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Cost-benefit analysis for a lead wheel weight phase-out in Canada

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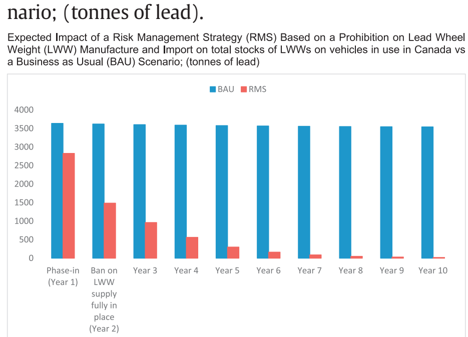
HIGHLIGHTS

- Lead wheel weights (LWWs) lost annually on roadways in Canada contribute to lead contamination of air, soil and dust.
- A LWW phase-out was predicted to result in a decrease in BLLs of up to 0.4 μg/dL in children.
- Net benefits of a LWW phase-out expected: C$248 million (8% discount rate) to C$1.2 billion (3% discount rate) per year.

GRAPHICAL ABSTRACT

Expected Impact of a Risk Management Strategy (RMS) Based on a Prohibition on Lead Wheel Weight (LWW) Manufacture and Import on total stocks of LWWs on vehicles in use in Canada vs a Business as Usual (BAU) Scenario; (tonnes of lead).



Net Costs/Benefits Expected with a Lead Wheel Weight Phase-out in Canada	
Discount rate	**Annualized Net Benefits (Public Health Benefits) (NPV C$)**
3%	$1,208 million per year
5%	$579 million per year
8%	$248 million per year

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ABSTRACT

Lead wheel weights (LWWs) have been banned in Europe, and some US States, but they continue to dominate the market in Canada. Exposure to lead is associated with numerous health impacts and can result in multiple and irreversible health problems which include cognitive impairment when exposure occurs during early development. Such impacts incur high individual and social costs. The purpose of this study was to assess the costs and public health benefits of a Risk Management Strategy (RMS) that would result from a LWW phase-out in Canada and compare this to a Business-As-Usual (BAU) scenario. The contribution of LWWs to lead concentrations in media including roadway soil/dust, ambient and indoor air, and indoor dust were estimated. The Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) was used to develop estimates for the blood lead levels (BLLs) in children (μg/dL) associated with the BAU and the RMS. The BLLs estimated via the IEUBK model were then used to assess the IQ decrements associated with the BAU that would be avoided under the RMS. The subsequent overall societal benefits in terms of increased lifetime earning potential and reduced crime rate, were then estimated and compared to industry and government costs. LWWs form 72% of the Canadian wheel weight market and >1500 tonnes of lead as new LWWs attached to vehicles enters Canadian society annually. We estimate that 110–131 tonnes of lead in detached WWs are abraded on roadways in Canada each year. A LWW phase-out was predicted to result in a drop in pre-school BLLs of up to 0.4 μg/dL. The estimated net benefits associated with the RMS based on cognitive decrements avoided and hence increased lifetime earning

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potential (increased productivity) and reduced crime are expected to be: C$248 million (8% discount rate) to C$1.2 billion (3% discount rate) per year.

1. Introduction

The Government of Canada developed a State of the Science Report and Risk Management Strategy for Lead that outlines actions to further reduce risks associated with exposure to lead (Health Canada, 2013a, 2013b, 2013c). The overall risk management objective (RMO) is to "reduce exposure to lead to the greatest extent practicable by strengthening current efforts in priority areas where the government can have the greatest impact upon exposure of Canadians." Several sources of lead exposure of the general population remain a concern and require further analyses. This study is focused on the use of lead in wheel weights (LWWs) in Canada.

Wheel weights are attached to the rims of automobile wheels in order to balance the tires. These weights can come loose and fall off. LWWs that fall from vehicles can be abraded and ground into tiny pieces by vehicle traffic resulting in higher lead content in fugitive dust along urban roadways, a potentially significant source of human lead exposure in urban environments (Root, 2000). Most wheel weights enter use via commercial tire dealers and automotive repair and maintenance shops (USGS, 2006; ECCC, 2013).

The health risks associated with lead include developmental neurotoxicity, neurodegenerative, cardiovascular, renal and reproductive effects. Epidemiological studies have reported an association between early-life lead exposure and adverse developmental endpoints including: neuromotor function, academic achievement, antisocial behaviour, attention and executive function, as well as auditory and visual functions (e.g. Bellinger et al., 1992; ATSDR, 2007a, 2007b; Sanders et al., 2009; Flora et al., 2012; Nevin, 2000, 2007, 2012). Young children are particularly vulnerable to the neurological effects of lead as the developing nervous system absorbs a higher fraction of lead (Needleman, 2004). Recent research has indicated that significant neurological damage to children occurs even at very low levels of lead exposure (Lanphear et al., 2005; Bellinger, 2008; Dribben et al., 2011; Lucchini et al., 2012; Budtz-Jorgensen et al., 2013). IQ (Intelligence Quotient) score has been the endpoint most widely used to assess the developmental neurotoxicity associated with lead exposure. Early childhood lead exposure has been shown to result in reduced IQ (i.e. reduced intellectual development) with subsequent negative impacts on social outcomes e.g. reduced lifetime earning potential, and behavioural effects including increased impulsivity and aggression and increased crime rates (Bellinger, 2008; Nevin, 2007, 2012; Pichery et al., 2011; Taylor et al., 2016).

In Europe, LWWs were banned on new vehicles and after-market wheels as of 1 July 2005 in response to concerns about losses along roadways and inappropriate disposal by tire retailers and scrap processors (European Commission, 2000; EC Directive 2000/53/EC, the "ELV Directive"). More than a decade later LWWs continue to be used in North America in significant quantities. A US EPA assessment of LWWs was initiated in 2009 and was originally expected to release its findings by the end of 2012 (US EPA, 2009a). At that time industry groups expected that a national ban on lead wheel weights could result (Modern Tire Dealer, 2012), however, this has not transpired. In the absence of federal regulation, some US states have taken regulatory action in this area (ECOS, 2011). For example, as of January 1, 2010, California law prohibited the manufacture, sale, or installation of wheel weights containing >0.1% lead (California DTSC, 2010). In addition, Vermont, Maine, Maryland, Minnesota, Washington, New Jersey, New York, Illinois and South Carolina have also enacted bills prohibiting their use. However, LWWs remain legal in 40 US States. In Canada there are currently no Federal or Provincial restrictions on the use of LWWs.

There have been various voluntary initiatives to reduce or eliminate the use of LWWs in North America. For example, the US EPA launched its 'National Lead-Free Wheel Weight Initiative' in August of 2008 (US EPA, 2008a). It was developed as "a partnership among federal agencies, states, wheel weight manufacturers, retailers, tire manufacturers, automobile trade associations and environmentalists" to encourage "the transition from the use of lead for wheel weights to lead-free alternatives." The Tire Industry has also developed an Environmental Best Practices which describes procedures to follow in transitioning away from LWWs and the precautions that should be followed to ensure the proper handling, management and recycling of existing LWWs (TIA, 2008).

Despite regulatory action in Europe and by some US States, and a decade of voluntary initiatives encouraging the use of alternatives, LWWs are still used in significant quantities in North America.

This study examines the costs associated with continued use of LWWs and the public health benefits that could be expected with a LWW phase-out in Canada. In this study, we evaluated a risk management strategy that prohibited the manufacturing and import of LWWs starting in 2017. All the costs and benefits are in $2013 Canadian Dollars (C$) and impacts are reported as net present values (NPV). We used a real social discount rate of 5% with sensitivity testing of 3% and 8%. The incremental costs and benefits of the proposed risk management strategy (the RMS scenario) were evaluated against a Business-As-Usual (BAU) scenario. The BAU scenario was based on the expected use profile for LWWs in Canada in the absence of any additional regulatory action.

2. Methods

2.1. Current uses of lead wheel weights and government/industry costs associated with phase-out

Data were collected via industry consultations and market research on the current uses of LWWs. These background data were used to examine the stocks of LWWs on vehicles in use, the amount of lead used in domestic manufacturing annually, the amount imported/exported, the quantity of wheel weights removed from vehicles, and the quantity of lead from wheel weights that flows to recycling operations (ECCC, 2013). We considered a wide range of possible incremental costs and benefits for this analysis and focused on the most relevant in this case i.e. industry compliance costs (equipment costs, ongoing input costs), government costs (administration and enforcement costs), and impacts on public health due to reduced environmental exposure to lead. In terms of government costs we assumed that the Government of Canada (ECCC) would conduct spot checks/ site inspections during the first two years of the phase-out. This estimate includes staff time, overheads and other inspection-related expenses. We assumed that further inspections would not be required beyond the first two years since the use of alternative wheel weights should be entrenched by that point. Industry costs for manufacturers were based on raw material cost changes (with steel being the primary alternative and one that is a substantially cheaper raw material than lead) and equipment costs (increased production steps and stamping equipment required to produce alternative non-lead weights). Industry costs for end users (tire dealers and automotive repair and maintenance facilities) were based on the current price differential between lead and the alternatives.

The cost scenarios we evaluated (3–15% price differential between LWWs and non-lead alternatives) take into account that not all users will choose the cheapest option and a combination of options may be used depending on the needs of the end-users. The total costs to