LEEP cost-effectiveness analysis - Malawi

LEEP advocates for lead paint regulation in countries with large and growing burdens of lead poisoning from paint. Our first target country was Malawi. After testing all main brands of paint on the market, we demonstrated that local paint contained high levels of lead and was not in compliance with existing lead paint standards. We presented this data to the Malawi Bureau of Standards, who stated that it was a 'wake up call' and committed to immediately begin implementing their existing paint standards through regular monitoring and enforcement. We were informed that the regulations had not previously been implemented because it was not known that paint in Malawi contained lead. We are currently supporting the local lead paint manufacturers to make the changes necessary to comply with regulation.

This document provides an overview of our cost-effectiveness analysis (CEA). To view the full model, including in spreadsheet format, please open the CEA and create your own copy. Use the 'scenario' tab to view the two versions of the model (one with point estimates and one with uncertainty distributions).

Our model estimates the effect of LEEP's intervention to bring about the implementation of lead paint regulation in Malawi. The model assumes that the implementation of lead paint regulation will limit additional exposure to lead from paint that would otherwise occur if lead paint regulation is delayed.

Overall, we estimate that this is a highly cost-effective intervention. Using estimates of the trade-offs people make between health and income (see 'Moral weights' section), we estimate this translates to approximately $12 to avert the equivalent of one disability-adjusted life year (DALY). When interpreting the cost per DALY, it is important to note that our estimates depend on various model assumptions. See the 'Where our CEA could go wrong' section for discussion of the key uncertainties.

SUMMARY

In order to estimate the impacts on health and income of averting childhood lead paint exposure in Malawi we estimate the number of children newly exposed to lead paint each year in two scenarios:

- **Counterfactual regulation scenario: regulation implemented after 9 years.** This timeframe is a guess - we are not sure how long it otherwise would have taken for someone to test the paint and bring it to the attention of the government.
- **LEEP intervention scenario: regulation implemented after 1 year.** This timeframe is plausible - the Director of Testing at the Malawi Bureau of Standards confirmed in month 7 they have begun monitoring activities and that this action was taken as a result of our paint study and their interaction with LEEP.

In both scenarios children are newly exposed to lead paint each year and the number of children exposed depends on the size of the population and the percentage of homes painted with unregulated paint. The difference between the two scenarios is that in the counterfactual regulation scenario the percentage of homes painted with unregulated lead paint falls after nine years, while in the LEEP intervention scenario it falls after one year.

In each scenario the impacts on health and income change over time in proportion to the change in the number of children newly exposed to lead due to paint. The impact of LEEP on health and income is the difference between the two scenarios.

MODEL INPUTS AND ASSUMPTIONS

The percentage of homes painted with unregulated paint

The starting assumption is that the current percentage of homes painted is equivalent to the percentage of the population that lives in urban areas. This is because currently in Malawi homes in urban areas are predominantly painted, whereas homes in rural areas are unpainted. All homes that are currently painted are painted with unregulated paint, as regulation had not been implemented.

Before regulation is implemented the percentage of homes painted with unregulated paint is assumed to grow in proportion to the growth in the paint market, minus population growth. This assumes that house size and the number of people per house remain the same. Growth in the paint market in Southern Africa is estimated to be roughly 5%, which also corresponds to the growth rate of the urban population of 4.4% . We assume that this growth rate in the paint market will continue for 20 years, then decrease over time to approximately correspond to population growth.

Once regulation is implemented and compliance to regulation begins to increase, newly painted homes and repainted homes will be painted with regulated paint and so the percentage of all homes painted with unregulated paint will fall. The change in the percentage of homes painted with unregulated paint takes into account the growth in the paint market, compliance to regulation, population growth, and replacement or repainting of homes. The frequency of replacement or repainting of homes is assumed to be 2% per year - in other words, we assume that the average home is repainted or replaced once every fifty years.

Children newly exposed to lead due to paint

The number of children with lead poisoning in Malawi (blood lead level over 5ug/dL) is estimated by the Institute of Health Metrics and Evaluation to be 3.4 million. We estimate that the number of children newly exposed to lead in the first year is equivalent to the average number of children with lead poisoning in a one-year age cohort (3.4 million divided by 18 years). This assumes that newly exposed children develop lead poisoning that lasts their entire childhood. It could also be the case

that many more children are exposed per year but have lead poisoning for a shorter time period. This assumption does not impact cost-effectiveness, but does reduce the estimate for the number of children with lead poisoning averted due to the intervention.

We adjust down the number of children newly exposed to lead each year for the proportion of lead exposure which is estimated to be due to lead paint. Over time the number of children newly exposed to lead paint each year changes in proportion to population growth and the percentage of homes painted with unregulated paint.

Health effects

The health effects of lead exposure are estimated in the Global Burden of Disease Study 2019. The study estimates the impact in disability-adjusted life years (DALYs) on a range of health outcomes, including intellectual disabilities, cardiovascular diseases, and kidney diseases. The estimate is adjusted to account for the proportion of lead exposure which is due to lead paint, which we assume to be 20%. The estimated DALYs due to these health effects that occur each year is proportionate to the number of children newly exposed to lead paint.

Income effects

The income effects of lead exposure in low- and middle-income countries are estimated by Attina and Trasande (2013). We raise the estimate in line with inflation. As with the health effects, it is also adjusted down to account for the proportion of lead exposure due to lead paint. We apply a 50% discount to the income loss estimate. This is because the estimates in Attina and Trasande assume that a unit increase in IQ is associated with a 2% increase in earnings. We use a more conservative estimate of 1% in our model, which is also consistent with GiveWell.

Estimates for additional economic costs, such as health care and crime costs estimated by Gould (2009) were not included because of uncertainty about how these would apply in the Malawi context.

Moral weights

We convert the income effects into DALY-equivalents using moral weights. They are estimated based on GiveWell's and IDinsight's previous research on how people make trade-offs between income and health. In its CEA model on Fortify Health, GiveWell assumes that 2.8 years of income is equivalent to one DALY. We use this assumption in our analysis.

Time discount

We discount future costs and benefits at a rate of 4% per year, in line with GiveWell. There is a debate over the appropriate discount rate, with the WHO using a rate of 3% for health impacts, and the UK Government guidance suggesting a lower rate than this for health impacts and a slightly higher rate for other impacts.

Years until benefits will be felt

We estimate that on average benefits to health and income will be felt 20 years in the future from the time childhood lead exposure is averted, 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 regulation but the earnings impact will be felt some time later once the non-exposed children reach working age.

The proportion of lead exposure which is 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 childhood lead exposure. Generally, experts indicate that lead paint is an important current and future source of exposure in low and middle income countries, particularly those still using lead paint. We could not find evidence for the proportion of lead exposure that is due to paint in low and middle income countries, and therefore discount the 70% US estimate substantially to an estimate of 20% in Malawi. This is a major area of uncertainty. We hope to develop another method to estimate the impact of lead paint in homes on children's blood lead levels and will update this section once this research is complete.

Years taken to implement regulation with LEEP intervention

The Malawi Bureau of Standards confirmed in January (month 4) that they would immediately implement existing regulation, which had not been implemented due to the perception that there was no lead in paint. In April (month 7) the Bureau confirmed that they are going ahead with implementation and paint samples are being collected to monitor for compliance.

Years regulation brought forward

In Malawi there was already lead regulation within existing mandatory paint standards but it had never been implemented. This was reported to be because it was not known that lead was present in paint in Malawi. Before our paint study, discussions with the Bureau of Standards indicated that action would not be taken towards reducing lead in paint without evidence that it was a problem. Once we presented our study showing high levels of lead in paint the Bureau of Standards confirmed that they would implement the regulation with monitoring and enforcement as a result of the new data. It seems likely that the regulation would not have been implemented until a study like this was carried out and evidence was presented showing lead in paint. Eight years is an uncertain estimate for the number of years regulation was brought forward by LEEPs intervention. This assumption accounts for counterfactual impact, so further adjustment is not made for counterfactual impact.

Compliance once regulation is implemented

Once regulation is implemented compliance is assumed to be 25% in year 1, 50% in year 2, then increase to reach 100% after 15 years. In Malawi we expect this level of compliance to be achievable

in part because the Bureau of Standards has testing facilities and capacity for enforcement. As well as this there are only four local manufacturers and two imported brands of paint to monitor. In India regulations were introduced in 2019 and by 2020 compliance was 80% according to Charity Entrepreneurship's interview with Toxics Link.

We expect LEEP's paint industry outreach to increase the likelihood of compliance. LEEP has been in contact with the four local manufacturers that produce all of the lead paint identified in our paint study. We offered to provide technical and practical advice to support their switch to lead-free and they have engaged with us positively. All of the local lead paint manufacturers expressed willingness to switch to lead-free if alternative ingredients are locally available at a reasonable price. Based on analysis of the results of our paint study, lead-free ingredients are already being used locally in certain paints. This suggests that they are locally available and in a comparable price range. We are collating the details of these lead-free alternative ingredients and their suppliers to provide a list to paint manufacturers. We will continue to engage manufacturers to support their switch and also follow up with a repeat paint study to quantify compliance.

Population of Malawi

The population and future population of Malawi is estimated by UN population projections.

Income per capita in Malawi

The income per capita of Malawi and growth rate is estimated by the World Bank. The growth rate is assumed to continue for the time-frame of the model. This assumption does not impact cost-effectiveness in the model.

Probability of regulation implementation with LEEP intervention

We estimate this probability to be high (80%) because in January the Director of Testing at the Malawi Bureau of Standards confirmed verbally and in writing that the Bureau will begin enforcing lead paint regulation immediately due to the findings of our paint study, and have since confirmed that they have begun. They continue to engage in communication with us regarding our outreach to the paint industry to support the switch to lead-free. They have also encouraged us to repeat our paint study in a few months to compare our market samples to their internal monitoring. This is all suggestive that regulation is being implemented through the Bureau of Standards' monitoring and enforcement.

Time-frame

We include the health and income effects occurring from the lead exposure that is averted over a 20-year time-frame from when regulation is implemented. This is a subjective assumption and is low relative to the long-lasting impact of lead paint in homes.

Annual charity costs

LEEP's annual charity costs are estimated based on our budget for year one, and are approximately the fixed costs of continuing to run the organisation without scale-up. This is a conservative estimate because the year one budget also covers activity in 2-3 other countries and in future years a lower proportion of this budget will be required for ongoing activities in Malawi. We do not account for the counterfactual impact of funding and co-founder time in LEEP's costs.

Charity years operating in Malawi

The annual charity costs are assumed to continue for 4 years after implementation of regulation as we expect to continue operating in Malawi to support the paint industry's switch to lead-free, and to support monitoring and enforcement if needed.

Annual government costs

Our estimate for annual government costs is relatively low because the Malawi Bureau of standards has existing capacity, including testing facilities, paint sampling audits, and a certification scheme for paints. In addition, the paint industry currently consists only of four local paint manufacturers and two imported paint brands, reducing costs of monitoring and enforcement. Costs are expected to consist only of additional staff time to follow monitoring and enforcement processes. We assume that our intervention is only responsible for the costs that occur in the years that regulation is brought forward. We also assume that the government costs will begin immediately.

Discount to government costs

We discount government spending that is redirected to lead paint regulation because we expect it would otherwise be spent on less cost-effective activities, making it less counterfactually valuable. Our approach is to discount government costs by 50%. This is an approach which has been used by GiveWell in the past, for example in its CEA of pesticide regulation.

WHERE OUR CEA COULD GO WRONG

- The estimated benefits rely on an estimate for the proportion of lead exposure that is from paint in Malawi. As discussed above, this estimate is very uncertain. According to our model, if 5% of childhood lead poisoning in Malawi is due to lead paint rather than 20%, the cost per DALY-equivalent averted increases from $8 to $34. If the proportion of lead exposure due to paint were 35% in Malawi, the cost per DALY-equivalent averted would decrease to $5.

- The estimated benefits rely on uncertain estimates of the growth of the paint market, which influence the rate at which the proportion of homes painted with unregulated paint decreases after regulation implementation. We are uncertain about these estimates, which are based on several sources on the paint market in Africa. This may not be an accurate

estimate for the growth rate in the relevant part of the paint market, which is solvent-based paints in Malawi. Solvent-based paints can contain lead, whereas water-based paints typically do not. In the Middle East and Africa solvent-based paints are currently estimated to take up 60% of the market share. We would expect this to decrease over time, perhaps to become more similar to Europe and North America, where solvent-based paints take up 20-30% of market share. We have not accounted for this in our model because it is not clear that this change would take place within the relevant timeframe, and even in countries with predominantly water-based paint markets, solvent based-paints are still used in homes on windows and doors due to higher durability. Paint on windows and doors is thought to be a significant contributor to lead dust and flakes due to mechanical wear.

- Our impact relies on a very uncertain estimate for the number of years that regulation implementation is brought forward due to LEEP's activity. In our analysis we assume that lead paint regulation would have been implemented and enforced 8 years later if LEEP had not been active. This is a guess. If it would have been implemented 4 years later without LEEP cost-effectiveness would be $12/DALY-equivalent averted, and if it would have been implemented 12 years later, cost-effectiveness would be $7/DALY-equivalent averted.

- Compliance with regulation is another uncertain estimate that also influences that rate at which the proportion of homes painted with unregulated paint decreases after regulation implementation. If monitoring and enforcement by the Bureau of Standards is ineffective or our industry outreach and support for switching to lead-free is insufficient, compliance may be slower to increase than expected. In our model compliance is 25% in the first year, 50% in the 2nd year, then increases by 4% per year. If compliance is 25% for the first two years, then increases by 4% per year thereafter, the cost per DALY averted is $11 rather than $8.

- The future earnings benefits, which make up the majority of the benefits of this intervention, rely on an estimate from one key study (Attina & Trasande 2013). This estimate is widely cited and estimates of benefits in high-income countries are similarly large (Gould 2009, Grosse 2002, Salkever 1995). It would be ideal to have multiple estimates for the effect in low-income countries given how reliant the intervention is on this. To account for uncertainty we have discounted the impacts cited in the Attina & Trasande study by 50%. The study assumes that a unit increase in IQ is associated with a 2% increase in earnings, while we assume that a unit increase in IQ is associated with a 1% increase in earnings. If we were to discount the impacts cited in the study further to 25% estimated cost-effectiveness would reduce to $15/DALY-equivalent averted.

- 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 an important assumption for this model. Benefits to health and income are assumed to on average be felt 20 years in the

future from the time childhood lead exposure is averted, so the time-discount is increased inline with this

- In our model we do not account for the counterfactual impact of co-founder time and funding. Interpreting the 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 LEEP working towards lead paint regulation in Malawi. The cost-effectiveness estimated may not be cross-applicable to our other target countries.