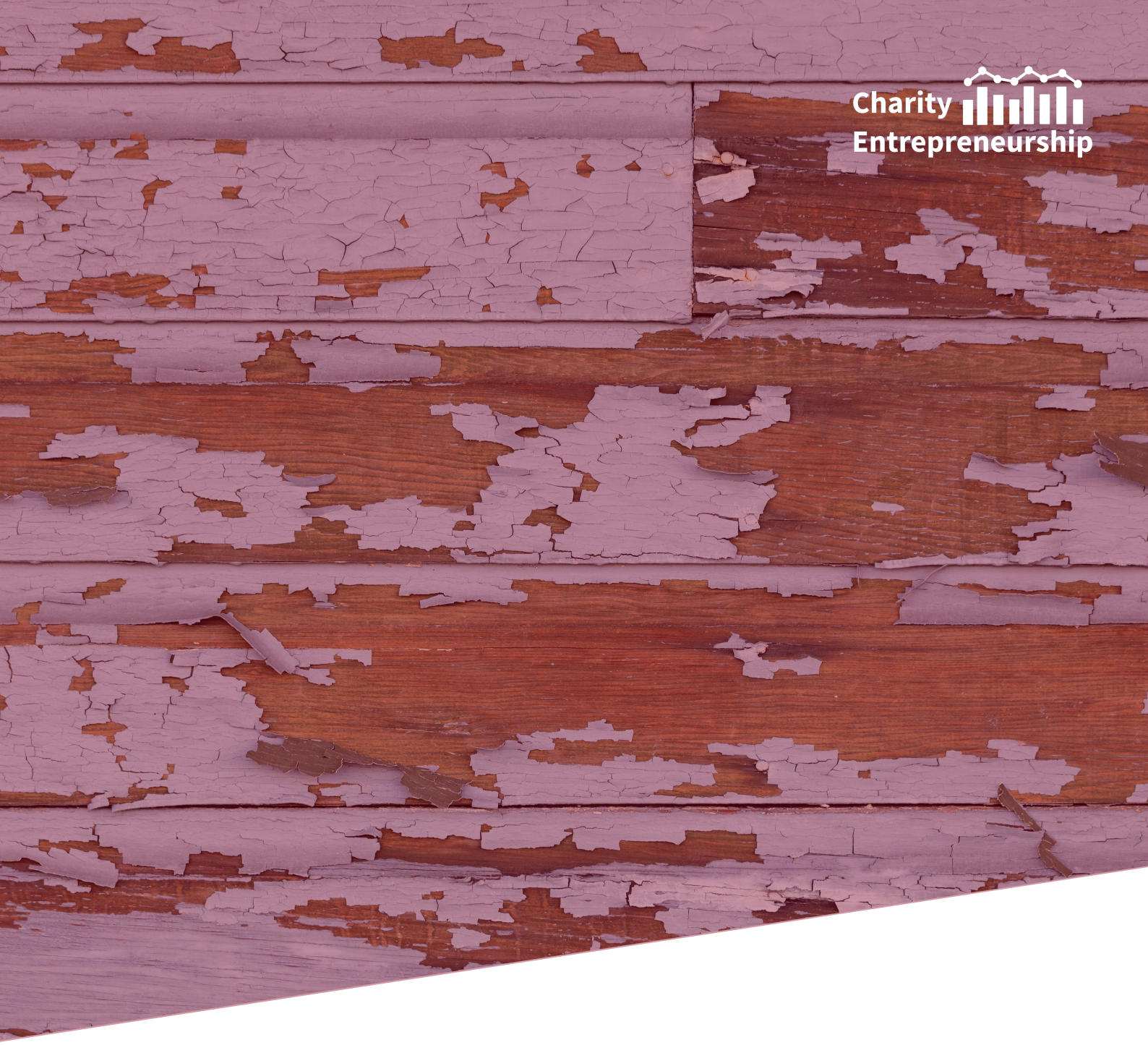

Charity Entrepreneurship

LEAD PAINT REGULATION

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Review: K. Sarek, E. Hausen

AUGUST 2020

RECOMMENDED

Research Report:
Health and Development Policy – Lead Paint Regulation (2020 Recommended Idea)

Primary author: Ali Ladak
Review: Karolina Sarek, Erik Hausen
Date of publication: August 2020
Research period: 2020

This is a summary report about lead paint regulation, a potential intervention in the field of health and development policy. In our five-step research process this report corresponds to step four, the drafting of an in-depth, 80-hour report on a potential intervention. All the ideas considered for health and development policy are listed in this spreadsheet.

Thanks to Karolina Sarek and Erik Hausen for reviewing the research, and to Antonia Shann, Urszula Zarosa, Nicoleta Faina, Fin Moorhouse, and Joe Benton for their contributions. We are also grateful to the experts who took the time to offer their thoughts on this research: Björn Beeler, Piyush Mohapatra, and Leonardo Trasande.

For questions about the content of this research, please contact Ali Ladak at ali.ladak@charityscience.com. For questions about the research process, charity recommendations, and intervention comparisons, please contact Karolina Sarek at karolina@charityscience.com.

Charity Entrepreneurship is a research and training program that incubates multiple high-impact charities annually. Our mission is to cause more effective charities to exist in the world by connecting talented individuals with high-impact intervention opportunities. We achieve this through an extensive research process and through our Incubation Program.

Research Process

Before opening the report, we think it important to introduce our research process. Knowing the principles of the process helps readers understand how we formed our conclusions and enables greater reasoning transparency. It will also clarify the structure of the report.

Our research process incorporates elements that are well established in some fields but uncommon in others. This is partly because of the unique goals of our research (i.e. finding new areas for impactful charities to be launched) and partly because we incorporate lessons and methodologies from other fields of research, primarily global health and medical science. Below is a quick overview of some of the key elements.

Iterative depth: We research the same ideas in multiple rounds of iterative depth. Our goal is to narrow down our option space from a very large number of ideas (often several hundred at the start) to a more workable number for deeper reports. This means we do a quick 30-minute prioritization, a longer 2-hour prioritization, and finally an 80-hour prioritization. Each level of depth looks at fewer ideas than the previous round.

Systematic: The goal of our research is to compare ideas for a possible charity to found. To keep comparisons between different ideas consistent our methodology is uniform across all the different ideas. This results in reports that consider similar factors and questions in a similar way across different interventions, allowing them to be more easily compared. This is commonly used in other charity evaluations and encouraged in other fields.

Cluster approach: Comparing different intervention ideas is complex. We are not confident that a single methodology could narrow down the field, in part due to epistemic modesty. To increase the robustness of our conclusions, we prefer instead to look at ideas using multiple independent methodologies and see which ideas perform well on a number of them (more information here). These methodologies include a cost-effective analysis, expert views, informed consideration and using a weighted factor model. We explain the merits and disadvantages of each method, as well as how we apply it, in the linked documents. Each methodology is commonly used in most fields of research but they are rarely combined into a single conclusion.

Decision relevant: Our research is highly specialized and focused. We only research topics that are directly related to the endline choice of what charity to found. Sometimes cross-cutting research is needed to allow comparison between different ideas, but all our research aims to be directly useful to getting new charities started. This level of focus on target practical outcomes is rare in the research world, but is necessary to our goal of generating more charity ideas with minimal time spent on non-charity idea related concepts.

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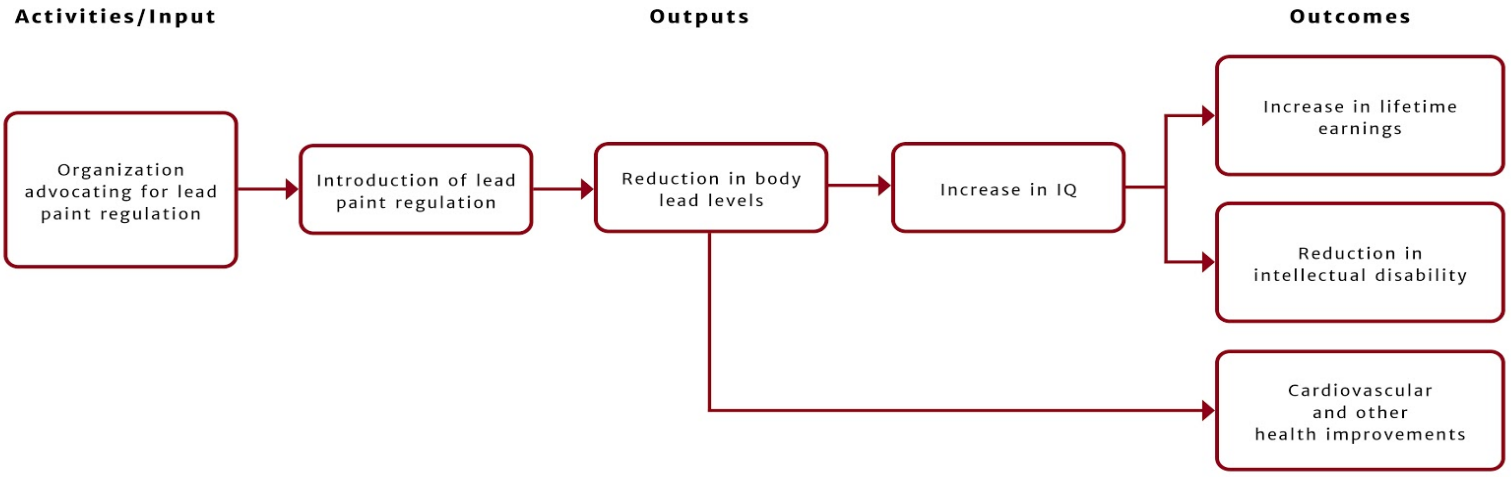
Description of the intervention

The intervention explored in this report is the introduction of lead paint regulation to reduce the harmful effects of lead exposure. While most high-income countries have regulations, this issue is still a major problem in low- and middle-income countries. Globally, only 39% of countries have confirmed that they have regulations to control the production, import, sale, and use of lead paints [1].

The diagram below sets out our theory of change for how we expect starting an organization that advocates for the introduction of lead paint regulation to lead to positive health and economic outcomes.



Summary conclusion

Our analysis suggests that lead paint regulation could be a highly cost-effective intervention. The main benefits are through the impacts of lead exposure on IQ, which is associated with decreased lifetime earnings. Globally, this has been estimated to cost almost $1 trillion per year [2]. While the introduction of lead paint regulation would have limited effect on the current costs (as existing lead paint will remain in the environment), it would avert any additional costs associated with lead exposure due to lead paint. This is potentially significant, as paint markets are large and growing in low-income countries, though we are quite uncertain about this issue.

This intervention is quite neglected, with regulations in less than 40% of countries. This suggests there is scope for expanding to other countries, potentially significantly increasing impact. On the other hand, we expect lead paint regulations will be introduced at some point in the future even if we do not start this

intervention. This may limit a new organization's potential impact to bringing regulation forward by a number of years.

A new organization working on this issue could become a partner of the International Pollutants Elimination Network (IPEN), a key organization in the space who can provide technical and policy support. This would make the probability of successfully introducing regulation significantly higher. However, IPEN's model differs from Charity Entrepreneurship's in some ways; for example, they expressed a preference for supporting existing organizations and local activists rather than Charity Entrepreneurship starting a new organization. We will need to discuss how to merge approaches to make the best use of resources in more detail with IPEN.

Ultimately, we recommend this as an intervention for a new organization to work on, and will carry out further discussion with IPEN to figure out how a new organization can best fit into this space.

The table below offers a step-by-step summary of our research process for this intervention. Color-coding reflects how well the intervention performed at each stage. The first two steps in the process involve background research prior to this report.

Report type	Summary results	Deeper reading
Idea sort	During the idea sort, this idea showed promise: it was in the top 31 of 256 total ideas.	Full report Process
Idea prioritization	After two hours of researching this intervention using the informed consideration methodology, it was one of our highest priorities for more in-depth research.	Full report Process
Prior view	This 80-hour report begins with a prior view, which summarizes the lead researcher's expectations before starting in-depth research. Prior knowledge of this area was mostly informed by our research at the two-hour stage. At this stage, lead paint regulation looked like a highly promising intervention.	Process
Informed consideration: Crucial considerations	Informed consideration occurs at two stages of our research process: the start and the end. At this first stage, we explored some of the key considerations of this intervention. We found that lead exposure is the cause of around 1% of the global burden of disease, and it also has significant economic impacts due to its effect on IQ. We also found that as of 2020 only 39% of countries had confirmed lead paint regulations, though this is gradually increasing.	Process

Expert view	We discussed the intervention with experts. Experts considered that this is likely to be an area where policy can be passed. A key bottleneck NGOs are currently facing is funding, although policy can often be passed at a relatively low cost. We also discussed a range of other issues including the reasons so few countries currently have lead paint regulations, how a new organization would fit into the current space, and the reliability of the study on the economic impacts in low- and middle-income countries.	Process
Weighted factor model	We then scored the intervention on preset weighted criteria. This intervention scored relatively well on each of the criteria, scoring 6/10 on each of strength of the idea, limiting factor, execution difficulty, and externalities, to give an overall weighted score of 30/50. While we consider this intervention to have a relatively high probability of success, a new organization may be limited to bringing regulations forward by several years rather than introducing regulations that would otherwise never exist.	Process
Cost-effectiveness analysis	We then built models to estimate the expected cost-effectiveness of this intervention. Our modeling suggests that the introduction of lead paint regulation in an average sub-Saharan African country would have a benefit-cost ratio of around 74:1. However, our model relies on some uncertain assumptions about paint markets in low-income countries. Interpretation of the figures cited here should be carried out cautiously due to their dependence on model assumptions (see section 'Where our CEA could go wrong').	Process
Informed consideration: Internal contemplation	The second part of the informed consideration closes the report. We conclude that though there are some remaining uncertainties, this intervention looks very promising. This is mainly due to the relatively high probability of success and our estimate of its cost-effectiveness. On this basis, we recommend that a new health and development policy charity focus on lead paint regulation.	Process
Supporting reports	There are a couple of key resources important for this intervention. Attina and Trasande (2013) is the paper which estimates the economic costs of lead exposure in low- and middle-income countries, relied on in this report. We also include a link to the Lead Paint Alliance's resources on lead paint elimination, and a link to IPEN's page on eliminating lead paint.	Attina and Trasande Lead Paint Alliance IPEN

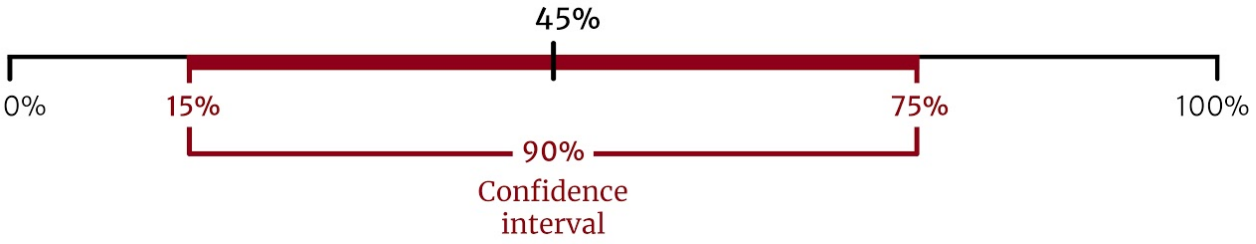
1 Prior view

This brief section summarizes our thoughts on this intervention before starting in-depth research.

Overall, we have a strongly positive view of this intervention and would not be surprised if it became one of our recommended charity ideas for health and development policy. The main reasons are that it has a large health and income burden [2] [3], it is rated highly by GiveWell [4], it is relatively uncontroversial - most people would agree we should not use lead paint when other alternatives are available, and it seems neglected - only 39% of countries regulate lead paint, and laws are often weakly enforced.

One concern we have is that an expert we spoke with about this idea suggested that it is not as neglected as it seems, so we will need to look further into that. A second concern is that since regulations may be weakly enforced, introducing them may have weaker effects than anticipated.

At this stage of the research, our subjective likelihood of recommendation is:



The probability estimates assume that:

- Two ideas will be recommended at the end of the process, so being recommended is equivalent to being in the top two ideas.
- With no prior information, each idea is equally likely to be recommended. Because 7 ideas will be considered, this means the prior probability is 2/7 * 100 = 29%.
- In this case, because this intervention came out very promising in the previous stage of the research, we have updated the likelihood of recommendation to 45%.
- The 90% confidence interval represents how sure we are that there is a 45% chance this idea will be in the top two ideas. We have not done very much research in this area, though there are some strong indications that this is a good idea, such as GiveWell's positive view of it.

2 Informed consideration: Crucial considerations

After the prior view, we began the research process by identifying crucial considerations for lead paint regulation. In this early phase, we identified the following areas to research:

- The effect of lead exposure on human health and well-being
- The lead paint landscape (e.g. existing regulations, barriers to introducing regulation)
- The key organizations in the space
- How neglected this intervention is
- The impact of COVID-19 on this intervention

The following subsections summarize our findings on each of these crucial considerations.

2.1 The effect of lead exposure on human health and well-being

Lead is a toxic metal that contaminates the environment and causes a range of health problems in people exposed to it. Children are particularly vulnerable to its effects, as are pregnant women. One key source of lead exposure is lead paint. When intact, lead paint is usually not a problem, but as it breaks down over time it creates flakes and dust which contaminate the environment and can be ingested by people. Lead can remain in the environment for long periods of time, and accumulates in the human body. There is no known safe level of lead exposure; even very low levels have been found to be associated with long-term health damage [5].

The Institute for Health and Metrics (IHME) estimated that 24 million disability-adjusted life years (DALYs) and 1.06 million lives were lost in 2017 as a result of lead exposure, with the highest burden in low- and middle-income countries [3]. In addition to these health costs, a commonly referenced study by New York University found total income costs of lead exposure in low- and middle-income countries at $1 trillion per year [2]. These large economic costs are due to the effect of lead exposure on IQ, which in turn affects economic productivity.

2.2 The lead paint landscape

Why is lead used in paint and what are the alternatives?

Lead is used as an ingredient in some paints for two main reasons - as pigments and as drying agents. It can also be added unintentionally through contaminated raw materials. It is commonly an ingredient in brightly colored paints. Cost-effective alternatives do seem to exist; however, industry groups have reported that these alternatives are not always easily available [5].

What proportion of countries have lead paint regulations?

The World Health Organization reports that as of May 2020 39% of countries have confirmed that they have lead paint regulations [1]. Of the remaining 61%, 18% did not provide data and 42% confirmed they did not have regulations in place.

What are the existing legal limits and levels of lead in paint?

The legal limit in most countries with regulations is 90 parts per million. In less restrictive countries it is 600ppm. Many developing countries have average levels of lead in paint hundreds of times higher than this, in many cases above 10,000ppm [5].

What are the barriers to eliminating lead paint?

According to the International Pollutants Elimination Network (IPEN), key barriers include a lack of data on the amount of lead in paint in many countries, a lack of legislative authority or regulatory experience to introduce regulations, and difficulty in monitoring once regulations are in place [6]. We discuss some of these barriers further in the 'Expert View' section.

2.3 The key organizations in the space

The Lead Paint Alliance is a partnership between the United Nations Environment Programme (UNEP) and the World Health Organization (WHO) with the goal of establishing lead paint laws in all countries [7]. It has developed a range of tools and materials to support countries to introduce legislation, including model law and guidance; annual updates on the global status of legal limits on lead in paint; a toolkit for establishing laws to eliminate lead paint; and communication and awareness-raising materials.

International Pollutants Elimination Network is a global network of NGOs working to eliminate the use of chemicals that are harmful to human health and the

environment [8]. It has been working on the elimination of lead paint since 2008 and consists of over 550 participating organizations in more than 120 countries. It is currently working on projects in Africa and Asia, and recently received a $250,000 grant from GiveWell [9].

World Coatings Council is a global council of national trade associations representing the paint and printing ink industries [10]. It supports Lead Paint Alliance's goal of eliminating lead paint, noting the effectiveness of regulations that exist in many countries and recommending their widespread adoption. It supports the Lead Paint Alliance's model law as a starting point for guidance [11].

2.4 How neglected is this intervention?

At the two-hour research stage we provisionally concluded that this intervention is likely to be neglected because only 39% of countries have regulations, and these are often weakly enforced. Although further research confirms this statistic, we now consider that it may be a little misleading. While only 39% currently have regulations, there is a strong push towards introducing regulations in many other countries, led by IPEN and LPA, whose goal is to ensure that all countries have regulations by 2030 [12]. This builds on an earlier target of ensuring all countries have regulations by 2020 [13]. However, there seems to be several barriers preventing the remaining 61% of countries from introducing regulations; some of these are cited above, and they are discussed further in the 'Expert View' section.

The impact of COVID-19 on this intervention

The impact of COVID-19 on this intervention is currently unclear. Many funding bodies are spending resources on COVID-19, so it is likely that in the short term fundraising will be more difficult. It is also possible that this will continue for a period of time after the pandemic is over, due to its negative impact on the economy and the resulting negative health and social impacts. However, we also consider this intervention can be run on a relatively low budget. Funding issues are discussed further in the 'Weighted Factor Model' and 'Expert View' sections.

3 Expert view

This section summarizes conversations between the lead researcher and a range of experts in the lead paint regulation space. Overall, experts considered this to be a highly cost-effective intervention that is neglected on the global scale. Funding was cited as a key reason lead paint regulations still do not exist in many countries. Several other barriers exist, but experts considered these could be overcome with persistent advocacy and funding.

Björn Beeler, International Pollutants Elimination Network

Profile: Björn is General Manager & International Coordinator of the International Pollutants Elimination Network, a global network of public interest NGOs working for the elimination of the use of toxic chemicals which are harmful to human health and development, with members in 126 countries.

Summary: Björn considered that there are many existing organizations working on lead paint regulation, and that the key bottleneck to policy change is not additional organizations, but additional funding and support for the existing organizations. He suggested several ways that CE could be valuable to these organizations.

Björn did not consider the area to be crowded, and considered that a new organization could work in a country where there is no existing lead paint elimination campaign. If a new organization were formed, it could then join IPEN's network (if the new organization is a nonprofit/nongovernmental organization) and benefit from their experience, plus technical and policy expertise. The conversation also covered IPEN's operating model; the barriers to introducing lead paint regulation; the costs of achieving policy change; the funding landscape; and New York University's study on the economic impacts of lead exposure.

More information can be found in the conversation summary.

Piyush Mohapatra, Toxics Link

Profile: Piyush is Senior Programme Coordinator at Toxics Link, an NGO operating out of India working on a range of environmental issues, with a particular focus on toxic chemicals and health. It serves as a regional hub in South Asia, coordinating local NGOs working on lead paint regulation.

Summary: Piyush provided information on how lead paint regulations were introduced in South Asia, and the ongoing challenges on enforcement and adoption of lead free paint, particularly for smaller companies. The conversation also covered

Toxics Link's current work; barriers to introducing lead paint regulation; the funding landscape; and advice to a new organization starting in this space.

More information can be found in the conversation summary.

Leonardo Trasande, New York University

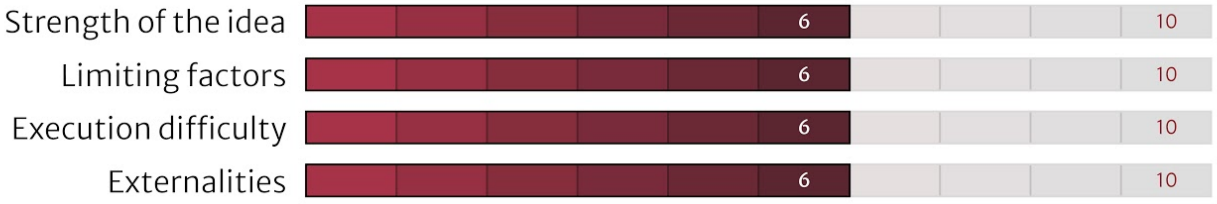
Profile: Leonardo is a Professor of Environmental Medicine and Population Health at New York University. He is the co-author of a key paper that we rely on in this report estimating the economic costs of lead exposure in low- and middle-income countries [2].

Summary: In an email exchange, we asked Leonardo about the robustness of the relationship between IQ and productivity and extrapolating this from the U.S. context to LMICs. He considered that the relationship between IQ and productivity has been rigorously and consistently documented in many studies. On the basis of these studies there has been significant action to tackle lead exposure in the U.S., Europe, and LMICs. Leonardo did not know of any other studies estimating the economic costs of lead exposure in LMICs. He considered that lead paint is a major source of lead exposure, and eliminating lead paint has resulted in rapid reductions in lead levels in many countries.

4 Weighted factor model

In this stage of research, we scored the lead paint intervention on each of the following preset criteria, with weightings in parentheses: strength of the idea (2), limiting factor (1.5), execution difficulty (1), and externalities (0.5).

Overall, the WFM suggests that lead paint regulation is a relatively strong intervention on all of the criteria considered, with a weighted score of 30/50. The graphic below summarizes how this intervention performed on each of the criteria; details of how we arrived at these scores follow.



4.1 Strength of the idea

Score: 6/10

Cost-effectiveness

There are two channels of benefits for this intervention; health and economic benefits. The health impacts are estimated in the Global Burden of Disease studies [14]. The key channel of impact is through the effect of lead exposure on IQ and blood pressure, which are in turn associated with a range of negative health outcomes including intellectual disability, heart disease, strokes, and kidney diseases [15]. In total, the GBD estimates lead exposure accounts for around 1% of the total global burden of disease.

Several studies have tried to estimate the broader social costs of lead exposure. A key impact is the effect of the reduction in IQ on future earnings. A study carried out by researchers at New York University (including Leonardo Trasande) estimates total productivity costs to be almost $1 trillion in low- and middle-income countries in 2011, equal to around 1.2% of global GDP. These large estimated costs only account for productivity costs, not social costs like crime and health care expenditure, although GiveWell considers these costs are more likely overstated than understated [16].

As far as we can tell, this study is the only one that estimates the economic impact of lead paint in low- and middle-income countries. However, estimates in higher-income countries are equally large. Grosse and colleagues (2002) estimate the impact of decline in blood lead levels in the U.S. between 1976 and 1999, and estimated that children had IQs which were 2.2-4.7 times higher than they would otherwise have been, which translates to productivity benefits of $110 to $319 billion per year [17]. Trasande and Liu estimated that in 2008 the economic costs of lead exposure in the U.S. were still over $50 billion per year [18].

Gould (2009) estimated the cost-effectiveness of the introduction of lead paint regulation in the U.S. [19]. The study included wider social costs, including health care costs, earnings, tax revenue, special education, attention deficit hyperactivity disorder, and the direct costs of crime. It estimated that each dollar invested generated a return of $17 to $221, and a total net benefit of $181 to $269 billion. Of this, productivity costs made up between a half to just over two-thirds of the overall societal costs.

Strength of evidence

Most of the impact of this intervention is expected to come from the effect of reduced lead exposure on IQ, which in turn causes productivity losses. We therefore focus on the strength of the evidence behind these relationships.

Needleman and Gatsonis (1990) carried out a meta-analysis that looked at the relationship between lead exposure and IQ [20]. Their analysis included 12 studies and found strong support in favour of a negative relationship. Schwarz (1992) carried out a meta-analysis of eight studies that found an increase in lead exposure from 10 to 20 micrograms per deciliter to be associated with a 2.6 IQ point reduction [21]. They attempted to account for potential confounding through sensitivity analyses, for example analyzing longitudinal and cross-sectional studies separately. They concluded that the consistency in the findings across study designs, continents, and populations, implies that the observed associations are unlikely to be due to confounding. They also cited neurological evidence and primate studies that support a causal relationship.

A more recent study by Lanphear and colleagues (2005) followed children from birth to 10 years of age in seven countries. Controlling for multiple potential confounding variables such as birth weight and maternal IQ, the study found supporting evidence of a strong relationship between lead and IQ, including at low levels of exposure. Overall the evidence suggests that reductions in lead exposure

would increase IQ, and this evidence is relied on by bodies such as the WHO (e.g. see [22]).

The effect of IQ on income is a major source of the expected benefits of this intervention. Randomization is again not possible, and so estimating the causal impact is not straightforward. It is particularly difficult in this case, because variables treated as confounders in some studies (to estimate the "pure" impact of IQ), are also channels through which IQ affects earnings (e.g. through increased education and occupational status) [23]. To estimate the impact of IQ on earnings for the purposes of understanding how lead exposure affects earnings, studies need to partial out the effect of confounding, but not block the channels through which IQ affects income. Some papers also estimate the impact on wage rates rather than total earnings; this may underestimate the effect as a proportion of the impact of IQ is expected to come from the number of hours worked.

Salkever (2014) [23] reviews the evidence on IQ and earnings in the context of these issues. The studies cited suggest a total impact, accounting for the direct, indirect, hours, and participation effects of IQ, to be ranging from around 1% to 3% of earnings per point change in IQ. The article is written in response to an "overstatement hypothesis" on the link between IQ and earnings, where the impact is considered to be closer to 0.5%. The authors conclude that this lower estimate corresponds with their own estimates of the direct effect of IQ on earnings.

Overall, we consider the evidence for the link between lead exposure and earnings is not as strong as it could be. The main study we rely on in our cost-effectiveness analysis uses a range of 1.76% to 2.37% for the impact of a one point reduction of IQ on earnings, with a mid-point estimate of 2% [2]. In our CEA model we use a lower estimate of 1%, an estimate which is in line with that used by GiveWell in its CEA models [24].

4.2 Limiting factor

Score: 6/10

The main limiting factor for this intervention is the existence of IPEN, a very good organization working in the space, which has received a grant for its lead paint policy work from GiveWell. It has a large lead paint program, has been involved in passing a number of lead paint policies historically, and currently works on lead paint in around 25 countries. It seems likely that it will continue to work in more countries if it successfully passes policies in the countries it currently works in.

While this will limit the scope to some extent, there are still over 100 countries without confirmed lead paint policies, so there are many countries to work in and to expand into. A new organization may be limited to bringing regulations forward in these countries by several years, rather than introducing regulations which would otherwise never exist. However, these benefits could still be substantial.

There are also positive aspects to the existence of IPEN in terms of starting a new organization. For example, a new charity can become a member of IPEN's network and take advantage of its extensive research on lead paint in different countries, and make use of its technical and policy expertise. This would help address the bottleneck of the technical expertise required to introduce policies. Support from IPEN would make it significantly more likely that a new organization will achieve policy change in a new country. For more detail on how a new organization could fit into the space, refer to our conversation with IPEN's Björn Beeler.

Fundraising is likely to be challenging; this was a key issue raised by IPEN in our discussion with them. However, a new organization in this space is likely to be able to run on a relatively low budget. In its conversation with GiveWell, IPEN estimated the cost of a campaign to be $50,000 per year [25]. We overall consider funding to be less of a problem due to the relatively low cost of campaigns.

4.3 Execution difficulty

Score: 6/10

This intervention should be slightly easier to execute than some of the other policy interventions being considered or already incubated by Charity Entrepreneurship, such as alcohol and tobacco regulation. This is because there is less of an opposition lobby group - the industry is generally supportive of lead paint regulation [26].

There is also a framework for introducing lead paint regulation, for example, the Lead Paint Alliance's model law and other resources, and IPEN can provide technical and policy support. Both of these factors will address some of the technical difficulties associated with this intervention, which would otherwise be very difficult for a new organization to obtain. While they will make the probability of success higher, we still consider it will be relatively low compared to non-policy interventions.

An important requirement for the success of a new organization working on this issue will be to build good relationships with government bodies and other NGOs working in the space, as well as potentially industry bodies. This may be challenging for a new charity, especially one coming from another country, as it may not have a good understanding of the local context.

4.4 Externalities

Score: 6/10

The externalities seem generally positive for this intervention. There is broad agreement that lead exposure is harmful and increasing IQ is good, suggesting most people would be in favor of this intervention.

The intervention is expected to have a large impact on growth, which is correlated with many other positive social outcomes such as life expectancy, life satisfaction, education, child mortality, and others [27].

While the main benefits of IQ are estimated to be reductions in intellectual disability and increases in individual incomes, an increase in IQ at the population level will also shift more people into the 'gifted' range (i.e. IQ of 130+) or more generally into the highest intelligence brackets in a society. This is likely to create additional societal benefits, for example through increased innovation, which are not captured in the direct analysis.

This intervention should also provide information about advocating for policy change for the EA movement using a relatively non-risky intervention.

5 Cost-effectiveness analysis (CEA)

This section provides an overview of our CEA, which weighs the expected cost of this intervention against the expected good accomplished.

Our models estimate the effect of introducing the regulation in a notional average sub-Saharan African country. This means the population the intervention is assumed to affect is a constructed population which has the average features of the region (e.g. population size, GDP per capita, etc.). This allows for comparison between interventions that will likely affect similar populations.

The model assumes that the introduction of lead paint regulation will limit *additional* exposure to lead from paint that would otherwise occur if lead paint regulation is delayed. We assume that existing costs will continue to be incurred, under the assumption that those costs are the result of existing lead in the environment, the removal of which will need further action beyond regulation.

Overall, we estimate that lead paint regulation is a highly cost-beneficial intervention, with each dollar invested expected to generate a return of around $74 (all figures are in international dollars [28]). Using estimates of the trade-offs people make between health and income (see 'Moral weights' section), we estimate this translates to approximately $156 to avert the equivalent of one DALY.

When interpreting the benefit-cost ratio and cost per DALY, it is important to note that our estimates depend on various model assumptions, which are consistently estimated within our global health and development policy research, but not necessarily outside of it. See 'Where our CEA could go wrong' section for discussion of the key assumptions.

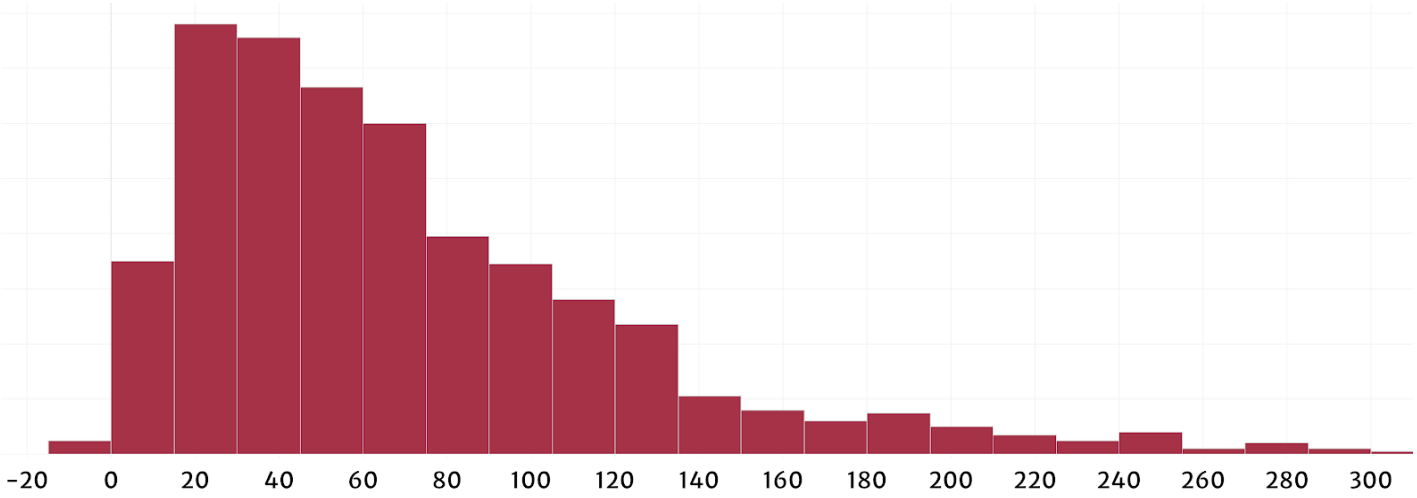
We estimated the following benefit-cost figures:

Spreadsheet CEA model estimates:
Benefit-cost ratio 74:1 (90% credible interval, 12:1 to 195:1)

The histogram below plots the distribution of benefit-cost ratios (BCR) simulated in the spreadsheet model. As the chart shows, the distribution is skewed to the right, indicating that in the majority of cases the estimated BCRs were clustered around the peak of the distribution, but in some cases the BCRs were much higher than the peak, generating very high returns on investment. This has the effect of dragging

the mean BCR upwards. The median BCR in the spreadsheet model is 58:1; it is lower than the mean, which reflects the skew in the distribution.

Distribution of benefit-cost ratios estimated in the uncertainty analysis



We also ran the CEA accounting for the counterfactual impact of funding and co-founder time costs. We assume that co-founders' impact would be equivalent to a donation of $25,000 each per year to GiveWell's top charities. To account for the counterfactual funding cost, we assume a range of impacts. Our central estimate assumes that 25% of the funding would come from charities equivalent to the Against Malaria Foundation, and 75% from charities equivalent to GiveDirectly. With these assumptions, the BCR falls to around 30:1. Note that these numbers are based on very rough comparisons of the impact of GiveWell charities versus this potential charity, so should be interpreted cautiously.

This section describes the model inputs and assumptions. We look at the following factors in this section:

- Effectiveness
- Costs
- Other model assumptions

We then discuss the main model limitations and report results of sensitivity analysis of several of the key model assumptions in the 'Where our CEA could go wrong' section.

5.1 Effectiveness

There are two sources of impact for this intervention: health and income. These are described below.

Health effects

The health effects of lead exposure are estimated in the Global Burden of Disease 2017 study [14]. The study estimates the impact in disability-adjusted life years on a range of health outcomes, including intellectual disabilities, cardiovascular diseases, and kidney diseases.

The total estimated number of DALYs lost in sub-Saharan Africa due to lead exposure is 1.2 million. For the analysis, this figure is adjusted to apply to a notional average sized sub-Saharan African country, calculated as the total population divided by the number of countries in sub-Saharan African. The estimate is also adjusted to account for the proportion of lead exposure due to lead paint, which we assume to be 25% (see 'Other model assumptions' section below).

We then consider two scenarios:

1. We start the charity, and regulation is introduced after 5 years. In this scenario, the costs grow at the rate of additional exposure for five years, and then, assuming full compliance, remain constant.
2. We do not start the charity, and the introduction of regulation is delayed by eight years. In this scenario, the costs grow at the rate of additional exposure for 13 years, and then, assuming full compliance, remain constant.

If the charity we start succeeds, its health impact will be the difference between (1) and (2). This difference is estimated using estimates of the additional exposure due to lead paint over time (see 'Additional lead paint impact per year' below). We consider that we have a 20% chance of success, and that compliance to regulations will be 50%, so we adjust the expected impact in line with these figures. The impacts are estimated over a twenty year time horizon, starting fifteen years after the policy is introduced.

We then converted the health effects into monetary terms. The monetary value of averting a DALY is assumed to be equal to 2.8 times the per capita income in sub-Saharan Africa. This is based on research of the trade-offs people are willing to make between income and health (see 'Moral weights' section below). Since per capita income is rising in sub-Saharan Africa, the value of averting a DALY increases over time in the model. Finally, the impacts are converted to present value

terms, using a discount rate for future impacts of 4% per year. Further details of the assumptions described here can be found in the 'Other model assumptions' section below.

Income effects

The income effects of lead exposure in low- and middle-income countries are estimated by Attina and Trasande (2013) [2]. The study estimates a total loss in Africa in 2011 of $134.7 billion. We exclude the costs in North Africa, adjust the figure to apply to the notional sub-Saharan African country in the way described above, account for the increase in lead exposure and increase in incomes since the estimate, and then uplift it to 2020 prices. As with the health effects, it is also adjusted to account for the proportion of lead exposure due to lead paint. A relatively wide confidence interval is assumed for this value to account for the uncertainty associated with it.

We use estimates from Gould (2009) to account for additional economic costs due to lead exposure [19]. The main cost is the cost to the health care system; the second most significant cost is the direct cost of crime, which accounts for less than 1% of the earnings impact. We exclude tax revenues, considering these a transfer from citizens to government. The total additional costs are roughly 17% of the total earnings cost; Gould (2009) estimates in the U.S. these are around one-third of the total economic impact.

We estimate the total economic impact of introducing the policy using the same approach as the health impacts: as the difference between the impacts of introducing the regulation in year five versus year thirteen, accounting for compliance and probability of success. We again estimate over a twenty year time horizon starting fifteen years after the policy is introduced, and convert the economic impacts to present value terms using a discount rate of 4%.

5.2 Costs

Charity costs

The charity costs are made up of fixed costs to set up the charity and ongoing annual costs to operate it, and ongoing costs after the policy change. Fixed costs in the first year are assumed to be $100,000; costs after this are assumed to be $150,000 per year until the policy is introduced, and a lower cost of $75,000 per year after that. This may be a slight overestimate, as after speaking with IPEN, we learned that organizations working on lead paint are often operating on

significantly lower budgets. This is also confirmed in IPEN's conversation with GiveWell, where the campaign costs are estimated at $50,000 per year [25]. However, to remain consistent with our other intervention reports, we assume these higher amounts.

Ongoing cost of regulation

We were unable to find data on the ongoing cost of enforcing lead paint regulation. Therefore, we have assumed the costs are equal to the costs of the WHO's "best buys", which estimates a cost of $0.10 per capita in low-income countries [29]. One reason it may be higher is that the framework for regulating the best buys (such as taxation) is probably already in place, while lead paint regulation may require equipment to test lead content that may not exist. We try to account for this in the assumption for the compliance rate rather than here.

Discount to government costs

We expect that government spending will be less impactful than philanthropic spending, which can be directed to highly cost-effective charities. Therefore, we discount government costs that we expect to redirect to alcohol policy. Our approach is to discount these costs by 50%. This is an approach that has been used by GiveWell in the past, for example in its CEA of pesticide regulation [30] [31].

5.3 Other assumptions

Charity years operating

The WHO's guidance on cost-effectiveness analysis suggests that an intervention should be assumed to run for ten years [32]. We consider this to be roughly appropriate, and assume this will be the case for each of the interventions we consider. In this case we assume the policy will take five years to introduce; after this the charity may need to continue to work on issues around monitoring and compliance.

Stopping point if charity is unsuccessful

We assume that the charity will definitely run for five years at full cost. At this point, if the intervention looks very unlikely to succeed, we assume the charity will end its operations. Our model therefore assumes that after this point the charity costs are incurred only in expectation.

Time taken to introduce regulation

We have assumed it will take five years to write and introduce the regulation. This period will include time taken for the charity to build the required knowledge around lead paint regulation, to convince the government to introduce the regulation, and for the regulation to be written up and introduced. IPEN suggested that we can expect it to take 2-3 years, so this may be a conservative estimate.

Year at which regulation costs begin

This is estimated as 50% of the total time taken to write and introduce the regulation. It reflects the fact that it will take some time before the new charity convinces the government to introduce regulation, and the costs to the government of doing this are not incurred until the government decides to do so.

Years until benefit will be felt

We assume the benefits will be felt in twenty years on average, taking into account that some of the benefits will be felt sooner and others later. For example, the intellectual disability benefits will be felt sooner after the policy; the earnings impact will be felt some time later, once the non-exposed children reach working age; and the health impacts due to cardiovascular disease will be felt later.

Discount rate

We discount future costs and benefits at a rate of 4% per year, in line with GiveWell [33]. There is a debate over the appropriate discount rate, with the WHO using a rate of 3% for health impacts [32], and the UK Government guidance suggesting a lower rate than this for health impacts and a slightly higher rate for other impacts [34]. We consider a rate of 4% appropriately captures our views on a relatively low pure time preference (i.e. a low discount to future utility), the impact of increasing incomes over time which reduce the benefit of income, and uncertainty. It also has the additional benefit of being comparable to GiveWell.

Years policy is brought forward

Our model assumes that by starting a charity in the space we will bring a policy that will otherwise be introduced forward by eight years. The WHO and the UN had a goal of ensuring all countries had policies by 2020; this has been missed, with regulations in only 39% of countries. IPEN has a goal of 2030, though there are still many countries where little campaigning has taken place so far - IPEN currently works in 25 to 30 countries [25], but there are over 100 without confirmed regulations (over 60% of all countries). However, it could be that a tipping point is

reached, and after this point countries will very quickly start to introduce regulations. Overall we consider eight years to be a reasonable assumption, though we test the sensitivity of this in the 'Where our CEA could go wrong' section.

Time horizon

We assume that once introduced, the impacts of the regulation will last for twenty years. A range of time horizons are used in cost-effectiveness analyses; in our case we consider twenty years to be reasonable because this is a regulatory change which can be expected to have lasting effects. This is quite a subjective assumption; our approach is to model the time horizon consistently across all of our interventions to ensure they are comparable.

Counterfactual impact

We account for the counterfactual impact in our assumption for the number of years the policy is brought forward, therefore we do not make a further adjustment through this input.

Probability of success

This reflects the probability that the regulation will be introduced and remain in place for the period analyzed. We have assumed 20%, which is the average estimate of the authors of this report. It is based on the assumptions that while policy change is very difficult to achieve, there are several factors making this intervention more likely to succeed, including historic successes in this area, support from IPEN, and the lack of a strong counterlobby. We also take into account GiveWell's estimates of the likelihood of policy change in its pesticides CEA model [30]. We consider that the most important part of this assumption is to ensure the probabilities across the interventions being considered are consistently estimated.

Proportion of lead exposure due to lead paint

Only a proportion of lead exposure is due to lead paint. Historically the most common source has been leaded gasoline, but this has been successfully phased out across the world. In the US, after the elimination of gasoline, lead paint has been estimated to be the source of 70% of lead exposure [35]. We could not find evidence on the proportion in developing countries. Conversations with several experts suggested a reasonable assumption would be around 25%, so we have used this in our analysis.

Compliance to regulations

It is unlikely that there will be 100% compliance. Based on our interview with Toxics Link who worked to introduce regulation in South Asia, regulations were introduced in India in 2019 and compliance is currently 75-80%. In sub-Saharan Africa there is a lack of testing facilities, so compliance is likely to be lower than this. Overall, we estimate a compliance rate of 50%. This estimate also takes into account the fact that our model assumes some government costs to monitor and ensure compliance once the regulations are passed.

Population affected

We have assumed this intervention will affect a notional average country in sub-Saharan Africa. The total population of SSA is 1.1 billion, and there are 46 countries in SSA, so our analysis assumes the population affected is 23.4 million [36] [37].

Population growth rate

The population growth rate is taken from the World Bank [38]. The current annual growth rate is assumed to continue throughout the period of the project.

Country income per capita

This is the current income per capita in sub-Saharan Africa in international dollars from the World Bank [39].

Country growth rate

This is the World Bank's estimate of growth in Africa [40]. It has been assumed to continue for the period of the project.

Discount factor to IQ effect

The estimated benefits in Attina and Trasande assume that a unit increase in IQ is associated with a 2% increase in earnings [2]. As discussed in the 'Weighted Factor Model' section, overall we use an estimate of 1% in our model, in line with GiveWell [24].

Additional lead paint impact per year

Our model assumes that the benefit of introducing lead paint regulation will be through averting additional lead exposure that would have otherwise occurred without regulation. We estimate additional exposure to lead paint of 2% per year. This is based on several assumptions including estimates of the size of the lead

paint market in sub-Saharan Africa [41], the proportion of paint that is used in households [42], and the proportion of paint that contains lead [43]. Paint markets are also growing in low-income countries, so we include a factor for this growth. Further details can be found in the 'Paint market' tab in the spreadsheet model.

Moral weights

The moral weights allow us to convert between impacts expressed in health and monetary terms. They are estimated based on GiveWell's and IDinsight's research on how people make trade-offs between income and health [44]. In its CEA model on Fortify Health, GiveWell assumes that 2.8 years of income is equivalent to one DALY [45]. We use this assumption in our analysis to convert between health and economic impacts so that we can report benefit-cost ratios and costs per DALY equivalent averted.

5.4 Where our CEA could go wrong

We considered how our CEA could go wrong in each step. There are several key assumptions which we believe are worth noting:

- The benefits rely on estimates of additional exposure to lead due to additional lead paint that will no longer enter the market. We are uncertain about these effects, as we have estimated them based on several sources on the paint market in low-income countries and how it is growing. This will be an important area of uncertainty to resolve to maximize the benefit of this intervention (for example, by choosing countries with large paint markets with high lead content paints).
- The future earnings benefits, which make up the majority of the benefits of this intervention, rely on an estimate from one key study. This estimate is widely cited, and estimates of benefits in developed countries are similarly large, but it would be ideal to have multiple estimates of this effect given how reliant the intervention is on this. We have discounted the impacts cited in this report, assuming that a unit increase in IQ is associated with a 1% increase in earnings compared to 2% used in the paper. This is in part to account for the uncertainty, and in part as it better reflects our own views.
- Our estimates rely on subjective assumptions about the probability of success. We are quite uncertain about this assumption and another researcher or charity entrepreneur could have significantly different intuitions about it. We assume a 20% probability of success; at a level of 5%, this intervention would generate benefits around 60% as high as our central estimate.

- In line with our other reports, we assume a discount rate of 4% for future costs and benefits. The benefits for this intervention happen quite far into the future, so it is a particularly important assumption for this report. This is particularly the case as incomes are rising due to the decreasing marginal utility of income. At a discount rate of 7% it would generate a return of roughly 60% as large as our central estimate.
- Our analysis models the impact on a constructed population reflecting the average characteristics of a sub-Saharan African country. This was done to ensure comparability across interventions, but it may result in an underestimate of the true cost-effectiveness, as a new organization would choose to work in a country that has the highest potential for impact.
- There is a lack of data on the ongoing cost of lead paint regulation. We have assumed the cost is the same as the WHO's best buys, a level of cost we have used for other interventions. It is unclear whether this level of cost is appropriate, but our best guess is that this is a reasonable assumption.
- We do not apply discounts for the evidence on health and economic impacts, though there are arguments to do this [46]. Our approach is to use the quality of evidence behind the interventions as a criterion to make an overall judgment about which interventions are likely to be most impactful.
- In our main model, we do not account for the counterfactual impact of co-founder time and funding. This is because these inputs are very uncertain, and are also expected to be roughly consistent between the interventions. However, interpreting the main CEA estimates directly may overestimate the benefits, because we do not account for the fact that some of the resources would have gone to high-impact interventions otherwise.
- We only model the impact of a new organization working to pass a policy in one country. In reality it is possible that a new organization will be able to promote policy change in this space in more than just one country, and so the actual benefits of this intervention could be underestimated by our model.

6 Informed consideration: Internal contemplation

In this stage, we analyzed all the data and insights gathered through previous steps in the research process. The most important conclusions from each are summarized here, as are our overall thoughts on lead paint regulation as an intervention.

The first informed consideration stage was used to build background knowledge of lead paint regulation as an intervention. We found that lead exposure is the cause of 24 million DALYs worldwide every year. The effect of lead exposure on IQ, which in turn affects productivity, has been found to cost low- and middle-income countries almost $1 trillion globally every year.

We also found this issue seemed highly neglected, with only 39% of countries with regulations in 2020. However, we considered that this may also be misleading, as the Lead Paint Alliance and IPEN are working with many partner organizations to introduce lead paint regulations.

We carried out three interviews with experts to get a deeper understanding of how promising this intervention is. Our discussion with IPEN shed light on several issues. A key constraint to regulation being passed is funding rather than dedicated activists, so IPEN considered it would be better to support existing organizations or activists that are already part of their network. They also suggested that there are some completely neglected countries, and gave advice on how and where to focus if we were to start a new organization.

IPEN considered that with consistent funding for a few years policy change could be achieved, especially with the policy and technical expertise that IPEN would provide. This conversation substantially updated us on the probability of success of this intervention.

Our weighted factor model suggested a fairly positive picture. We judged the overall idea to be strong, though the strength of the evidence, particularly for the economic impact, could be stronger. We considered that there is scope for a new organization to expand into other countries, but it is likely that it will be bringing regulation forward by several years rather than introducing regulation that would otherwise never exist. We considered execution would be difficult, as with all policy interventions, but it will be made easier by the lack of a strong counterlobby, and with IPEN's technical and policy support.

The WFM also suggested that the externalities would be broadly good: increasing incomes is associated with many positive welfare measures; a shift in the IQ distribution will push more people into the upper 'gifted' range of the distribution, which could have broader positive effects; and lead paint is a relatively uncontroversial way for the EA movement to enter the policy space.

We modeled the impact of the introduction of lead paint regulation in a notional sub-Saharan African country in our cost-effectiveness analysis. Our model assumes that the new organization would bring regulation forward by eight years. Our analysis suggests a high return on investment, with a benefit-cost ratio of 74:1. Using estimates of the trade-offs people are willing to make between income and health based on GiveWell's research, we estimate this is to be equal to averting the equivalent of a DALY for $156.

While the cost-effectiveness analysis looks strong, an important caveat is that the estimate relies on quite uncertain analysis of paint markets in low-income countries. This will be an important area to get more clarity on, in order to choose the best countries to work in.

Overall, we conclude that this is likely to be a very strong intervention. It looks very cost-effective, it is relatively uncontroversial, and we consider the probability of passing a regulation to be relatively high. Further discussion is needed with IPEN to determine the best approach a new organization should take, but overall, we recommend this as an intervention for a new organization to work on.

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