BMJ Open

Integrated disease prevention campaigns: assessing country opportunity for implementation via an index approach

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To cite: Jiwani A, Matheson A, Kahn JG, *et al*. Integrated disease prevention campaigns: assessing country opportunity for implementation via an index approach. *BMJ Open* 2014;**4**: e004308. doi:10.1136/bmjopen-2013-004308

▸ Prepublication history and additional material is available. To view please visit the journal (http://dx.doi.org/10.1136/bmjopen-2013-004308).

Received 22 October 2013
Revised 19 February 2014
Accepted 20 February 2014

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ABSTRACT

Objectives: To help stakeholders identify and prioritise countries with the best opportunities for implementation of an integrated prevention campaign (IPC) focused on diarrhoea, malaria and HIV prevention.

Design: Cross-sectional analysis of country-specific epidemiological data using an index tool developed for this purpose.

Setting: We calculated the total disability-adjusted life years (DALYs) attributed to diarrhoea, malaria and HIV for 214 World Bank economies. Criteria for inclusion were: low-income and middle-income countries, and total annual DALY burden in the top tertile (≥87 000 DALYs). 70 countries met inclusion criteria and were included in our opportunity analysis.

Outcome measures: We synthesised data on 10 indicators related to the potential reduction in burden and new coverage achievable by an IPC. We scored and ranked countries based on three summary opportunity metrics: DALYs per capita across the diseases, a composite score of tertile rankings of burden for each disease, and a score combining burden and intervention opportunity.

Results: We estimated the total annual global burden attributable to diarrhoea, malaria and HIV at 135 million DALYs. All of the countries with the highest opportunity for implementation of a diarrhoea, malaria and HIV IPC are in sub-Saharan Africa, regardless of opportunity metric used. Although the overall rank order changes, 16 countries rank among the top 23 highest opportunity countries for all three metrics.

Conclusions: Stakeholders can use this objective metric-based approach to prioritise countries for IPC scale-up. Priority countries are largely robust to the opportunity metric chosen.

Strengths and limitations of this study

- Systematic synthesis of data on disease burden and existing coverage of interventions relevant to diarrhoea, malaria and HIV prevention.
- Three alternative ways to prioritise countries for integrated prevention campaign (IPC) implementation in a visually accessible format.
- Facilitation of more objective decision-making regarding areas for IPC scale-up.
- Limitations in the availability of published data.

INTRODUCTION

The Millennium Development Goals (MDGs) provide specific targets for global improvements in access to healthcare by 2015.[1] However, despite the availability of simple, low-cost interventions for many diseases, the capacity of healthcare systems to deliver these interventions is often limited, and many countries are unlikely to meet these targets.[2 3] In response, the United Nations General Assembly passed a resolution in 2010 identifying the integration of services, the increased use of common delivery platforms, and the scaling up of proven interventions as critical strategies to accelerate progress towards the MDGs.[4]

Community-based interventions targeting multiple diseases have the potential to rapidly and equitably increase intervention uptake, often reaching greater numbers of underserved populations than interventions delivered in health facilities.[5] In 2008, an integrated prevention campaign (IPC) in Western Province, Kenya delivered insecticide-treated bed nets (ITNs), a point-of-use water filter, HIV testing, condoms and health messages to more than 80% of local adults in 7 days.[6] Participants who tested HIV-positive received on-site CD4 cell count, cotrimoxazole and referral for HIV care and treatment. The IPC was estimated to avert 16 deaths and 440 disability-adjusted life years (DALYs), and save more than US$16 000/1000 participants.[7]

Global scale-up of IPCs may represent a practical and cost-effective method to deliver

multiple health interventions to populations at highest risk. However, to ensure that available funds are well used, stakeholders must identify areas where IPC implementation can have the greatest impact. To promote more objective decision-making than traditional processes, which are often opaque and based on subjective assessment,[8] stakeholders need systematic methods to identify areas of greatest opportunity. Using the example of the Kenya diarrhoea, malaria and HIV IPC, we developed a data-driven tool to assist stakeholders in synthesising country-specific data to determine the potential impact of IPC implementation. We have focused on one proven IPC in particular to help explore the utility of this type of approach; however, this type of tool could be readily adapted and used for a multitude of other diseases and potential interventions.

METHODS

Overview

We developed three versions of an 'opportunity index' to identify countries with the greatest potential for IPC impact by adapting a previously developed method. Our goal is to provide a country-level, easy-to-read summary of the factors related to the potential success of an IPC focused on diarrhoea, malaria and HIV prevention. We collected data on relevant indicators from global databases and used a colour-coding system to represent each country's opportunity level based on each indicator. Finally, we ranked countries based on three composite measures: absolute burden across the three diseases (in DALYs per capita); burden rank across the three diseases in relation to other countries and disease burden plus 'intervention opportunity,' that is, the current lack of coverage for IPC-related interventions.

DALY burden

To quantify the overall disease burden attributed to diarrhoea, malaria and HIV, we used DALYs—a summary measure combining the number of Years of Life Lost due to premature mortality with Years of Life with Disability.[9] We calculated the total DALYs due to the three diseases for 214 World Bank-defined economies.[10] Total DALYs per disease were calculated as the product of annual cases (see online data supplement 1 for details) and the DALYs associated with each case.

Using a discount rate of 3%, we estimated the DALYs due to a case of diarrhoea and a case of malaria using the following formula:

$$\mathrm{CFR} \times \mathrm{DALY_d} + (1 - \mathrm{CFR}) \times \mathrm{DALY_m} \qquad (1)$$

where CFR is case death rate, $\mathrm{DALY_d}$ is the DALYs due to a death from the disease and $\mathrm{DALY_m}$ is DALYs due to morbidity from the disease.

We calculated country-specific case death rates for malaria and diarrhoea (see online data supplement 1), and estimated the DALYs due to each malaria and diarrhoea death at 28 (author derivation).[11] Using published estimates of disability weights[12] and average duration of disease,[13 14] we calculated an estimate of the DALYs due to each non-fatal episode of malaria and diarrhoea at 0.0037 and 0.0013, respectively.

For HIV, we estimated 10 DALYs per case, assuming 18 years on antiretroviral treatment (ART), life expectancy at age 35 (average age of initiation of ART)[15] of 34 years in Kenya,[16] and 75% access to ART. This assumption is based on projected increases in ART access, and we examine uncertainty in this estimate in a sensitivity analysis in a separate IPC cost-effectiveness analysis paper.

We obtained a combined total DALY burden in each country by summing the total DALYs across the three diseases.

Country inclusion

To facilitate identification of those countries in which an IPC would be most beneficial, we limited the prioritisation analysis to low-income and middle-income countries as defined by the World Bank,[10] and countries with a total DALY burden for the three diseases in the highest tertile of the sample (≥87 000 DALYs).

Country indicators

We identified 10 disease burden and intervention coverage indicators to help characterise countries based on their level of opportunity for IPC implementation (table 1; see online data supplement 1 for additional indicators).

Disease burden: We calculated a DALYs per capita metric as the total DALY burden divided by the country's population.[17] For diarrhoea and malaria, we also collected data on the percentage of deaths under 5 due to diarrhoea and malaria, respectively, since the majority of cases, and particularly fatal cases, are in this demographic.[18] For HIV, we collected data on prevalence in the adult (15–49 years) population.[22–25]

Intervention coverage: We compiled data on the existing coverage of relevant interventions that could affect burden in the three IPC diseases. For diarrhoea and malaria, respectively, this included the percentage of the population using an improved drinking water source [27] and the percentage of households owning at least one ITN.[28] For HIV, we collected data on the percentage of pregnant women tested for HIV in the past 12 months.[29] The latter was used as a proxy for HIV counselling and testing coverage since reliable data on population-level coverage is unavailable for all countries.

Each of the indicators were colour coded into opportunity tertiles based on their ranking relative to other countries in the sample, with red, yellow and blue indicating high, medium and low opportunity, respectively. Visually, a country with more indicators coded in red suggests higher overall opportunity for the IPC compared with other countries in the sample.

Table 1 Opportunity index indicators and definitions

Category	Indicator	Definition	Source
DALYs per capita	DALYs per capita	DALYs per person for diarrhoea, malaria and HIV. Calculated as the total DALY burden divided by the population[17]	Author derivations; The World Bank
Disease burden: diarrhoea	Diarrhoea burden	Percentage of childhood (<5 years) deaths due to diarrhoea[18]	Black *et al*[18]
	DALYs	Total DALYs from diarrheal disease in the population. Calculated as number of annual cases of diarrhoea[19] times the number of DALYs due to a case of diarrheal disease (author calculation). Assumes an average diarrhoea episode duration of 4.43 days[14] and a disability weight for diarrhoea of 0.105[12]	Author derivations based on data from Fischer Walker *et al*[19]; Lamberti *et al*[14]; Mathers *et al*[12]
Disease burden: malaria	Malaria burden	Percentage of childhood (<5 years) deaths due to malaria[18]	Black *et al*[18]
	DALYs	Total DALYs from malaria in the population. Calculated as number of annual cases of malaria[20 21] times the number of DALYs due to a case of malaria (author calculation). Assumes an average malaria episode duration of 7 days[13] and a disability weight for malaria of 0.191[12]	Author derivations based on data from Cibulskis *et al*[20]; Snow *et al*[13]; and Mathers *et al*[12]
Disease burden: HIV	HIV burden	Prevalence in 15–49 years olds, 2009[22–25]	Gapminder.org; Ethiopia and DRC: 2012 Country Progress Reports for UNAIDS; Afghanistan, Iraq and Yemen: UNAIDS 2010 Global Report
	DALYs	Total DALYs from HIV/AIDS. Calculated as number of new HIV infections[26] times the number of DALYs due to a case of HIV (author calculation). Assumes 18 years on ART, life expectancy at 35 (average age of initiation of ART) of 34, and 75% access to ART	UNAIDS AIDSInfo database
Coverage of existing interventions	Improved drinking water coverage (diarrhoea)	Percentage of the population in 2010 using an improved drinking water source[27]	WHO: Global Health Observatory Data Repository
	ITN coverage (malaria)	Percentage of households in 2010 owning at least 1 insecticide-treated bed net. Countries with >100% reported have been corrected to 100, and are designated with an asterisk[28]	WHO Global Malaria Programme; World Malaria Report[21]
	Pregnant women tested, coverage (HIV)	Percentage of pregnant women tested for HIV based on facility registers for ANC, L&D and postpartum care (2010). Denominator is # pregnant women giving birth in the last 12 months[29]	WHO: Global Health Observatory Data Repository

ART, antiretroviral treatment; DALYs, disability-adjusted life years; ITN, insecticide-treated bed net.

Opportunity ranking

To quantify each country's level of opportunity we created three opportunity metric ranking systems using the 10 indicators.

First, we ranked countries based on *DALYs per capita* to identify the countries with the greatest disease burden attributed to diarrhoea, malaria and HIV. Since this combines DALYs for the three diseases, countries were ordered irrespective of whether the DALY burden was concentrated in one disease or spread across all three.

Second, to identify countries where the relative burden was high for all three diseases, we ranked countries based on disease burden relative to other countries for each disease. To calculate this *composite ranked disease burden score* we assigned numerical values to three burden indicators: the percentages of childhood deaths

due to diarrhoea and malaria, and HIV prevalence among adults. The values were on a scale of 1–3, where 1=low burden, 2=medium burden and 3=high burden in relation to the other countries in the sample. We calculated a country's ranked burden score by adding together numerical values for each burden indicator, and organised countries based on this new variable. For countries with the same numeric rank, those with a higher DALY per capita value were listed first.

Finally, we developed a score combining disease burden and intervention opportunity. Intervention opportunity reflects existing intervention coverage and the potential gains from implementing an IPC. We created three intervention score variables representing the relative coverage score for each intervention, again using three levels: 1=high existing coverage (low opportunity), 2=medium existing coverage and 3=low existing coverage (high opportunity). Countries with missing data were assigned the medium coverage score. We then calculated a summary intervention opportunity score for each country. A *combined burden and intervention opportunity score (CBIO)* was constructed to explore the combined effect of relative disease burden and intervention opportunity. We weighted the individual disease burden score by a factor of two, and added the intervention opportunity score. Disease burden was assigned a greater weight than intervention coverage for two reasons: to filter out countries that appear to be high opportunity due to low existing intervention coverage, but which also have low disease burden and thus a lower need for an IPC; and the coverage data represent similar, but not identical, interventions as the IPC (ie, HIV testing among pregnant women is only a subset of the general adult population targeted by the IPC). We then ranked the countries based on the CBIO.

RESULTS

Country sample

In the 214 World Bank economies assessed for inclusion, we estimated the total annual DALY burden attributed to diarrhoea, malaria and HIV at nearly 135 million. The total DALY burden in each country ranged from 14 (Republic of Korea) to more than 33 million (India). Based on our country inclusion criteria of low-income and middle-income countries with a combined DALY burden in the top tertile, 70 countries were included in the final sample for analysis (figure 1).

Forty-two of the 70 countries meeting our inclusion criteria were in Africa, with the majority of the rest from Asia and South and Central America. Collectively, the 70 countries in the sample accounted for 98% of the total DALYs attributed to diarrhoea, malaria and HIV in the world. Ninety per cent of the total global DALYs were concentrated in only 32 countries, and nearly three-quarters of the global DALYs were concentrated in just 16 countries.

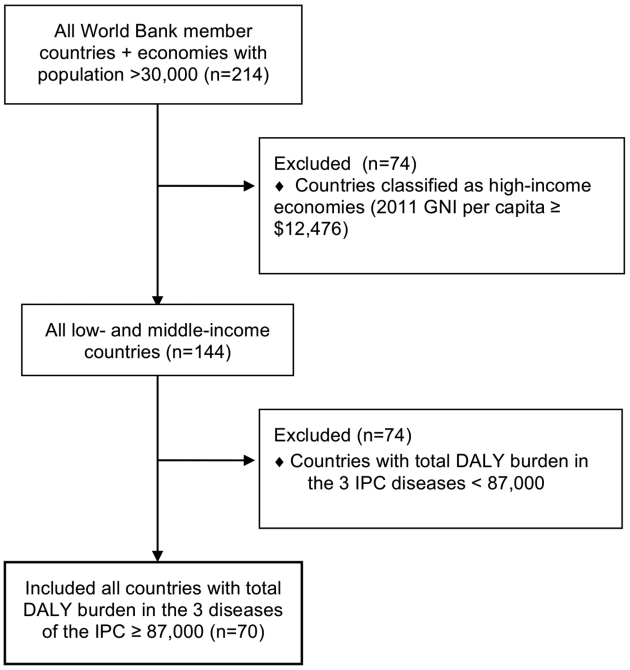

Figure 1 Country inclusion flow chart (DALY, disability-adjusted life year; IPC, integrated prevention campaign).

Opportunity indices

Absolute DALY burden: Table 2 lists the highest opportunity (top tertile) countries based on DALYs per capita for diarrhoea, malaria and HIV. Swaziland was ranked highest based on burden across the three disease areas (0.15 DALYs per capita; dominated by HIV). All of the 23 countries ranking in the top tertile were in sub-Saharan Africa (see online supplementary appendix figure 1, data supplement 1). While the overall DALYs per capita for these countries was high, in several cases the DALY burden was concentrated in just one or two of the diseases. Although India had the highest total DALY burden for diarrhoea, malaria and HIV in our country sample, once the size of its population was factored in it did not appear in the top tertile of countries based on DALYs per capita (see online data supplement 2 for the complete opportunity indices including all 70 countries in our sample).

Disease burden rank: Table 3 shows the opportunity index of the top 23 countries based on the composite ranked burden score. Countries at the top of the list have the highest relative burden in all three diseases. Five countries (Guinea-Bissau, Nigeria, Chad, Central African Republic and Cameroon) had high opportunity (ie, score of 3) in all three disease burden indicators, and 15 had high opportunity in at least two of the three, with medium opportunity (score of 2) in the third. Compared to the opportunity index based on DALYs per capita, five countries (Swaziland, Lesotho, South Africa, Guinea and Angola) no longer rank in the top tier, due to lower relative burden (ie, score of 1 or 2) in two of the diseases. These five countries were replaced

Table 2 Highest opportunity countries based on DALYs per capita

		Diarrhoea			Malaria			HIV		
DALYs per capita	Country	Diarrhoea burden	DALYs	Improved drinking water coverage	Malaria burden	DALYs	ITN coverage	HIV burden	DALYs	Pregnant women tested, coverage
0.1497	Swaziland	8.4	16 523	71	0.0	4,338	59	25.9	137 200	83
0.1406	Mozambique	11.9	532 817	47	12.5	1 482 080	38	11.5	1 274 000	87
0.1340	Guinea-Bissau	19.1	78 434	64	17.7	104 089	21	2.5	20 580	44
0.1335	Nigeria	18.7	4 995 101	58	20.2	12 818 894	49	3.6	3 332 000	14
0.1280	Zambia	14.6	410 637	61	15.2	499 280	52	13.5	744 800	94
0.1263	Burkina Faso	18.9	659 064	79	20.4	1 353 652	95	1.2	66 640	54
0.1240	Mali	19.2	715 293	64	20.8	1 145 312	52	1	45 080	15
0.1213	Somalia	21.8	534 781	29	5.8	512 605	20	0.7	84 280	1
0.1195	Chad	21.9	652 646	51	18.6	400 213	7	3.4	289 100	7
0.1190	Sierra Leone	20.9	246 659	55	12.9	405 647	130	1.6	46 060	50
0.1183	Burundi	23.6	393 025	72	9.2	461 645	100[#]	3.3	137 200	39
0.1154	Lesotho	9.9	25 067	78	0.0	Unknown	Unknown	23.6	225 400	57
0.1118	Congo, the Democratic Republic of the	18.5	3 414 271	45	17.0	3 389 027	69	1.3	568 400	11
0.1103	Niger	20.3	744 317	49	18.0	907 275	33	0.8	59 780	40
0.1095	Malawi	10.9	431 392	83	16.6	485 593	42	11	715 400	66
0.1053	Central African Republic	17.3	140 555	67	14.3	272 074	78	4.7	50 960	26
0.1051	Uganda	16.0	1 078 814	72	22.4	1 258 363	57	6.5	1 176 000	63
0.0999	Cameroon	16.2	683 514	77	19.0	705 891	13	5.3	568 400	41
0.0971	South Africa	8.7	1 010 490	91	0.1	19 404	Unknown	17.8	3 822 000	>95
0.0953	Guinea	13.8	305 921	74	23.6	584 210	60	1.3	60 760	12
0.0920	Liberia	17.2	112 638	73	15.6	231 809	74	1.5	23 030	42
0.0881	Angola	25.0	974 838	51	8.4	491 628	39	2	215 600	32
0.0837	Côte d'Ivoire	13.2	518 311	80	21.1	966 623	20	3.4	166 600	59

ITN coverage: values marked '100[#]' were reported as >100% by countries and corrected to 100 in this analysis.
DALYs, disability-adjusted life years; ITN, insecticide-treated bed net.

Table 3 Highest opportunity countries based on composite ranked burden score

			Diarrhoea			Malaria			HIV		
Composite ranked burden score	DALYs per capita	Country	Diarrhoea burden	Diarrhoea burden score	DALYs	Malaria burden	Malaria burden score	DALYs	HIV burden	HIV burden score	DALYs
9	0.1340	Guinea-Bissau	19.1	3	78 434	17.7	3	104 089	2.5	3	20 580
9	0.1335	Nigeria	18.7	3	4 995 101	20.2	3	12 818 894	3.6	3	3 332 000
9	0.1195	Chad	21.9	3	652 646	18.6	3	400 213	3.4	3	289 100
9	0.1053	Central African Republic	17.3	3	140 555	14.3	3	272 074	4.7	3	50 960
9	0.0999	Cameroon	16.2	3	683 514	19.0	3	705 891	5.3	3	568 400
8	0.1280	Zambia	14.6	2	410 637	15.2	3	499 280	13.5	3	744 800
8	0.1263	Burkina Faso	18.9	3	659 064	20.4	3	1 353 652	1’2	2	66 640
8	0.1240	Mali	19.2	3	715 293	20.8	3	1 145 312	1	2	45 080
8	0.1183	Burundi	23.6	3	393 025	9.2	2	461 645	3.3	3	137 200
8	0.1118	Congo, the Democratic Republic of the	18.5	3	3 414 271	17.0	3	3 389 027	1.3	2	568 400
8	0.1103	Niger	20.3	3	744 317	18.0	3	907 275	0.8	2	59 780
8	0.1095	Malawi	10.9	2	431 392	16.6	3	485 593	11	3	715 400
8	0.1051	Uganda	16.0	2	1 078 814	22.4	3	1 258 363	6.5	3	1 176 000
8	0.0920	Liberia	17.2	3	112 638	15.6	3	231 809	1.5	2	23 030
8	0.0837	Côte d’Ivoire	13.2	2	518 311	21.1	3	966 623	3.4	3	166 600
8	0.0749	Tanzania, United Republic of	11.6	2	1 025 316	16.4	3	1 355 472	5.6	3	980 000
8	0.0747	Togo	11.6	2	124 279	25.7	3	227 957	3.2	3	98 000
8	0.0709	Rwanda	22.6	3	357 674	5.9	2	309 499	2.9	3	86 240
8	0.0669	Congo, Reppublic	14.3	2	81 602	23.8	3	125 349	3.4	3	63 700
8	0.0651	Kenya	20.5	3	796 738	10.9	2	762 667	6.3	3	1 078 000
7	0.1406	Mozambique	11.9	2	532 817	12.5	2	1 482 080	11.5	3	1 274 000
7	0.1213	Somalia	21.8	3	534 781	5.8	2	512 605	0.7	2	84 280
7	0.1190	Sierra Leone	20.9	3	246 659	12.9	2	405 647	1.6	2	46 060

DALYs, disability-adjusted life years.

by Tanzania, Togo, Rwanda, the Republic of Congo and Kenya—countries with medium opportunity based on DALYs per capita, but with higher relative opportunity when considering the burden of the three diseases equally.

Combined disease burden and intervention opportunity: After including existing intervention coverage levels, 21 countries that ranked as high opportunity based on the composite ranked burden score alone remained on the list of top 23 countries, although with changes to the relative order (table 4). Mozambique and Sierra Leone were replaced by Angola and Ethiopia, countries with the same composite ranked burden score but lower existing levels of intervention coverage.

See online supplementary appendix figure 2 (data supplement 1) for maps providing a visual representation of where the greatest opportunity for IPC implementation exists.

The three complete opportunity indices including data on all 70 countries in our country sample are available in online data supplement 2.

DISCUSSION

This tool illustrates the application of an index comparing country-specific data on disease burden and intervention coverage to facilitate prioritisation for IPC scale-up. While the data presented here apply specifically to a diarrhoea, malaria and HIV IPC, the same methodology could be applied to prioritise other diseases or interventions.

We estimated the total global burden due to diarrhoea, malaria and HIV at nearly 135 million DALYs per year, indicating a tremendous opportunity to impact global disease targets via interventions such as IPCs.[30] To determine countries in which implementation of a diarrhoea, malaria and HIV IPC would yield the most value, we used a visually accessible, systematic approach to summarise the opportunity for implementation in 70 high-burden countries. Based on each of the opportunity metrics we used, all of the countries with the highest opportunity for implementation are in sub-Saharan Africa. Although the overall rank order changes, 16 countries rank among the top 23 highest opportunity countries for all three opportunity metrics.

The lists ranked by DALYs per capita and by composite ranked burden score vary somewhat in order and composition, since the former is an absolute ranking of *total* burden across the three diseases. Consequently, it is possible for one disease to dominate the DALY burden for a given country (as is the case with Swaziland, with low diarrhoea and malaria burden, but high HIV burden). Conversely, the indices ranked by the two composite scores are relative, so that the burden in each disease is weighted equally, maximising the countries where the burden in all three diseases is the highest. Our analysis indicates that five countries are classified as high opportunity based on DALYs per capita but fall down the list of opportunity when ranking based on the composite ranked burden score due to lower relative burden in at least one of the diseases.

Stakeholders considering IPC scale-up may consider a number of factors when making decisions about where, and in how many countries, to implement: disease priority, the extent of funding resources, existing coverage of relevant interventions, etc. This analysis provides three ways to prioritise countries for IPC implementation: based on a high absolute burden, based on a high relative burden for all three diseases and by maximising countries where burden is high and existing coverage of IPC-relevant interventions is low (see online data supplement 1 for strategies for further prioritisation).

In addition to factors impacting opportunity, feasibility factors, such as current levels of government expenditure on health, the presence of conflict, and access to routine health services are also important considerations. Community-based campaigns can enhance access to interventions among underserved and marginalised populations,[5 31 32] and IPCs may represent an efficient way to promote equitable coverage of important preventative interventions. Human resource capacity is another critical consideration; in countries with workforce shortages, IPCs may require mobilisation of existing healthcare workers for an extended period of time. In a separate analysis, we characterised our sample of 70 countries based on four feasibility metrics (see online data supplement 1). Given the variety of possible stakeholders in an IPC, feasibility determination and the specific measures for consideration will differ based on the implementing body. Once key feasibility metrics are pinpointed, this type of feasibility index could be applied to high-opportunity countries, and a revised list could be created to summarise the countries that fulfil both high opportunity and high feasibility criteria. Regardless of the approach used, stakeholders must be cognizant of feasibility considerations that could influence the potential success or failure of a campaign.

There are several strengths to the approach presented here. The index method synthesises a large volume of data from disparate sources into a single table, enabling side-by-side comparisons of several indicators between countries. The system of colour-coding indicators into low, medium and high opportunity facilitates quick visual assessment of the overall opportunity within a country and the relative opportunity between countries. Finally, summary metrics synthesise data from various indicators, allowing quantitative ranking of countries based on priority areas, and facilitating more objective decision-making about where to implement an IPC.

We acknowledge important limitations to our analysis. First, many factors could potentially influence the level of opportunity a given country has for IPC implementation. In our indices, we only included factors, such as disease burden and existing intervention coverage, which clearly have a large effect on the potential impact of an IPC intervention. Second, our list of opportunity

Table 4 Highest opportunity countries based on CBIO score

			Diarrhoea				Malaria				HIV			
CBIO score	DALYs per capita	Country	Diarrhoea burden	Diarrhoea burden score	Improved drinking water coverage	Drinking water coverage score	Malaria burden	Malaria burden score	ITN coverage	ITN coverage score	HIV burden	HIV burden score	Pregnant women tested, coverage	Testing coverage score
27	0.1195	Chad	21.9	3	51	3	18.6	3	7	3	3.4	3	7	3
26	0.1335	Nigeria	18.7	3	58	3	20.2	3	49	2	3.6	3	14	3
25	0.1340	Guinea-Bissau	19.1	3	64	3	17.7	3	21	2	2.5	3	44	2
25	0.0999	Cameroon	16.2	3	77	2	19.0	3	13	3	5.3	3	41	2
24	0.1240	Mali	19.2	3	64	3	20.8	3	52	2	1	2	15	3
24	0.1053	Central African Republic	17.3	3	67	2	14.3	3	78	1	4.7	3	26	3
23	0.1118	Congo, the Democratic Republic of the	18.5	3	45	3	17.0	3	69	1	1.3	2	11	3
23	0.1103	Niger	20.3	3	49	3	18.0	3	33	2	0.8	2	40	2
23	0.0669	Congo, Republic	14.3	2	71	2	23.8	3	Unknown	2	3.4	3	21	3
22	0.1280	Zambia	14.6	2	61	3	15.2	3	52	2	13.5	3	94	1
22	0.1213	Somalia	21.8	3	29	3	5.8	2	20	2	0.7	2	1	3
22	0.0881	Angola	25.0	3	51	3	8.4	2	39	2	2	2	32	3
22	0.0837	Côte d'Ivoire	13.2	2	80	2	21.1	3	20	2	3.4	3	59	2
22	0.0747	Togo	11.6	2	61	3	25.7	3	63	1	3.2	3	42	2
22	0.0651	Kenya	20.5	3	59	3	10.9	2	37	2	6.3	3	83	1
21	0.1263	Burkina Faso	18.9	3	79	2	20.4	3	95	1	1.2	2	54	2
21	0.1183	Burundi	23.6	3	72	2	9.2	2	109	1	3.3	3	39	2
21	0.1095	Malawi	10.9	2	83	2	16.6	3	42	2	11	3	66	1
21	0.1051	Uganda	16.0	2	72	2	22.4	3	57	1	6.5	3	63	2
21	0.0920	Liberia	17.2	3	73	2	15.6	3	74	1	1.5	2	42	2
21	0.0749	Tanzania, United Republic of	11.6	2	53	3	16.4	3	107	1	5.6	3	86	1

CBIO, combined burden and intervention opportunity; ITN, insecticide-treated bed net.

indicators was limited by the availability of published data. Given our interest in examining indicators on a cross-country basis, we required standardised metrics reported by all countries, which may have resulted in the selection of less than ideal metrics for some variables. For example, we included data on the coverage of HIV testing in antenatal care settings, a widely and routinely collected indicator, whereas a more suitable assessment of existing levels of HIV testing would be based on coverage in the general population. However, such data was unavailable for many countries. We also assessed opportunity at the country level due to limited availability of regional data for all variables. There may be areas within a country with opportunities that depart radically from the overall country assessments to which our analysis is confined. Consequently, the rankings presented here could overlook the true opportunity for IPC implementation in particularly high-burden and low-coverage subregions of countries. In countries where such variation in burden, access and coverage are known to exist, collection of regional data and application of this type of index would help to identify regions for targeted campaign introduction, channelling resources to areas in greatest need. Finally, the choice of weighting when calculating the CBIO scores was subjective. However, if we were to weight disease burden by a factor of three instead of two, the overall composition of the top 23 countries ranked by CBIO score would be the same, although the relative order would change somewhat. Even when weighting disease burden and intervention opportunity equally, 16 countries would remain on the list of top 23.

Conclusion

Prior assessments have shown that IPCs can rapidly increase the uptake of communicable disease interventions, representing a promising strategy to accelerate progress in meeting MDGs. The index presented here provides a data-driven tool by which to prioritise countries for implementation of an IPC for diarrhoea, malaria and HIV. Application of this opportunity index, in conjunction with other stakeholder-specific assessments (eg, funding, feasibility, etc), may facilitate more objective decision-making regarding areas where IPC scale-up would yield the most value and lead to a more efficient use of resources.

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Acknowledgements The authors would like to thank Mikkel Vestergaard Frandsen and Navneet Garg for their thoughtful input into this project. The opportunity index method used in this paper was adapted from a similar index created by the Strategic Analysis, Research, and Training Program (START) at the University of Washington. The authors thank the authors of the original opportunity index project, Matheson AI, Manhart LE, Pavlinac PB, Means AR, Akullian A, Levine GA, Jacobson J, Shutes E, Walson JL, for their work on developing the original method.

Contributors AJ helped design the study, conducted the analyses and drafted and revised the paper. AM provided data for the study, helped with the analyses and revised the draft paper. JGK and EM helped guide design and implementation of the study, and edited the paper. AR and SV critiqued the analysis and revised the draft paper. JW conceived and guided design and implementation of the study, and edited the paper.

Funding This work was supported by Vestergaard Frandsen.

Competing interests JW, AJ, JGK and EM were contracted by Vestergaard Frandsen (VF) to conduct this analysis. AR was formerly employed by VF as an HIV/AIDS Advisor. JW and JGK have had additional consultancies with VF outside of this analysis. VF supported author SV's travel and expenses for the 2012 International AIDS Society conference.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement The three complete opportunity indices for all 70 countries in our sample are available in online data supplement 2. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

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