By Eran Bendavid, Andrew Duong, Charlotte Sagan, and Gillian Raikes

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Health Aid Is Allocated Efficiently, But Not Optimally: Insights From A Review Of Cost-Effectiveness Studies

Eran Bendavid (ebd@stanford.edu) is an assistant professor in the Department of Medicine at Stanford University, in California.

Andrew Duong is a research assistant in the Program of Human Biology at Stanford University.

Charlotte Sagan is a research assistant in the School of Medicine at Stanford University.

Gillian Raikes is a research assistant in the Program of Human Biology at Stanford University.

ABSTRACT Development assistance from high-income countries to the health sectors of low- and middle-income countries (health aid) is an important source of funding for health in low- and middle-income countries. However, the relationship between health aid and the expected health improvements from those expenditures—the cost-effectiveness of targeted interventions—remains unknown. We reviewed the literature for cost-effectiveness of interventions targeting five disease categories: HIV; malaria; tuberculosis; noncommunicable diseases; and maternal, newborn, and child health. We measured the alignment between health aid and cost-effectiveness, and we examined the possibility of better alignment by simulating health aid reallocation. The relationship between health aid and incremental cost-effectiveness ratios is negative and significant: More health aid is going to disease categories with more cost-effective interventions. Changing the allocation of health aid earmarked funding could lead to greater health gains even without expanding overall disbursements. The greatest improvements in the alignment would be achieved by reallocating some aid from HIV or maternal, newborn, and child health to malaria or TB. We conclude that health aid is generally aligned with cost-effectiveness considerations, but in some countries this alignment could be improved.

Development assistance from high-income countries to the health sectors of low- and middle-income countries (health aid) is an important source of funding for health in recipient countries. In 2010 health aid made up nearly 40 percent of public health spending in countries with a per capita gross domestic product of less than $2,000.[1,2] Most of the increases in the amounts of health aid since 2000 have gone toward disease-specific programs.[3] This earmarking of funds for disease programs has led to questions about the principles guiding the allocation of health aid.[4]

How do donors decide on health aid allocation to different priorities? Several factors are relevant to such decisions. One factor is that aid, coming mostly from national treasuries in donor countries, may be allocated to follow donor priorities, even if those priorities are not aligned with recipient priorities.[5] Some donors may apply more health-centered approaches to allocation so that health aid complements domestic public health spending or focuses on diseases that are prevalent among the most disenfranchised in recipient countries.[6]

The burden of disease in recipient countries is also an important factor when donors consider the allocation of aid. However, previous analyses suggest that health aid and disease burden are poorly aligned.[1,7,8] This is particularly true for the comparison between donor funding for HIV and

for noncommunicable diseases such as heart disease and cancer: On a global level, donor funding for HIV and noncommunicable diseases has been inversely related to their relative disease burden.[9]

The cost-effectiveness of the available interventions to address different diseases is also a relevant factor to donors who aim to maximize the health benefits that could be expected to result from investments in specific health priorities.[10] The purpose of this analysis is to present evidence on the relationship between health aid allocation and cost-effectiveness considerations.

Allocating aid based on the cost-effectiveness of available interventions may imply a different allocation pattern than would an approach based on disease burden. For example, the health benefits from investing a fixed amount in an inexpensive intervention for a relatively low-burden disease, such as treating intestinal parasites, may provide greater health benefits than a costly intervention for a high-burden disease, such as thrombolytic treatment in acute ischemic stroke.[11,12] In theory, if all interventions could be ranked by relative cost-effectiveness, funders with a fixed budget could maximize health gains by prioritizing interventions with lower (more favorable) cost-effectiveness ratios.[13,14] We examined the extent to which health aid disbursements were aligned with the cost-effectiveness of financed interventions.

Development assistance to the health sector has flattened since 2010, increasing the importance of considering value when investing limited resources.[15] The extent to which funders allocate health aid to priorities with relatively higher health returns from each dollar remains unknown. We make no attempt to indicate how health aid should be allocated; instead, by exploring the relationship between the actual allocation of health aid and its potential to efficiently improve health, we add a new dimension to the understanding of how it is currently allocated.

Study Data And Methods

OVERVIEW We conducted a comprehensive analysis of the relationship between the amount of health aid from donors and the cost-effectiveness of interventions for the disease priorities financed by this aid. We proceeded in three stages. In the first stage we conducted a systematic search for cost-effectiveness studies of interventions addressing the top causes of disease burden in twenty aid-recipient countries. We then matched those cost-effectiveness estimates with the amount of category-specific health aid provided to each country between 2001 and 2012. Finally, we analyzed the alignment between category-specific, country-specific health aid and the cost-effectiveness of related interventions. Below we describe each stage in greater detail.

COUNTRY SELECTION We selected the twenty countries that received the greatest total amount of aid between 2008 and 2011 (in 2011 US dollars), a period of historically unprecedented growth in health aid (see the online Appendix).[16] We used the Institute for Health Metrics and Evaluation's Development Assistance for Health database to identify these countries. This data set is based on the Organization for Economic Cooperation and Development's Creditor Reporting System, a project-level database of all foreign assistance from donor countries. Health-related aid from the Creditor Reporting System is supplemented with aid provided through private donors such as nongovernmental organizations and foundations.[17] The Development Assistance for Health database tracks health aid earmarks most closely in five disease categories: HIV; malaria; TB; noncommunicable diseases; and maternal, newborn, and child health (MNCH).

COST-EFFECTIVENESS ESTIMATES We searched for country-specific cost-effectiveness of interventions addressing high-burden diseases. We used the 2010 Global Burden of Disease study to identify the top fifteen causes of disease burden in the study countries, measured in total disability-adjusted life-years (DALYs) lost.[18] We used disease burden in identifying our search terms since cost-effectiveness studies are typically disease specific, and burden is often used to imply the potential for health improvements in studies of health aid allocation.[7,8] We then used the following approach to search for studies that estimated the cost-effectiveness of interventions addressing these diseases in the study countries. We searched for all studies that included the terms "cost-effectiveness" or "cost effectiveness" together with any of the country names and any of the diseases in the title or body of the article, using PubMed and Google Scholar. In addition, we searched the Disease Control Priorities in Developing Countries project.[19] Finally, we searched for articles containing "cost-effectiveness" on the websites of country-specific medical journals, since those are imperfectly catalogued in PubMed. We included all studies that estimated at least one incremental cost-effectiveness ratio (ICER) of an intervention addressing the disease. We only included studies with ICERs measured in costs per DALY averted, life-year gained, or quality-adjusted life-year (QALY) gained. We excluded estimates of costs per infection averted or other noncomparable health outcomes. We also excluded studies that reported

only average cost-effectiveness ratios (as opposed to incremental).[20] The ICER is the principal metric of cost-effectiveness studies. It is calculated as the ratio of the change in costs to incremental health benefits of an intervention relative to a comparator. The use of life-years, QALYs, or DALYs allows for comparisons across diseases and interventions. A lower ICER implies that an intervention can yield greater health improvements from each dollar compared with an intervention with a higher ICER.

To match the cost-effectiveness estimates with health aid, we categorized each cost-effectiveness estimate as addressing priorities in one of the five disease categories that could be identified in the Development Assistance for Health database: HIV; malaria; TB; noncommunicable diseases; and maternal, newborn, and child health. Interventions addressing cardiovascular disease, stroke, pulmonary disease, or diabetes were grouped as noncommunicable diseases, while interventions addressing neonatal, child, and maternal health were grouped as MNCH.

We extracted the cost-effectiveness of 551 interventions in the twenty study countries. The estimates were obtained from articles published between 1993 and 2013, with 93 percent of the studies published after 2000. Additional details on the data extraction are in the online Appendix (Section 2).[16]

HEALTH AID IDENTIFICATION The Development Assistance for Health database was used to identify health aid disbursements for the five disease categories between 2001 and 2011.[21] We removed fund flows between channels that were listed twice in the database, and we used the estimated disbursements in 2011 US dollars that could be allocable to specific countries and specific disease categories. This resulted in US$41.5 billion of health aid to the twenty study countries and the five disease categories between 2001 and 2011.

ANALYSES The goal of the analyses was to provide a quantitative answer to the following question: Are health aid disbursements correlated favorably (aligned), correlated unfavorably (misaligned), or unrelated to the cost-effectiveness of interventions addressing the disease categories that they target? We regressed country-specific, category-specific ICER estimates on health aid disbursements targeting the related disease categories. Detailed specifications of the econometric models are in the Appendix (Section 2).[16] In our models, a negative relationship suggests that health aid is aligned with high-value (low-ICER) interventions.

We also performed analyses to examine the implications of health aid reallocation. A common concern is that disease-specific, "vertical" health aid (such as aid specifically for HIV) may lead to inefficient use of health aid resources.[4] We simulated reallocation of health aid from HIV and examined the alignment of the reallocated health aid portfolio and cost-effectiveness. We reduced each country's HIV aid by 1 percent up to 95 percent and reallocated that entire amount to each of the other disease categories in turn. We then compared the alignment at each level of reallocation to the original alignment. We performed the same analysis with the second-greatest disease category in terms of health aid dollars, MNCH (Appendix Section 8).[16]

The current allocation of health aid is generally aligned with the cost-effectiveness of targeted interventions.

We conducted sensitivity analyses to test the stability of our findings. First, to test the influence of any single country on the overall findings, we show the alignment from models where each country, in turn, is left out of the sample. Second, we tested the influence of outlier ICER estimates by removing one, six, eleven, sixteen, and twenty-one of the highest and lowest ICERs and rerunning the primary specifications. Finally, to test for the role of heterogeneity in ICER estimates within disease categories, we repeated the analysis with only the lowest (most attractive) country-specific, category-specific ICER estimates. These findings are included in the Appendix (Sections 4 and 5).[16] All analyses used Stata 13, and the analytic code and data are available from the authors.

LIMITATIONS The study had several limitations. Its literature review was influenced by published cost-effectiveness estimates. If the literature favored the publication of cost-effectiveness studies for highly funded diseases such as HIV and also favored studies with attractive cost-effectiveness ratios, then attractive cost-effectiveness ratios may be more common for more highly funded disease categories.[22,23] It is also possible that the cost-effectiveness of interventions has changed over time, although the direction of these changes is unclear. We also recognize that our data set contains measurement errors as a

EXHIBIT 1

Descriptive Statistics Of The Cost-Effectiveness And Health Aid Estimates In Twenty Study Countries

Category	*N* (number of ICER estimates)	Mean ICER	Median ICER	Interquartile range	Amount of health aid earmarked (in millions of current[a] US dollars)
Noncommunicable diseases	79	875.5	187.4	(35.4–739.6)	$ 537.5
TB	31	75.4	8.2	(2.3–21.0)	2,552.0
Malaria	69	46.4	9.7	(1.9–37.0)	4,006.6
Maternal, newborn, and child health	184	402.8	67.7	(19.0–240.0)	16,092.0
HIV	188	260.3	48.9	(9.2–206.5)	24,355.6

SOURCE Authors' analysis. **NOTES** Health aid estimates are for the entire period in the Development Assistance for Health data set, from 1990 to 2011. Incremental cost-effectiveness ratio (ICER) data are extracted from articles published between 1993 and 2013. [a]Current refers to the year of the disbursement. So if a grant was given in 2011, it is counted in 2011 dollars.

result of inconsistencies in the underlying study designs and the use of three different ICER units. Our statistical analysis was designed for and limited to providing a descriptive association of the relationship between health aid and cost-effectiveness, not to imply any causal or normative relationship.

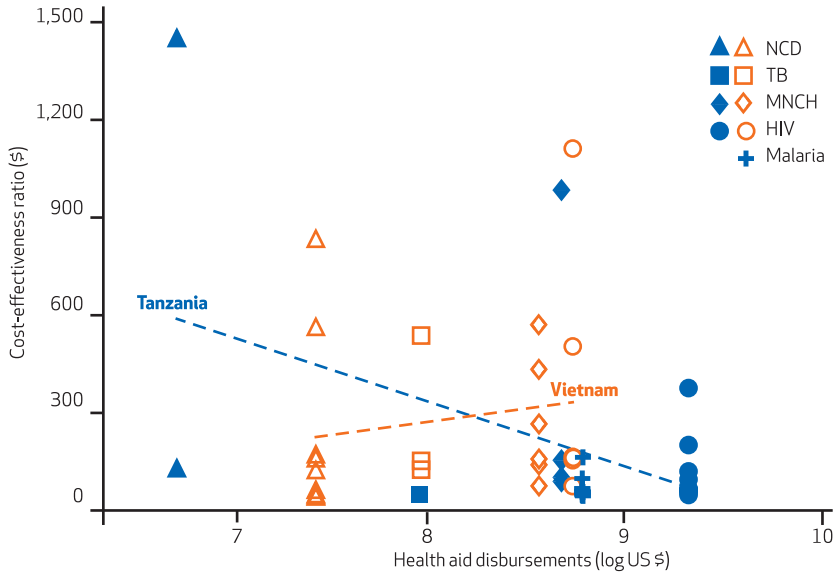
Study Results

The twenty study countries received US$58.0 billion out of the total US$103.2 billion in recorded country-specific health aid disbursements to 170 countries between 2001 and 2011 (56.2 percent). Exhibit 1 describes the overall disease categories, including the total amount of health aid earmarked for each category, and the distribution of cost-effectiveness ratios for interventions in each category. Over the period 2001–11, a greater amount of disbursements flowed to HIV programs than any other disease category. On average, interventions addressing malaria had the lowest ICERs, which indicates that malaria interventions could yield greater health improvements from each dollar compared with interventions having a higher ICER. Interventions addressing noncommunicable diseases had the highest ICERs, which indicates that interventions could yield less improvement from each dollar compared with interventions with a lower ICER.

Exhibit 2 contains illustrative relationships—one aligned and one misaligned—in two study countries: Tanzania and Vietnam, respectively. The exhibit shows that an aligned relationship such as in Tanzania has more interventions with low ICERs that receive a greater amount of aid, while in the misaligned example of Vietnam, the ICERs are relatively high in the categories that receive the greater amount of aid. Panels for all twenty study countries are shown in the Appendix (Section 7).[16] The relationship is negative (aligned) in fifteen countries and positive (misaligned) in five (Afghanistan, Botswana, India, Indonesia, and Vietnam), four of which are outside sub-Saharan Africa. The Appendix figure panels also show the wide variation in the distribution of cost-effectiveness estimates: Highly cost-effective interventions are available for disease categories that receive little health aid, and relatively cost-ineffective interventions are available for disease categories that receive high amounts of aid. Some interventions are frequently misaligned. For example, aspirin and beta-blockers have generally very attractive

EXHIBIT 2

Country-Specific Relationship Of Health Aid And Cost-Effectiveness Of Interventions



SOURCE Authors' analysis. **NOTES** The figure shows the relationship between health aid and the cost-effectiveness of interventions for disease categories supported by aid in Tanzania, where the relationship is downward sloping, with more money flowing to more cost-effective interventions, and in Vietnam, where the relationship is upward sloping, with more money flowing to less cost-effective interventions. Health aid estimates are for the entire period in the Development Assistance for Health data set, from 1990 to 2011. Incremental cost-effectiveness ratio data are extracted from articles published between 1993 and 2013. NCD is noncommunicable diseases. MNCH is maternal, newborn, and child health.

EXHIBIT 3

Results On The Alignment Of Health Aid And Cost-Effectiveness, Overall And After Removing One Country At A Time

	Change in ICER with each:		
	$1 billion more health aid	1% higher health aid[a]	Observations (*N*)
Overall (without country fixed effects)	–$105.7**	–$76.7***	551
Overall (with country fixed effects)	–163.4**	–92.7***	551
Overall alignment after excluding:[b]			
Afghanistan	–167.2**	–103.7***	518
Bangladesh	–177.5*	–101.8***	511
Botswana	–146.7*	–95.7***	534
China	–157.6*	–91.8***	520
Democratic Republic of the Congo	–162.6*	–94.7***	527
Ethiopia	–169.7*	–94.0***	526
Ghana	–157.8*	–80.3***	523
India	–228.3**	–94.6***	515
Indonesia	–167.5**	–96.6***	528
Kenya	–172.6*	–93.5***	526
Malawi	–163.7*	–94.1***	524
Mozambique	–165.1*	–93.8***	526
Nigeria	–160.9*	–84.1***	524
Pakistan	–167.2*	–96.2***	513
Rwanda	–163.7*	–92.9***	526
South Africa	–143.5*	–80.3***	533
Tanzania	–112.4**	–89.1***	522
Uganda	–170.7*	–94.7***	525
Vietnam	–164.7**	–96.2***	527
Zambia	–161.2**	–85.8***	521

SOURCE Authors' analysis. **NOTES** Data are from ordinary least squares models of the relationship between incremental cost-effectiveness ratios (ICERs) (the outcome) and health aid for the targeted disease categories (the main predictor). Standard errors are clustered at the country level. In addition to the overall association, we show a sensitivity analysis after excluding one country at a time. Health aid estimates are for the entire period in the Development Assistance for Health data set, from 1990 to 2011. The ICER data are extracted from articles published between 1993 and 2013. MNCH is maternal, newborn, and child health. NCD is noncommunicable diseases. TB is tuberculosis. [a]We used log-transformed health aid disbursement data. The coefficient on the log-transformed health aid variable can be interpreted as the change in the outcome (ICER) with a 1 percent change in the main predictor (health aid). [b]All leave-one-country-out regressions used country fixed effects and robust standard errors. *$p < 0.10$ **$p < 0.05$; ***$p < 0.01$

ICERs, but their disease category (noncommunicable diseases) is commonly underfunded. On the other hand, antiretroviral therapy has relatively high ICERs, although HIV is commonly the most highly funded disease category.

Overall, our regression analysis suggests that the association between health aid and the cost-effectiveness of interventions in the study countries is negative (Exhibit 3). That is, more money was disbursed for health categories with more cost-effective interventions. We estimate that each $1 billion greater health aid disbursement is associated with ICERs that are lower by $163.2 per QALY gained (or DALY averted or life-year gained) ($p = 0.049$). This relationship implies that, on average, additional health aid funds are prioritized to disease categories with more cost-effective interventions. The negative association is stable regardless of whether or not fixed effects are included and whether or not health aid is log-transformed. No single country drives the findings in a meaningful way, although the significance level on the relationship between the untransformed disbursements and ICERs exceeds $p = 0.05$ with fifteen country exclusions, up to $p = 0.092$ when excluding South Africa (the p value remains below 0.01 for all log-transformed relationships).

Although health aid is aligned with the cost-effectiveness of targeted interventions, on average, there may still be room for improving the alignment of aid and cost-effectiveness. We tested the implications for overall alignment with cost-effectiveness considerations of keeping the total available resources fixed and reallocating health aid from the two disease categories that receive the greatest amount of health aid—HIV and maternal, newborn, and child health—to other disease categories. We re-estimated the alignment after reallocating all of the freed-up funds to a single other health category.

Exhibit 4 shows that the alignment improves if up to 61 percent of HIV aid is reallocated for TB control and up to 80 percent is reallocated for malaria control. However, changing disbursements from HIV to noncommunicable diseases and MNCH programs generally weakens the alignment. Reallocating up to 58 percent of MNCH aid to any of the other disease categories, on the other hand, improves the alignment, with the greatest improvement resulting from reallocation to malaria control. In our data, shifting more than 58 percent of MNCH disbursements to HIV worsens overall alignment (see figure in Appendix Section 8).[16]

While the typical cost-effectiveness estimate in our review is smaller than estimates found in wealthier countries, the range of estimates in our analysis is large.[24] We tested the influence of outliers on our primary findings by repeating the primary analysis after removing the highest and lowest ICERs (Appendix Section 4).[16] The strength of the association is unchanged when using the log-transformed disbursement estimates and mildly weakened when using untransformed disbursements. While the direction of the relationship remains negative throughout, the coefficient is smaller without the extreme values. To address the issue of heterogeneity in ICER estimates within countries and categories, we repeated the primary models after keeping only the most cost-effective intervention within each country and category (Appendix Section 5).[16] This analysis suggests that even if all the ear-

marked aid is directed toward the most cost-effective intervention within each category, the overall allocation of aid is still negatively aligned.

Discussion

We present a systematic, quantitative analysis of the alignment between global health aid and cost-effectiveness of interventions for specific health priorities. Our analysis supports three principal observations. First, health aid disbursements are generally aligned with cost-effectiveness considerations, contrary to concerns that health aid priorities are misaligned.[25] Second, changing the allocation of health aid earmarked funding could possibly lead to greater health gains in some countries even without expanding overall disbursements. Third, our evidence suggests that the greatest improvements in the efficiency of global health dollars could result from reallocating funds to malaria and TB control programs.

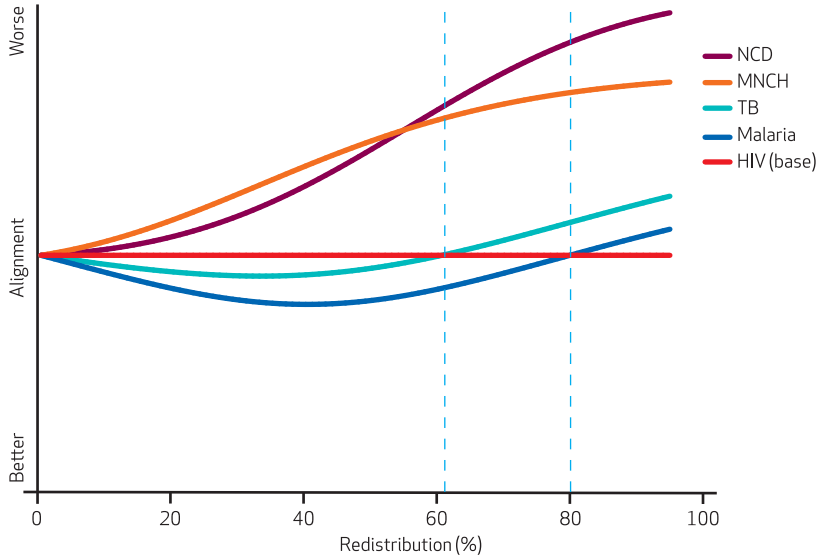
The alignment between health aid and the cost-effectiveness of interventions it aims to support may be surprising given the mismatch between aid and burden of disease, especially for HIV (high aid and low global disease burden) and noncommunicable diseases (low aid and high global disease burden). However, in our analysis, the ICERs of interventions for the control of communicable diseases are lower than those for the control of noncommunicable diseases. This has intuitive appeal that mirrors the history of health improvements in developed countries: Many interventions available for the control of infectious diseases are effective and inexpensive (for example, use of mosquito bednets to prevent the spread of malaria), while those for the control of noncommunicable disease are often challenging and relatively costly (for example, use of statins to lower cholesterol levels). In addition, investing in the control of HIV and other communicable diseases is uniquely appealing in sub-Saharan Africa, where most of the study countries are located. In other words, among health aid recipients, investments in communicable disease control may be more of a priority than investments in noncommunicable disease control, even if on the global level the burden of noncommunicable diseases may be higher than that caused by communicable disease.

That the overall relationship between health aid priorities and cost-effectiveness is not regressive may be welcome news, but we also found substantial room for improvement in the allocation of aid funding. We found that reallocating up to 61 percent of HIV aid for TB or malaria control could improve the alignment between aid and cost-effectiveness. We also found that reallocating MNCH funds improves the overall alignment of aid funding, as the ICERs for several MNCH interventions such as pneumococcal vaccination, sanitation, and household chlorination and filtration are relatively high. It is important to emphasize that the cost-effectiveness of nearly all MNCH interventions are considered good value according to standards of cost-effectiveness established by the Commission on Macroeconomics and Health, and it is their juxtaposition with other interventions that leads to their relative inefficiency.[14,26]

The unique features of this study that explain the surprising findings deserve further exploration. The twenty study countries represent mostly poor countries, with a mean gross domestic product per capita under $2,000 in 2010. The burden of infectious diseases, including HIV, tuberculosis, and malaria, remains high in these poor countries, while the coverage of relatively inexpensive interventions for their improvements (especially for malaria and tuberculosis) leaves much room for improvement. Thus, the epidemiologic profile of countries with high HIV and other communicable disease burden

EXHIBIT 4

Alignment Of Health Aid After Reallocation Of HIV Aid To Other Disease Categories



SOURCE Authors' analysis. **NOTES** The *x*-axis is the portion of the country-specific HIV aid reallocated to another disease category, and the *y*-axis is the difference between the coefficient on the regression of the alignment between health aid and cost-effectiveness after reallocation compared with the baseline (0 percent reallocation). A negative value thus denotes improved alignment (reallocated coefficient is more negative than base coefficient), and a positive value suggests worsening alignment. The vertical dashed lines indicate the level of reallocation when the alignment becomes worse than the baseline. Health aid estimates are for the entire period in the Development Assistance for Health data set, from 1990 to 2011. The incremental cost-effectiveness ratio data are extracted from articles published between 1993 and 2013. Appendix section 8 shows a similar figure for reallocation of MNCH aid (see Note 16 in text). NCD is noncommunicable diseases. MNCH is maternal, newborn, and child health.

may explain the dominance of aid for the control of communicable disease as well as the overall alignment of aid funding.

Second, we observed high variability in the ICERs within each disease category. For example, ICERs for TB ranged from $0.46 per DALY averted for community-based, directly observed treatment in Malawi to $998 per DALY averted for bacillus Calmette–Guérin vaccination in China. The analysis assumed that health aid is disbursed among the range of interventions represented in the studies, which might not be the case, as the choice of financed interventions within disease categories may be guided by cost-effectiveness considerations. However, when the analysis is repeated only with the most cost-effective intervention within each disease category and country, the findings continue to indicate an overall negative (favorable) alignment between health aid and cost-effectiveness. An additional sensitivity analysis shows that the overall pattern is only mildly influenced by outliers and heterogeneity (Appendix Sections 3 and 4).[16]

The study's focus on five disease categories leaves unanswered questions about aid for broad health system strengthening, for which specific interventions with cost-effectiveness estimates are hard to find.

Conclusion

Health aid is increasingly recognized as an important driver of health improvements in developing countries.[27,28] However, health aid has stagnated since 2010, raising awareness that cost-effectiveness considerations may be valuable in designing health aid allocation strategies. This study shows, for the first time, that the current allocation of health aid is generally aligned with the cost-effectiveness of targeted interventions. Contrary to common views that advocate for reprioritization toward noncommunicable diseases, our data suggest that the alignment could best be improved by focusing on malaria and TB, especially where addressing those diseases is highly cost-effective. ■

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