The Value of Reducing Children's Exposure to Lead (Pb)

A stated preference approach

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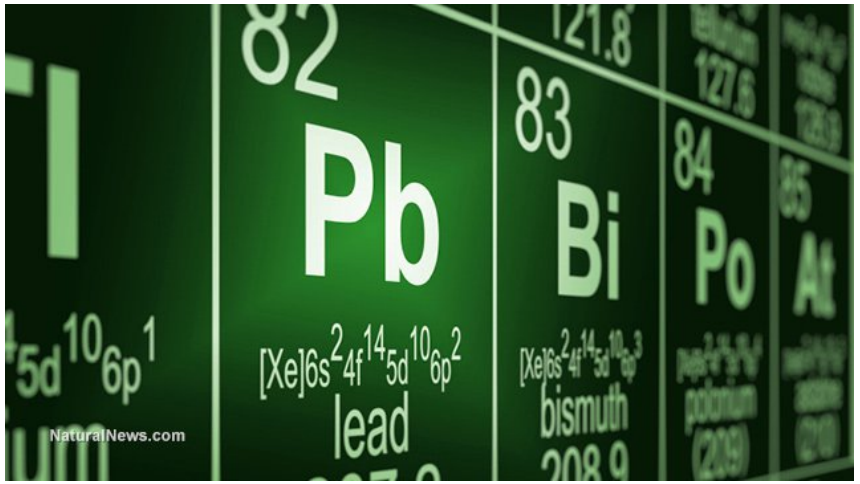
Overview

A new approach to valuing lead (Pb) exposure

- Lead and its health impacts
- Existing literature
- Methods
- Results
- Discussion & Conclusion
- Questions and Further research

Lead and its health impacts (1)

- High lead exposure can cause damage to the central nervous system, blood cell creation, liver and kidneys
- **No safe threshold**
- Chronic lead exposure is still a concern, especially in **young children**:
  - Greater absorption rate
  - Developmental vulnerabilities
  - Mouthing



(Ziegler et al. 1978; Tong et al. 2000; Lanphear et al. 2002; Lidsky and Schneider 2003; Koller et al. 2004; Kalia and Flora 2005; Bellinger 2008; Chandramouli et al. 2009)

Lead and its health impacts (2)

- **Low-level lead exposure** in young children can cause physical and neurobehavioural effects:

  - Immune system damage
  - Reproductive impairments
  - Delayed growth

  - Learning difficulties
  - Antisocial behaviour
  - **Reduced IQ scores**

- Estimated **gain of 1 IQ point per 1.949 µg/dL BLL reduced** (Lanphear et al. 2005; Gould 2009)

(Grosse et al. 2002; Selevan et al. 2003; Miranda et al. 2007; Nevin 2007; Reyes 2007; Bellinger 2008; Chandramouli et al. 2009; WHO 2010; McLaine et al. 2013)

Valuing IQ

- Estimated effect of IQ changes on lifetime earnings
  - e.g. 1 IQ point reduction = 2.4% reduction in lifetime earnings (EPA 1998)
- Household-level valuations of non-use benefits
  - **Revealed preference** – using chelation therapy payments in the USA. WTP per IQ point of just over £1,000 (Agee and Crocker 1996; Lutter 2000)
  - **Stated preference** – using a parental valuation of a hypothetical 10 year-old child in the USA. WTP per IQ point of £400 (von Stackelberg and Hammitt 2009)

(Grosse et al. 2002)

Objectives

- Provide new (and policy relevant) approach to valuing lead exposure
- Strong focus on respondent education regarding the lead>IQ>end-point scenario
- Explore scope sensitivity
- Provide a household measure of IQ change value (in the context of lead exposure)
    - Also relevant to other heavy metal exposures, health treatments and education policies

(Hansen et al. 2004; Mulhern et al. 2005; Brown 2007)

Survey Design

- Payment vehicle

5-18% EU children <3 years potentially exposed to lead via consumer products (ECHA, 2013)

- Focus Groups

- Pilots

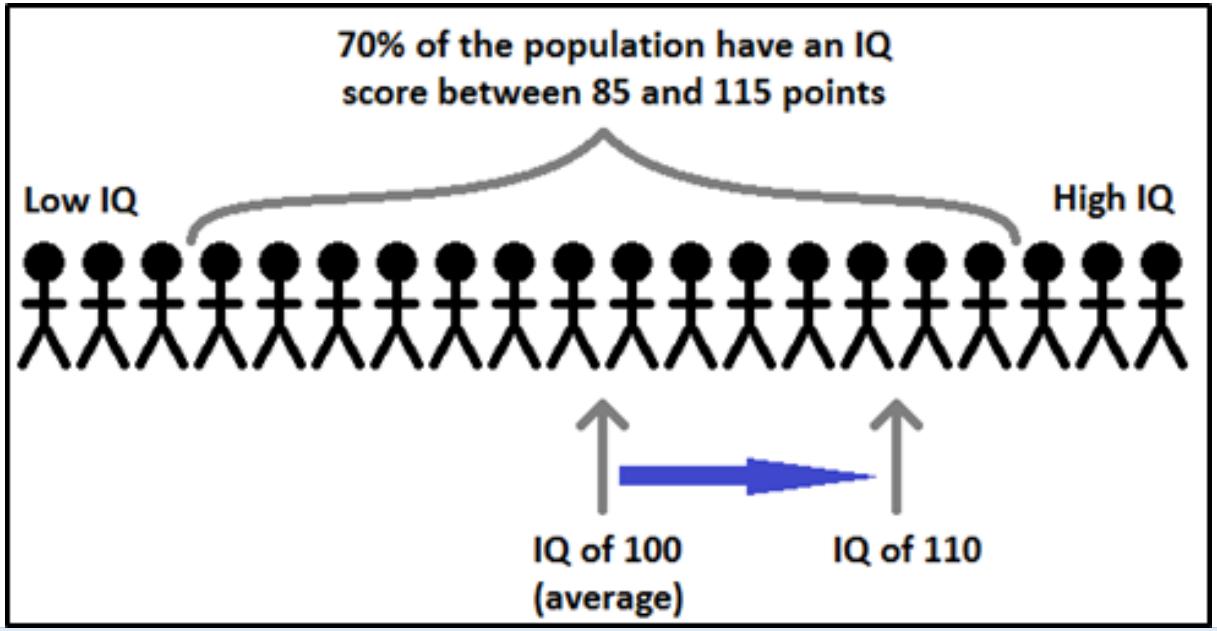
- Online survey (15minutes) to >3,000 respondents (July 2014)

  - Attitudes, knowledge and behaviour
  - Educate respondents (juvenile lead exposure; IQ changes; quiz test)
  - DBDC WTP question and follow-ups
  - socio-economic characteristics

The IQ change scenario (1)

The IQ scale

"For the [number of] children who will be affected by this new regulation, **their IQ score is expected to increase by about 10 points** as a result of their reduced exposure to lead (Pb)."



The IQ change scenario (2)

The IQ change context

- Used background information from the IQ change literature

- Interviews/discussions with experts in public health, childhood learning and IQ measures including:
  - Anna Freud Centre
  - Early Intervention Foundation (KCL)
  - University of Bristol
  - Centre for Cognitive Ageing and Cognitive Epidemiology (Edinburgh Uni)
  - Family Achievement Clinic (Cleveland, USA)
  - Institute of Education (University of London)
  - Psychometrics Centre (Cambridge Uni)
  - Public Health England
  - Penn State College of Education (USA)
  - University College London

(Mackintosh and Mascie-Taylor 1985; Deary et al. 2007; Wright et al. 2008; Mackintosh 2011)

The IQ change scenario (2)

The IQ change context

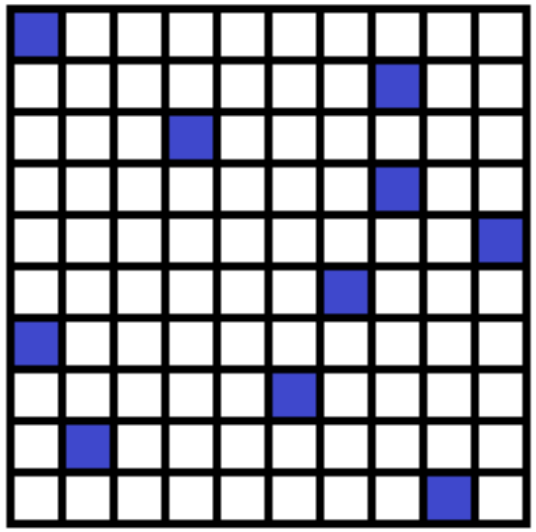
Compared with a child who has the average IQ of 100 points, when a child with an IQ of 110 points grows up she/he is:

- Expected to have a better paid job with more responsibility
- Less likely to get arrested
- More likely to live in a detached house
- Expected to earn at least two extra GCSEs at grades A*–C
- More likely to take school subjects such as English, Maths, Science, Geography, History and Language

The IQ change scenario (3)

Outcome probability variations

- Probability was repeated throughout the survey - either ‘1 in 10’, ‘1 in 100’ or ‘1 in 1,000’
- Tested in ‘true or false’ quiz
- Visual aid provided



The WTP Question

- Two-week payment period
- Previous fortnight spend exercise
- Cheap talk
- Minimum time limits used throughout

“Over a typical two-week period of time (not necessarily the last two weeks), do you think your household would be happy to pay the following extra amount (above and beyond your normal spending habits) for these three groups of consumer products?”

10p **£1** **£3** **£8** **£20** **£70**

Protests and Non-responses

- 3,197 completed surveys
- 170 (5%) removed (protest or invalid bids)

  (e.g. “did not understand the WTP question” or “did not believe the scenario to be realistic”)
- 374 declined household income – assigned the average
- Minimum response times set

(Bateman et al. 2002)

Results

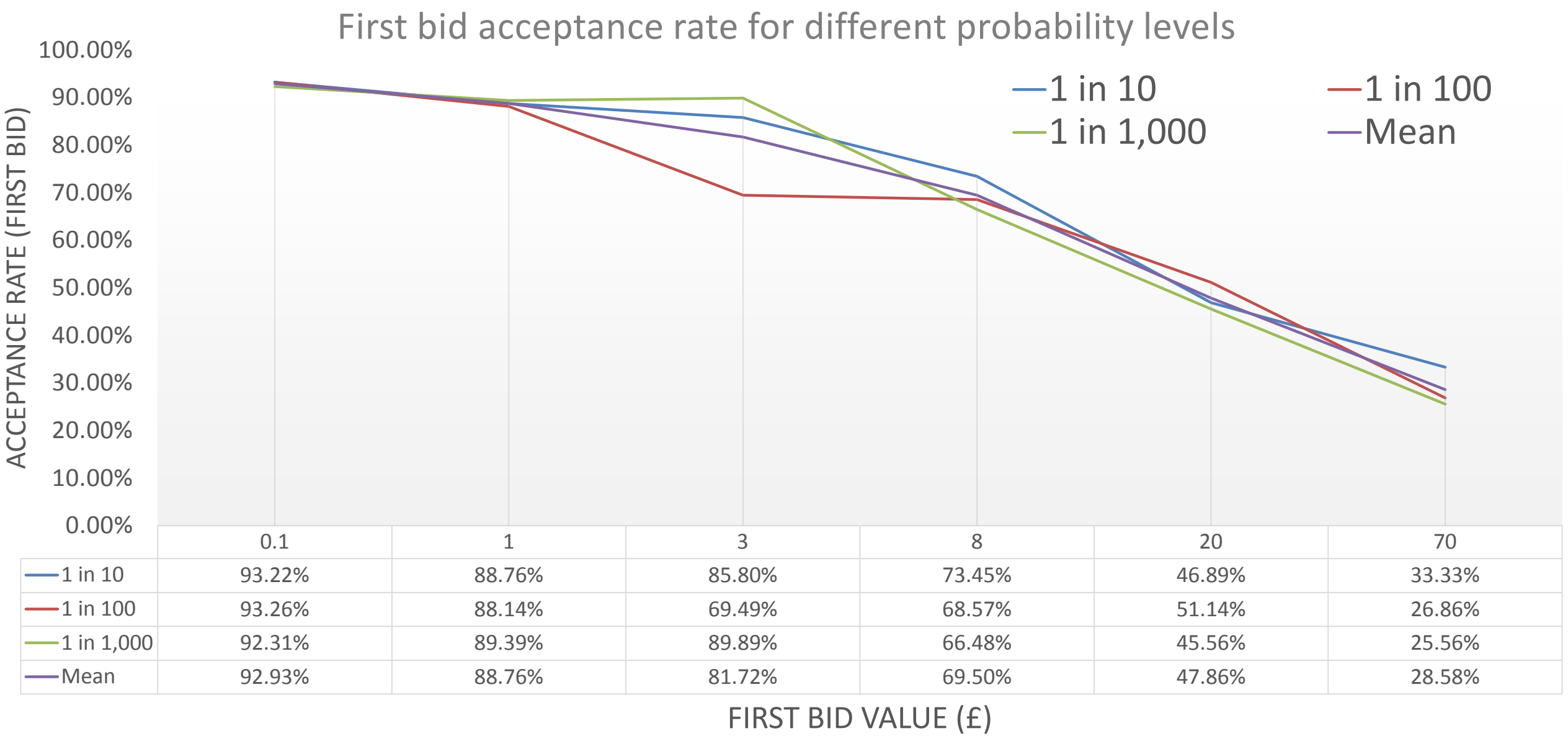
- Logit, Probit and DBDC models were run
- DBDC models produced considerably smaller WTP estimates
- Most variables performed as expected
- Sample weights had negligible impact on WTP

Logit: Compared with '1 in 10' outcome probability, firstbid acceptance probability drops:

- **19% (p<0.05) for '1 in 100' probability**
- **28% (p<0.01) for '1 in 1,000' probability**

Variable	Coefficient	95% Confidence Intervals
prob 0.001	397.5816*** (21.51486)	355.4133, 439.75
age	–1.549377** (0.74988)	–3.019115, –.079639
parent	52.3062** (23.07733)	7.075457, 97.53694
hhincome	1.365592*** (0.3802261)	.6203623, 2.110821
envreguknoten	82.42617*** (20.86149)	41.5384, 123.3139
childeasybin	74.78898*** (25.67299)	24.47084, 125.1071
respgov	68.1726*** (22.08842)	24.88009, 111.4651
respparqua	135.8434*** (20.57854)	95.51016, 176.1766
respprod	81.17527*** (26.04756)	30.12298, 132.2276
charityhighbin	59.71615*** (22.04246)	16.51372, 102.9186
constant	–153.0721*** (47.54034)	–246.2495, –59.89474
Observations	3027	
Log Likelihood	-6069.7297	
Standard errors in parentheses. ***=p<0.01, **=p<0.05, *=p<0.1		

Results – Scope Insensitivity



	0.1	1	3	8	20	70
1 in 10	93.22%	88.76%	85.80%	73.45%	46.89%	33.33%
1 in 100	93.26%	88.14%	69.49%	68.57%	51.14%	26.86%
1 in 1,000	92.31%	89.39%	89.89%	66.48%	45.56%	25.56%
Mean	92.93%	88.76%	81.72%	69.50%	47.86%	28.58%

Discussion

- ‘1 in 10’ level (n=997) produced most conservative WTP estimates
- Mean household WTP figure is given as £872 IQ-point^{-1} child^{-1} yr^{-1} ($p<0.001$)
- Figure recommended for policy use applies parental value, so:

£892 IQ-point^{-1} child^{-1} yr^{-1} (£788–997)

£458 µg-lead^{-1} dL-blood^{-1} child^{-1} yr^{-1}

- Scope issue:
  - No variation in low bid amounts
  - Starting point bias
  - ‘Independent’ non-use WTP values

(Cicchetti and Wilde, 1992; Hausman and McPherson, 1993; Rolfe and Windle, 2015)

Conclusion

- **£892 IQ-point^{-1} child^{-1} yr^{-1}** (this study)
- **~£400** (Stackelberg and Hammitt 2009)
- **~£1,000** (Lutter 2000)

Improved and policy relevant measure of value

Incorporates explicit non-use benefits associated with neurodevelopmental impacts (e.g. elevated academic ability, upgraded housing and increased earnings)

First estimate from Europe, with various policy applications (some other heavy metal exposures; health; and education evaluation)

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Questions and Ideas

1. How to compare ‘lifetime’ and ‘annual’ values?
2. Further causes for ‘scope insensitivity’?
3. How to incorporate other health impacts (beyond IQ)?

- Extend similar research to other EU countries
- Need more neurobehavioural valuation studies
- Valuation studies where risks (or policy outcomes) are uncertain

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