731,760)
Total cost, drugs ('000)	35,540,162	1,015,207	42,415	36,597,604
	(10,457,989 - 104,929,696)	(541,810 - 2,025,161)	(24,888 - 69,847)	(11,417,360 - 106,717,120)
Optimal coverage				
DALY reduction	12,295	29,669	2,658	44,623

Parameter / strategy	Disease area			Total
	HIV	Tuberculosis	Drug dependence	
	(3,174 - 41,094)	(15,115 - 61,910)	(270 - 5,588)	(24,318 - 84,320)
Total cost ('000)	83,541,897	13,368,055	32,639,500	129,549,452
	(24,003,224 - 254,117,408)	(7,047,342 - 28,883,846)	(19,348,462 - 51,964,524)	(67,277,304 - 310,526,048)
Total cost, major compo-	71,992,940	10,284,865	6,615,291	88,893,096
nents ('000)[c]	(20,905,424 - 218,347,616)	(5,403,485 - 22,724,726)	(3,914,598 - 10,508,141)	(36,871,632 - 244,809,904)
Total cost, drugs ('000)	60,272,500	4,367,343	745,192	65,385,053
	(17,891,382 - 179,148,560)	(2,302,367 - 9,436,353)	(416,730 - 1,253,047)	(22,500,028 - 188,604,832)
Avg. treatment cost ('000)	8,203	1,130	1,177	10,510
	(7,525 - 8,937)	(887 - 1,489)	(883 - 1,577)	(9,666 - 11,399)
Avg. treatment cost, major	7,072	877	236	8,185
components ('000)[c]	(6,465 - 7,739)	(676 - 1,200)	(183 - 316)	(7,507 - 8,889)
Avg. treatment cost, drugs	5,863	370	30	6,263
('000)	(5,245 - 6,465)	(290 - 487)	(22 - 42)	(5,661 - 6,889)

Avg. = Average; DALY = Disability-adjusted life years; HIV = Human immunodeficiency virus; PWI = People who are incarcerated.

Figures in bracket correspond to bias-corrected 95% confidence interval.

[a] = Mass screening strategy assumed, enforced on every new adult entrant into the penitentiary system (N = 16,577 per annum).

[b] = Those who have no HIV infection at entry, no risk of tuberculosis, nor history of drug dependence.

[c] = Excluding personnel, training and supervision, and land and building.

from current coverage would add an extra IDR 3.25 billion to a total of IDR 50.87 billion, IDR 1.19 billion to a total of IDR 3.10 billion, and IDR 2.26 billion to a total of IDR 2.34 billion for HIV and TB, and DDR treatment, respectively. Major components overall retained an 83% share of the total cost for all treatment programmes combined, but only 20% of the total DDR cost due to its large share of personnel (76%). About 65% of the total cost of this strategy would be attributed to drug outlays.

4.3.3. Optimal strategy

A maintenance of 90% treatment coverage for all programmes reduced 44,623 DALYs annually. Similar to the gradual strategy, the largest reduction was attributed to the TB treatment with nearly 30,000 units in DALY reduction (**Table 4**). The total annual cost for all treatment programmes exceeded IDR 100 billion (IDR 129.55 billion). The increase in cost relative to the current strategy was 75%, seven times, and 389 times as much for HIV, TB, and DDR, respectively. The cost of major components was IDR 71.99 billion (82%) for HIV, IDR 10.28 billion (77%) for TB, and IDR 6.62 billion (20%) for DDR. The share of drugs as a proportion of total cost was about 50% overall.

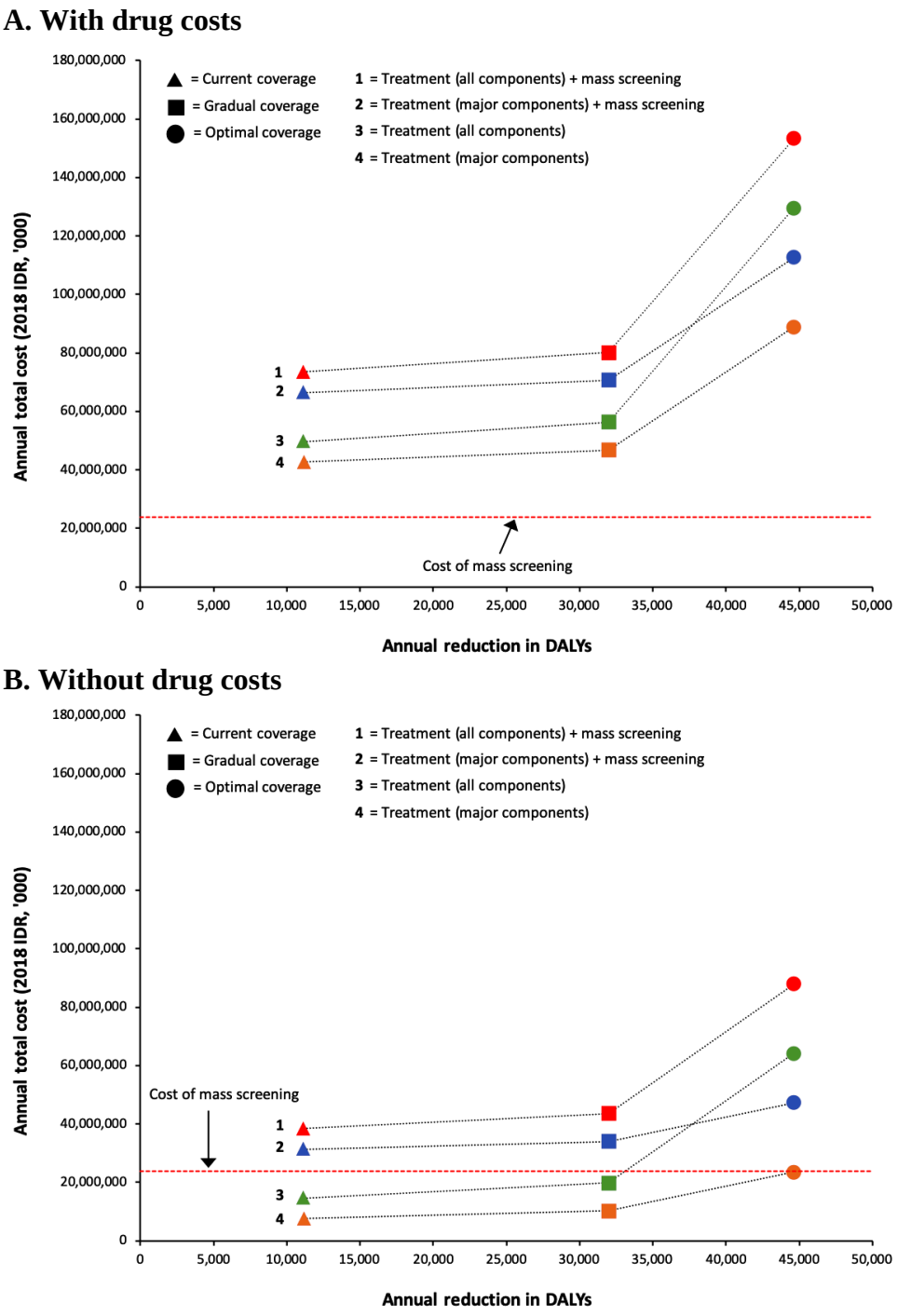
4.3.4. Average treatment costs

The average treatment cost for all treatment programmes was estimated at IDR 10.96 million annually (**Table 4**). Of this amount HIV treatment had the largest share (78%) at IDR 8.20 million per annum. The average costs for TB and DDT treatments were IDR 1.13 million and IDR 1.18 million, respectively. The reason for these discrepant cost estimates is that the treatment costs for TB and DDR were averaged over both PWI who had the disease and those who were cured but remained at risk of reinfection/relapse in the remaining budget period. This notion of average cost is essentially different from chronic HIV treatment where being cured is impossible, and drug costs were always incurred for all PWI. Major components cost IDR 8.19 million for HIV (86% of HIV total), IDR 877,000 for TB (78% of TB total), and IDR 236,000 for DDR (20% of DDR total).

4.3.5. Expansion path

Figure 3 plots the total cost estimates in the expansion path with and without the drug costs (panels **A** and **B**, respectively). It can be seen that shifting from the current strategy to gradual improvements to attain the optimal treatment coverage by the end of the budget period would impact the budget more affordably, going from IDR 49.60 billion to IDR 56.31 annually (a difference of about IDR 7 billion per annum). Shifting from current coverage to the optimal strategy demands a significantly larger extra investment of IDR 79.93 billion, or more than ten-fold the investment when shifting to the gradual strategy. The net health effects from adopting the gradual strategy were the largest (a mean difference of 20,819 units in DALY reduction relative to the current strategy) and diminished when shifting from the gradual strategy upward to the optimal strategy (a mean difference of 12,655 units in DALY reduction). Adding the cost of

Figure 3. Expansion path of strategies



Mean annual total costs and reduction in disability-adjusted life years are plotted based on the three strategies assessed. Departure from the current strategy, shown as the triangle symbol, results in a larger DALY reduction at an increasing cost. The red dotted line is the annual cost of mass screening for HIV, tuberculosis, and drug dependence valued at over IDR 24 billion. The two lines in the upper section denoted by **1** and **2** shows the total cost inclusive of mass screening. Costs are presented either comprising all programme components or only major components (excluding personnel, training and supervision, and land and building).

mass screening, fixed at IDR 23.81 billion, will shift all the curves in an upward direction proportionally by this amount.

5. Discussion

5.1. Study implications

An annual total cost of approximately IDR 56 billion and IDR 130 billion was estimated respectively for the gradual strategy targeting full programme coverage by the end of the budget year and for the optimal strategy providing full programme coverage over the entire 2020-2024 budget period. The gradual strategy represents a 13% increase of the annual budget relative to the current (enhanced) strategy for a nearly three-fold reduction in DALYs, whereas the optimal strategy costs more than two-fold with four times as much reduction of DALYs in absolute terms. Major programme components constitute more than 80% of the total cost, except for DDR where a bulk of unit cost falls on personnel (>70%). Blanket screening and diagnosis adds a further IDR24 billion to either competing strategy, which claims a considerable portion of the total programme cost when enforced.

The gradual strategy presents a trajected growth in programming for a fraction of additional costs relative to the current strategy. When targeting an expansion, the gradual strategy may seem an attractive option. This relatively small increase in cost was driven by the annual growth in coverage for HIV programmes, having the highest treatment cost of all three disease areas, due to the short gap to full coverage from the current situation (an estimated 51% coverage). This may seem an attractive policy option when targeting an expansion under a strict health maximization objective during the budget period. An equitable reduction in disabilities and premature deaths due to TB and DD can only be achieved beyond the budget period when programme coverage across all three disease areas benchmark uniformly to the optimal level beginning in 2024. In the policy context where considerations of access equity prominently permeate the decision-making process in budget allocation, catch-up investments should be prioritized for TB and DDR programmes to match the HIV programme coverage. By contrast, this trade-off between health maximization and access equity is not present in the optimal strategy, and the most pressing issue in this case is one of budget affordability.

Mass screening upon entry ensures a smooth linkage to treatment for PWI diagnosed with a disease. It should be noted, however, that the modelling results suggest a high marginal cost per diagnosed PWI as nearly all new entrants (~90%) into the penitentiary system are expected to have none of these diseases. Field studies on unit costing demonstrates a possible non-inferiority of targeted screening in prisons with high disease burden such as narcotic prisons [43]. An efficiency of a blanket screening strategy will very much depend on the disease prevalence. An efficiency argument would favor rationing mass screening and innovations in targeted screening in low-

burden prisons to reduce the share of dedicated investment in disease screening and to possibly divert a portion to expand treatment programmes. What remains unclear is the relative cost effectiveness of different screening strategies, combining both blanket and targeted screening for different PWI characteristics or prison types, in this population who have little to no engagement with the mainstream health care system. A concurrent study finds that about half of the cohort of PWI diagnosed with HIV had their first HIV test in the penitentiary setting [44]. Balancing the potential opportunity loss from missed diagnoses and the cost of targeted screening is a contested policy area of prison health [45].

The estimated average costs of treatment should be interpreted with the following caution. These costs cover all PWI at risk of TB reinfection and relapse to drug use after undergoing successful treatment into the healthy state. In effect, this inflates the size of the denominator and produces seemingly small estimates in relation to the description of unit costs reported in **Table 2** as not only those both with a disease and receiving treatment were included in the calculation of these average costs. The exception here is HIV where once infected and diagnosed, the person is always diseased, varies by its severity, and cannot revert to the healthy state indicating the absence of the disease. The reported average costs for TB treatment and DDR are therefore applicable to all at-risk individuals, with the risk being defined by past or current exposure to the disease. Thus, these average costs should be assigned to PWI with a history or TB or DD in addition to those who are suspects upon health screening at entry when budgeting annual resource needs. Although the use of unit costs over the total number of diseased PWI will broadly approximate the estimate from the average costs over at-risk PWI, the results will be overestimated by unaccounted cost variations due to death and heterogeneous treatment behaviors among PWIs which were built into the model as the value range of parameters.

The question of what strategy to choose when targeting change from the current strategy is a delicate policy question given the cost findings. An extra investment at a relatively small size would enable policy makers to afford the gradual strategy with the greatest health effects. Once adopting this strategy, a subsequent shift to the optimal strategy would require an ambitious extra investment in the amount that might not be substantially different from a direct shift from the current strategy. If affordability is a key issue, as any rational decision maker would base their budget allocation decision on, adoption of the gradual strategy should be complemented with cost-effective innovations in service delivery to reduce the additional cost of improving coverage in the next budget period.

5.2. Study limitations

There are several shortcomings of this study. First, a gross costing approach was employed in the calculation of programme unit costs in which resource utilization rates

were apportioned by indirect estimates of productive time (e.g. for personnel) and quantities (e.g. equipment, supplies, medications) during data collection. Actual resource utilization data are not subject to routine monitoring system for many resource items in the study setting and neither did the research project have the capacity to collect fresh data for this purpose under the current modality. In many instances, gross costing represents a compromise between practicality and accuracy that is widely acknowledged and should be pursued when urgency calls for economic decision making [46]. Second, the cost data were calibrated to other studies in similar settings to help ensure that an adequate list of essential goods and services that make up a resource item were captured. Although this effort was instrumental to fill the data gaps that manifested during primary data collection and in administrative data, variations across study settings may limit the accuracy of the cost and effectiveness estimates.

Third, the cost estimates were based on the findings from two prison sites in Jakarta, which may limit the generalizability of the study results at the national level despite attempts to introduce site-level variability by incorporating plausible value ranges either assumed, estimated, or extracted from the reference studies. These sites also had no female PWI, and differences in health outcomes and programme costs by gender were not captured in this study. Fourth, all analyses were limited to first-line treatments where in fact emergence of drug-resistant infections requiring more advanced and expensive medications has become a major threat to Indonesia's public health [35]. Lastly, some cost estimates, notably for HIV treatment, lost precision with very wide confidence intervals due to high uncertainty in some basic health indicators such as disease prevalence which were integral to the model inputs. This may suggest a lack of engagement with prison health within the public health surveillance system in Indonesia. Prison health provides a key opportunity to improve the health of many hard-to-reach individuals who shun the mainstream public health care for many reasons, and this merit should be supported with adequate health monitoring system and greater evidence base.

5.3. Direction of future research

The report highlights some areas of improvement for future reference. The first of these is around the data monitoring system within DGC. Collection of routine health indicators in consistent quality by pre-specified definitions across the prison units will be the first major step towards improvement in this regard. This way direct and context-specific evidence will be available and dramatically reduce the risk of inaccuracy from adopting external data for modelling purposes. Capacity development for monitoring and research will be a key important activity to support in the future. Another theme worth exploring is around the evaluation of the efficiency of screening strategies as the expectation of enforcing a blanket approach exacts a large sum of resources with considerable opportunity costs to treatment programmes if both programme areas compete from the same budget allocation.

With uncertainties surrounding the continuation of international health assistance, the State and Regional Budgets should play a greater role in prison health funding, which will heighten the competition for resources among the disease and programme areas. Priority setting will then be paramount for which the ranking of disease burden and DALYs for all areas of prison health will initiate the process. These are all the priority research agenda for prison health economics in the short term.

6. Conclusion

This report informs the budgetary needs for prison health in HIV, TB, and DDR. Evidence-informed budgeting is an important step to advocate for the resource needs commensurate with the size of the disease burden. Achieving the universal coverage for these three diseases in the penitentiary setting requires substantial resource commitments far above the meagre allocation that is presently in force. The next step in the process is funding. For DGC the options for prison health funding are the status quo, in which prison health largely falls under the public health system but with administrative barriers in access to social health insurance for PWIs, or negotiating a clear autonomy in prison health that eventually diverts a portion of public health funding to DGC for independent provision of essential health services for PWIs such as the three disease areas under analysis or more. The resulting budget estimates from the health sector perspective can account for the second option although the question of whether this option represent the best modality of delivering prison health is beyond the remit of this report. Prison health is often a neglected area in the larger public health system, and this report provides the evidentiary basis on the size of the resource needs as the first step to inform future debate on the funding mechanism.

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