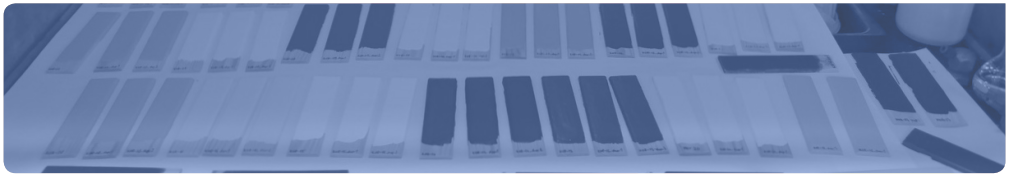
KOREA



LEAD IN SOLVENT-BASED PAINTS FOR HOUSEHOLD USE IN KOREA

October 2019

노동환경건강연구소
Wonjin Institute
for Occupational & Environmental Health

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IPEN
for a toxics-free future

NATIONAL REPORT

LEAD IN SOLVENT-BASED PAINTS FOR HOME USE IN KOREA

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ACKNOWLEDGMENTS

We take this opportunity to thank all those who were instrumental in compiling and shaping this paint study.

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While this study was undertaken with funding assistance from the New York Community Trust and the Swedish Government, responsibility for the content lies entirely with IPEN and Wonjin Institute for Occupational and Environmental Health. The New York Community Trust and the Swedish Government do not necessarily share the expressed views and interpretations.

Established in 1998, IPEN is currently comprised of over 500 Participating Organizations in 121 countries, primarily developing and transition countries. IPEN brings together leading environmental and public health groups around the world to establish and implement safe chemicals policies and practices that protect human health and the environment. IPEN's mission is a toxics-free future for all.

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PREFACE

Lead paints for home use continue to be widely produced, sold, and used in developing countries despite the fact that most highly industrial countries banned lead paints for household use more than 40 years ago. IPEN and Participating Organizations are part of the global movement to eliminate lead paint by 2020 to protect children´s health.

In 2007 and 2008, NGOs in the IPEN network collected and analyzed decorative (home use) paints on the market in 11 developing countries, and in countries with economies in transition. The results were startling. In every one of these countries, many of the paints contained dangerously high lead levels. In response, IPEN launched its Global Lead Paint Elimination Campaign, which seeks to eliminate lead in paint and raise widespread awareness among business entrepreneurs and consumers about the adverse human health impacts of lead paint, particularly on the health of children. Since then, IPEN-affiliated NGOs and others have sampled and analyzed paints on the market in more than 50 low- and middle-income countries.

This report presents new data on the total lead content of solvent-based paints for home use available on the market in Korea. It also presents background information on why the use of lead paint is a source of serious concern, especially to children's health; a review of national policy frameworks that are in place to ban or restrict the manufacture, import, export, distribution, sale and use of lead paint, and provides a strong justification to adopt and enforce further regulatory controls in Korea. Finally, it proposes action steps by different stakeholders to protect children and others from lead paint.

This study was conducted by Wonjin Institute for Occupational and Environmental Health (WIOEH) in partnership with IPEN.

IPEN is an international NGO network of health and environmental organizations from all regions of the world of which WIOEH is a member. IPEN is a leading global organization working to establish and implement safe chemicals policies and practices to protect human health and the environment. Its mission is a toxics-free future for all. IPEN helps build the capacity of its member organizations to implement on-the-ground activities, learn from each other's work, and work at the international level to set priorities and achieve new policies.

WIOEH was established in 1999 with the compensation money secured from strikes of a Wonjin carbon disulfide poisoning victims (about 1,000 victims up to now). WIOEH is the affiliated research institute of the foundation which was established by the victims. Members of WIOEH have been participating in diverse studies searching for the causes and solutions encountered in issues at occupational or environmental area.

EXECUTIVE SUMMARY

Lead is a toxic metal that causes adverse effects on both human health and the environment. While lead exposure is also harmful to adults, lead exposure harms children at much lower levels, and the health effects are generally irreversible and can have a lifelong impact.

The younger the child, the more harmful lead can be, and children with nutritional deficiencies absorb ingested lead at an increased rate. The human fetus is the most vulnerable, and a pregnant woman can transfer lead that has accumulated in her body to her developing child. Lead is also transferred through breast milk when lead is present in a nursing mother.

Evidence of reduced intelligence caused by childhood exposure to lead has led the World Health Organization (WHO) to list "lead-caused mental retardation" as a recognized disease. WHO also lists it as one of the top ten diseases whose health burden among children is due to modifiable environmental factors.

Lead paint is a major source of childhood lead exposure. The term lead paint is used in this report to describe any paint to which one or more lead compounds have been added. The cut-off concentration for lead paint used in the report is 90 parts per million (ppm, dry weight of paint), the strictest legal limit enacted in the world today. All lead concentrations in the report are total lead levels, unless otherwise specified.

Most highly industrial countries adopted laws or regulations to control the lead content of decorative paints—the paints used on the interiors and exteriors of homes, schools, and other child-occupied facilities—beginning in the 1970s and 1980s. In Korea, there are some regulations that control the lead content in paints. For example, in the "Enforcement Decree to the Environmental Health Law," the lead content in paints used in places where children spend their time (e.g., kindergarten or elementary school) should be less than 0.06 percent by dry weight. And according to the "Special Act on Children's Product Safety," the lead content in the paint or coating on the children's product should be less than 90 ppm. However, there is currently no comprehensive and rigorous regulation in place limiting the amount of lead in paint for all uses.

In November 2018, WIOEH purchased a total of 23 cans of solvent-based paint, including three anti-corrosive industrial paints sold for home use from stores in Seoul, Korea. The paints represented 11 different brands produced by

eight manufacturers. All paints were analyzed by an accredited laboratory in the United States of America for their lead content, based on dry weight of the paint. The laboratory participates in the Environmental Lead Proficiency Analytical Testing (ELPAT) program operated by the American Industrial Hygiene Association (AIHA), assuring the reliability of the analytical results.

RESULTS

Four out of 23 analyzed solvent-based paints sold for home use (17 percent of paints) were lead paints, i.e., they contained lead concentrations above 90 parts per million (ppm, dry weight of paint). This is also the regulatory limit for lead in decorative paint in e.g., India, the Philippines, Ethiopia and the United States of America. Moreover, two paints (nine percent of paints) contained dangerously high lead concentrations above 10,000 ppm. Of the paints which were confirmed to contain lead above 90 ppm, three were anti-corrosive paints and one was a yellow enamel alkyd paint intended for industrial use but was commercially available online. One yellow paint and one red paint contained lead levels above 10,000 ppm. The highest lead concentration detected was 230,000 ppm in a reddish-brown anti-corrosive paint.

On the other hand, 19 out of 23 solvent-based paints for home use (83 percent of paints) contained lead concentrations below 90 ppm, suggesting that the technology to produce paint without leaded ingredients exists in Korea.

Four out of 11 analyzed brands (36 percent of paint brands) sold at least one lead paint, i.e., a paint with lead concentration above 90 ppm. Two out of 11 analyzed brands (18 percent of paint brands) sold at least one lead paint with dangerously high lead concentrations above 10,000 ppm.

In general, most paint can labels did not carry meaningful information about lead content or the hazards of lead paint. Only three out of 23 paints (13 percent of paints) provided information about lead on their labels and most paints carried little information about any ingredients on can labels. Fortunately, manufacturing dates or batch numbers were included on the labels of all 23 paints (100 percent of paints) included in this study.

Although there were warning symbols on the paint cans about flammability, toxicity, and environmental impact according to the GHS (Globally Harmonized System of Classification & Labelling of Chemicals) requirements of the paints, there were no precautionary warnings on the effects of lead to children and pregnant women were provided. In addition, there were no warning symbols required by GHS on the products which are sold as a subdivided paint.

Subdivided paints were formulated, canned, and sold not by manufacturer but by agency according to the buyers' requirements for the special color or volume.

CONCLUSIONS

This study demonstrates that solvent-based paints with high concentrations of lead are available and sold for home use in Korea since the paints included in this study are brands commonly sold in retail and online stores all over Korea. However, the fact that 19 out of 23 paints (83 percent of paints) contained lead concentrations below 90 ppm indicates that the technology to produce paints without added lead exists in Korea. Since industrial paints with high levels of lead were easily available in online stores, it shows the importance of prohibiting the use of lead in all types of paint. Also, until a complete prohibition is achieved, it should be mandatory for all paints to include labeling information regarding lead content and precautionary warnings on their usage. The study results provide a strong justification to adopt and enforce a regulation that will ban the manufacture, import, export, distribution, sale and use of all paints with total lead concentrations greater than 90 ppm.

RECOMMENDATIONS

To address the problem of lead in paint, the WIOEH and IPEN propose the following recommendations:

Government and Governmental Agencies

The Ministry of Environment should immediately draft a regulation that will ban the manufacture, import, export, distribution, sale and use of all paints that contain total lead concentrations exceeding 90 ppm, the standard recommended in the *Model Law and Guidance for Regulating Lead Paint*,* developed by the Global Alliance to Eliminate Lead Paint (GAELP) and published by the UN Environment Programme. They should require paint companies to display sufficient information indicating harmful content on paint can labels such as solvents and provide a warning on possible lead dust hazards when disturbing painted surfaces. They should also ensure that lead paint is not sold in online stores.

Paint Industry

Paint companies that still produce lead paints should expeditiously stop the use of leaded paint ingredients in paint formulations. Paint companies that have

* https://www.unenvironment.org/resources/publication/model-law-and-guidance-regulating-lead-paint

shifted to non-lead paint production should get their products certified through independent, third party verification procedures to increase the customer´s ability to choose paints with no added lead.

Individual, Household and Institutional Consumers

Paint consumers should demand paints with no added lead from paint manufacturers and retailers, as well as full disclosure of a paint product's content. Household and institutional consumers should ask for, consciously buy, and apply only paints with no added lead in places frequently used by children such as homes, schools, day care centers, parks and playgrounds.

Organizations and Professional Groups

Public health groups, consumer organizations and other concerned entities should support the elimination of lead paint, and conduct activities to inform the public and protect children from lead exposure through lead paint, lead in dust and soil, and other sources of lead.

All Stakeholders

All stakeholders should come together and unite in promoting a strong policy that will eliminate lead paint in Korea.

1. BACKGROUND

1.1 HEALTH AND ECONOMIC IMPACTS OF LEAD EXPOSURE

Children are exposed to lead from paint when lead-containing paint on walls, windows, doors or other painted surfaces begins to chip or deteriorate, since this causes lead to be released to dust and soil. When a surface previously painted with lead paint is sanded or scraped in preparation for repainting, very large amounts of lead-contaminated dust is produced, which, when spread, can constitute a severe health hazard.[1]

Children playing indoors or outdoors get house dust or soil on their hands, and then ingest it through normal hand-to-mouth behavior. If the dust or the soil is contaminated with lead, the children will ingest lead. Hand-to-mouth behavior

Lead Paint Terminology

As used in this booklet:

• "Paint" includes varnishes, lacquers, stains, enamels, glazes, primers, or coatings used for any purpose. Paint is typically a mixture of resins, pigments, fillers, solvents, and other additives.

• "Lead paint" is paint to which one or more lead compounds have been added.

• "Lead pigments" are lead compounds used to give a paint product its color.

• "Lead anti-corrosive agents" are lead compounds used to protect a metal surface from rusting or other forms of corrosion.

• "Lead driers" are lead compounds used to make paint dry more quickly and evenly.

• "Decorative paint" refers to paints that are produced for use on inside or outside walls, and surfaces of homes, schools, commercial buildings, and similar structures. Decorative paints are frequently used on doors, gates, and windows, and to repaint household furniture such as cribs, playpens, tables, and chairs.

• "Solvent-based, enamel decorative paint" or "enamel decorative paint" refers to oil-based paints.

• "ppm" means parts per million total lead content by weight in a dried paint sample. All lead concentrations in the report are total lead levels, unless otherwise specified.

is especially prevalent in children aged six years and under, the age group most easily harmed by exposure to lead. A typical one- to six-year-old child ingests between 100 and 400 milligrams of house dust and soil each day.[2]

In some cases, children pick up paint chips and put them directly into their mouths. This can be especially harmful because the lead content of paint chips is typically much higher than what is found in dust and soils. When toys, household furniture, or other articles are painted with lead paint, children may directly ingest the lead-contaminated, dried paint when chewing on them. Nonetheless, the most common way that children ingest lead is through lead-contaminated dust and soil that gets onto their hands.[3]

While lead exposure is also harmful to adults, lead exposure harms children at much lower levels. In addition, children absorb up to five times as much of ingested lead than adults. Children with nutritional deficiencies absorb ingested lead at even increased rates.[2]

The younger the child, the more harmful lead can be and the health effects are generally irreversible and can have a lifelong impact. The human fetus is the most vulnerable, and a pregnant woman can transfer lead that has accumulated in her body to her developing child.[4] Lead is also transferred through breast milk when lead is present in a nursing mother.[5]

Once lead enters a child's body through ingestion, inhalation, or across the placenta, it has the potential to damage several biological systems and pathways. The primary target is the central nervous system and the brain, but lead can also affect the blood system, the kidneys, and the skeleton.[6] Lead is also categorized as an endocrine-disrupting chemical (EDC).[7]

It is generally agreed that one key element in lead toxicity is its capacity to replace calcium in neurotransmitter systems, proteins, and bone structure, altering function and structure and thereby leading to severe health impacts. Lead is also known to affect and damage cell structure.[8]

According to the World Health Organization (WHO): "Lead has no essential role in the human body, and lead poisoning accounts for about 0.6 percent of the global burden of disease."[2] Evidence of reduced intelligence caused by childhood exposure to lead has led WHO to list "lead-caused mental retardation" as a recognized disease. WHO also lists it as one of the top ten diseases whose health burden among children is due to modifiable environmental factors.[9]

In recent years, medical researchers have been documenting significant health impacts in children from lower and lower levels of lead exposure.[2, 6] According

to the factsheet on Lead Poisoning and Health from WHO: "There is no known level of lead exposure that is considered safe."[10]

When a young child is exposed to lead, the harm to her or his nervous system makes it more likely that the child will have difficulties in school and engage in impulsive and violent behavior.[11] Lead exposure in young children is also linked to increased rates of hyperactivity, inattentiveness, failure to graduate from high school, conduct disorder, juvenile delinquency, drug use, and incarceration.[2] Lead exposure impacts on children continue throughout life and have a long-term impact on a child's work performance, and—on average—are related to decreased economic success.

A recent study investigating the economic impact of childhood lead exposure on national economies in all low- and middle-income countries estimated a total cumulative cost burden of $977 billion international dollars* per year.[12] The study considered the neurodevelopmental effects on lead-exposed children, as measured by reduced IQ points, and it correlated lead exposure-related reductions in children's IQ scores to reductions in lifetime economic productivity, as expressed in lifelong earning power. The study identified many different sources of lead exposure in children, with lead paint as one major source. Broken down by region, the economic burden of childhood lead exposure as estimated by this study was:

Africa: $134.7 billion of economic loss, or 4.03 percent of Gross Domestic Product (GDP);

Latin America and the Caribbean: $142.3 billion of economic loss, or 2.04 percent of GDP; and

Asia: $699.9 billion of economic loss, or 1.88 percent of GDP.

Country estimates used in this study can be accessed at a publicly available website, **http://www.med.nyu.edu/pediatrics/research/environmentalpediatrics/leadexposure**.

* An international dollar is a currency unit used by economists and international organizations to compare the values of different currencies. It adjusts the value of the U.S. dollar to reflect currency exchange rates, purchasing power parity (PPP), and average commodity prices within each country. According to the World Bank, "An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States." The international dollar values in this report were calculated from a World Bank table that lists GDP per capita by country based on purchasing power parity and expressed in international dollars.

1.2 THE USE OF LEAD IN PAINT

Paints contain high levels of lead when the paint manufacturer intentionally adds one or more leaded compounds to the paint for some purpose. A paint product may also contain some amount of lead when paint ingredients contaminated with lead are used, or when there is cross-contamination from other product lines in the same factory. Leaded paint ingredients are most commonly intentionally used in solvent-based paint due to their chemical properties, and solvent-based paints have been found to have high lead content in many countries.[13-15]

The leaded compounds most commonly added to paints are pigments. Pigments are used to give the paint its color, make the paint opaque (so it covers well), and protect the paint and the underlying surface from degradation caused by exposure to sunlight. Lead-based pigments are sometimes used alone, and sometimes used in combination with other pigments.

Leaded compounds may also be added to enamel paints for use as driers (sometimes called drying agents or drying catalysts). Leaded compounds are also sometimes added to paints used on metal surfaces to inhibit rust or corrosion. The most common of these is lead tetroxide, sometimes called red lead or minium.

Non-leaded pigments, driers, and anti-corrosive agents have been widely available for decades, and are used by manufacturers producing the highest quality paints. When a paint manufacturer does not intentionally add lead compounds in the formulation of its paints, and takes care to avoid the use of paint ingredients that are contaminated with lead, the lead content of the paint will be very low—less than 90 parts per million (ppm) lead by dry weight, and frequently down to 10 ppm or less.

Most highly industrial countries adopted laws or regulations to control the lead content of decorative paints beginning in the 1970s and 1980s. Many also imposed controls on the lead content of paints used on toys and for other applications likely to contribute to lead exposure in children. These regulatory actions were taken based on scientific and medical findings that lead paint is a major source of lead exposure in children, and that lead exposure in children causes serious harm, especially to children aged six years and under.

The use of lead in production of decorative paint is prohibited in the European Union through regulations related to safety of consumer products and specific prohibitions for most leaded raw materials. In the U.S., Canada, Australia and other countries with regulations restricting the use of leaded ingredients in decorative paint, standards specifying a maximum lead limit are in place. The

current standard for household paints in e.g., the U.S., the Philippines, and India is a total maximum lead content of 90 ppm, and adherence to this ensures that a manufacturer can sell its paint anywhere in the world. This standard is also recommended in the Model Law and Guidance for Regulating Lead Paint, which was developed by the Global Alliance to Eliminate Lead Paint (GAELP) and published by the UN Environment Programme.

1.3 PAINT MARKET AND REGULATORY FRAMEWORK IN KOREA

1.3.1 Korea Paint Market Analysis

The paint industry in Korea has been growing rapidly in the past few years. In 2016, the Korean paint market was worth 5.6 trillion won (USD $4.9 billion) and the total domestic paint production in Korea was 1.04 million kiloliters. In 2017, the total production volume further increased to 1.06 million kiloliters.

Paints intended for home use such as architectural, decorative and flooring paints account for 28 percent of the country's overall paint production. This is followed by steel paints (17 percent), automotive paints (15 percent), and marine paints (12 percent). In the recent three years, the fast-increasing product family is the decorative and flooring paint, which increased by an annual average of 4.2 percent, mainly influenced by the increase in infrastructure and residential construction. Analyzing the markets by usage shows that paints intended for household use hold 67 percent of market share and paints intended for industrial use hold 33 percent market share.

Five paint companies—KCC (Korea Chemical Co.), Samwha Paint, Norupyo Paint, Kangnam Jevisco, and Jokwang Paint—account for about 80 percent market share and create an oligopoly market situation. The decorative paint market is led by these five major paint companies and composed of about 160 small- and medium-sized businesses. Because of tightened environmental regulations, many paint companies have started investing in research and development (R&D) to manufacture healthier and eco-friendly paints.

1.3.2 Korean Framework for Regulating Lead Paint

In Korea, there are some regulations that control the lead content in paints. For example, in the "Enforcement Decree to the Environmental Health Law," the lead content in paints used in places where children spend their time (e.g., kindergarten or elementary school) should be less than 0.06 percent by dry weight. And according to the "Special Act on Children's Product Safety," the lead content in the paint or coating on the children's product should be less

than 90 ppm. As per MOE Public Notice No. 2011-136, the paint for wooden toy containing lead (CAS No. 7439-92-1) and mixtures at the level of 0.06% or more is prohibited from manufacture, import, sale, keeping, storage, transportation and use. In this case, the wooden toy means the product for children under 13 years old. However, there is currently no comprehensive and rigorous regulation in place limiting the amount of lead in paint for all uses.

2. MATERIALS AND METHODS

In November 2018, 23 cans of solvent-based paint sold for home use were purchased by WIOEH from various stores and internet shopping malls in Korea. The paints represented 11 different brands produced by eight manufacturers.

In most cases, one white paint and one or more bright-colored paint such as red or yellow were selected. Additionally, three anti-corrosive paints for industrial use were also included in this study. The availability of these paints in online retail establishments suggested that they were intended to be used within home environments.

During the paint sample preparation, information such as color, brand, manufacturer, country where manufactured, product codes, production dates, and other details as provided on the label of the paint can were recorded. Generic paint colors were recorded, e.g., "yellow" instead of "sunflower." For all colored

Figure 1. Preparation of Paint Samples.

paints, the protocol called for obtaining “bright” or “strong” red and yellow paints when available.

Paint sampling preparation kits containing individually numbered, untreated wood pieces, single-use paintbrushes and stirring utensils made from untreated wood sticks were assembled and shipped to WIOEH by the staff of the IPEN partner NGO, Arnika, in The Czech Republic.

Each can of paint was thoroughly stirred and was subsequently applied onto individually numbered triplicates of untreated, labeled wood pieces using different unused, single-use paintbrushes by a researcher of WIOEH as shown in Figure 1.

Each stirring utensil and paintbrush was used only for the same paint, and extra caution was taken to avoid cross contamination. All samples were then allowed to dry at room temperature for five to six days. After drying, the painted wood pieces were placed in individually labeled, resealable plastic bags and shipped for analysis of lead content to Forensic Analytical Laboratories, Inc. in the United States of America. The laboratory participates in the Environmental Lead Proficiency Analytical Testing (ELPAT) Program operated by the American Industrial Hygiene Association. In the laboratory selection process, IPEN further assessed the reliability of the laboratory results by conducting an independent quality assurance testing. This was made by sending paint samples with a known lead content to the laboratory, and evaluating the results received.

The laboratory’s lower limit of detection for the lead concentration in the paint samples is dependent on the amount of paint in the samples. Generally, the detection limit increases if the amount of paint in the samples are insufficient for analysis.

The paint samples were analyzed using method EPA3050B/7000B, i.e., through acid digestion of the samples, followed by Flame Atomic Absorption Spectrometry, as recognized by the WHO as appropriate for the purpose.[16]

3. RESULTS

3.1 SUMMARY OF RESULTS

This study shows that:

- Four out of 23 analyzed solvent-based paints (17 percent of paints) were lead paints, i.e., they contained lead concentrations above 90 parts per million (ppm), dry weight. In addition, two paints (nine percent of paints) contained dangerously high lead concentrations above 10,000 ppm.
- Of the paints which were confirmed to contain lead above 90 ppm, three were anti-corrosive paints and one was a yellow enamel alkyd paint intended for industrial use but were commercially sold online for home use.
- Four out of 11 analyzed brands (36 percent of paint brands) sold at least one lead paint, i.e., a paint with lead concentration above 90 ppm. Also, two out of 11 analyzed brands (18 percent of paint brands) sold at least one lead paint with dangerously high lead concentrations above 10,000 ppm.
- Four out of 17 bright-colored paints (24 percent of bright-colored paints) were lead paints, i.e., they contained lead concentrations above 90 parts per million (ppm), dry weight. One yellow paint and one red paint contained lead concentrations greater than 10,000 ppm.
- The highest lead concentration detected was 230,000 ppm in a reddish-brown anti-corrosive industrial paint sold for home use. All three anti-corrosive industrial paints contained lead levels above 90 ppm.
- Only three out of 23 paints (13 percent of paints) provided information about lead on their labels and most paints carried little information about ingredients.

3.2 LEAD CONTENT ANALYSIS

Four out of 23 analyzed solvent-based paints (17 percent of paints) were lead paints, i.e., contained a lead concentration above 90 ppm—two of these contained dangerously high lead concentrations above 10,000 ppm (nine percent of paints).

A reddish-brown anti-corrosive paint contained the highest concentration of lead at 230,000 ppm, while the lowest concentration of lead less than 60 ppm was detected in 19 paints.

The four solvent-based paints with lead over 90 ppm are summarized in Table 1.

TABLE 1. FOUR SOLVENT-BASED PAINTS WITH LEAD LEVELS OVER 90 PPM.

Rank	Sample No.	Type of Paint	Usage	Color	Lead Content (ppm)
1	KOR-13	Alkyd Paint	Anti-corrosive steel primer	Reddish-brown	230,000
2	KOR-11	High-Glossy Enamel Alkyd Paint	For indoor and outdoor purposes	Yellow	44,000
3	KOR-14	Alkyd Paint	Anti-corrosive primer for steel stuff	Reddish-brown	5,100
4	KOR-23	Alkyd Paint	Anti-corrosive primer for steel stuff	Reddish-brown	190

3.3 PAINT BRAND ANALYSIS

Two out of 11 analyzed brands (18 percent of paint brands) sold at least one paint with dangerously high lead concentration above 10,000 ppm.

Among solvent-based decorative paints, one yellow high-glossy alkyd paint contained 44,000 ppm lead. On the other hand, at least one paint from eight brands contained lead below 90 ppm. This indicates that the technology to produce paints without added lead exists in Korea.

All three anti-corrosive industrial paints contained lead levels above 90 ppm. The highest concentration of lead was 230,000 ppm, followed by two paints with 5,100 ppm and 190 ppm lead. All anti-corrosive paints were manufactured in Korea.

3.4 PAINT COLOR ANALYSIS

Four out of 17 bright-colored paints (24 percent of bright-colored paints) such as yellow and red contained lead concentrations above 90 ppm, two paints of which contained dangerously high lead concentrations above 10,000 ppm (12 percent of bright-colored paints).

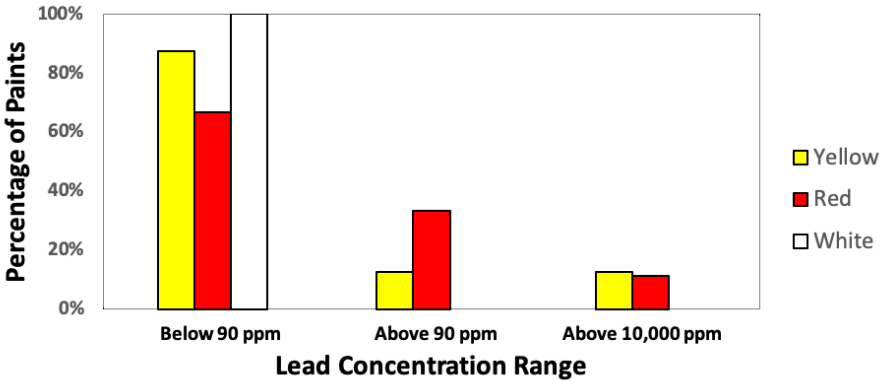

Figure 2. Distribution of Lead Concentrations in Solvent-Based Household Paints by Color.

This study included nine red paints, eight yellow paints and six white paints. Red and yellow paints contained the highest lead concentrations.

Among bright-colored paints, three out of nine red paints (33 percent of red paints) contained lead concentrations above 90 ppm, one paint of which exceeded more than 10,000 ppm of lead. Moreover, one out of eight yellow paints contained lead concentrations above 10,000 ppm.

The distribution of lead concentrations in different colors is shown in Figure 2.

3.5 LABELING

In general, most paint can labels did not carry meaningful information about lead content or the hazards of lead paint.

Only three out of 23 paints (13 percent of paints) provided information about lead on their labels and most paint can labels carried little information about any ingredients. Three paints with labels indicating "free of heavy metals such as lead" were verified correct based on lab results.

Most paints were merely labeled as "solvents, pigments and resin," with no further details on the type of solvents and pigments (organic or inorganic) provided on paint can labels. Fortunately, manufacturing dates or batch numbers were included on the labels of all paints included in this study. Although there were warning symbols on the paint cans about flammability, toxicity, and environmental impact according to the GHS (Globally Harmonized System of Classification & Labelling of Chemicals) requirements of the paints, there were no

precautionary warnings on the effects of lead to children and pregnant women were provided. In addition, there were no warning symbols required by the GHS on the products which are sold as a subdivided paint. Subdivided paints were formulated, canned, and sold not by manufacturer but by agency according to the buyers' requirements for the special color or volume.

4. CONCLUSIONS AND RECOMMENDATIONS

This study demonstrates that solvent-based paints with high concentrations of lead are available and sold for home use in Korea since the paints included in this study are brands commonly sold in retail stores or through internet shopping malls all over Korea. However, the fact that 19 out of 23 paints (83 percent of paints) contained lead concentrations below 90 ppm indicates that the technology to produce paints without added lead exists in Korea. Since industrial paints with high levels of lead were easily available in online stores, it shows the importance of prohibiting the use of lead in all types of paint. Also, until a complete prohibition is achieved, it should be mandatory for all paints to include labeling information regarding lead content and precautionary warnings on their usage. The study results provide a strong justification to adopt and enforce a regulation that will ban the manufacture, import, export, distribution, sale and use of all paints with total lead concentrations greater than 90 ppm.

To address the problem of lead in paint, WIOEH and IPEN propose the following recommendations:

For the Ministry of Environment to immediately draft a regulation that will ban the manufacture, import, export, distribution, sale and use of lead paints, i.e., paints that contain total lead concentrations exceeding 90 ppm, the standard recommended in the Model Law and Guidance for Regulating Lead Paint, developed by the Global Alliance to Eliminate Lead Paint (GAELP) and published by the UN Environment Programme. They should require paint companies to display sufficient information indicating toxic content on paint can labels and provide a warning on possible lead dust hazards when disturbing painted surfaces. They should also ensure that lead paint is not sold in online stores.

For paint companies that still produce lead paints to expeditiously stop the use of leaded paint ingredients in paint formulations. Paint companies that have shifted to non-lead paint production should get their products certified through independent, third party verification procedures to increase the customer's ability to choose paints with no added lead.

For paint consumers to demand paints with no added lead from paint manufacturers, as well as full disclosure of a paint product's lead content. Household and institutional consumers should ask for, consciously buy, and apply only paints with no added lead in places frequently used by children such as homes, schools, day care centers, parks and playgrounds.

For public health groups, consumer organizations and other concerned entities to support the elimination of lead paint, and conduct activities to inform the public and protect children from lead exposure through lead paint, lead in dust and soil, and other sources of lead.

For all stakeholders to come together and unite in promoting a strong policy that will eliminate lead paint in Korea.

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APPENDIX

TABLE 2. SOLVENT-BASED PAINTS FOR HOME USE INCLUDED IN THE STUDY.

Sample No.	Brand	Color	Volume (L)	Price (KRW)	Date of Manufacture (y/m/d)	Batch No.	Date of Purchase (y/m/d)	Is there website on label?
KOR-1	Brand 1	white	1	11,000	2018/06/14	N/A	2018/11/23	N/A
KOR-2	Brand 1	yellow	1	11,000	2018/07/31	N/A	2018/11/23	N/A
KOR-3	Brand 1	red	1	11,000	2018/04/17	N/A	2018/11/23	N/A
KOR-4	Brand 2	white	1	11,000	2018/11/09	N/A	2018/11/23	N/A
KOR-5	Brand 2	yellow	1	11,000	2018/08/24	N/A	2018/11/23	N/A
KOR-6	Brand 2	red	1	12,700	2018/08/14	N/A	2018/11/23	N/A
KOR-7	Brand 3	white	1	12,000	2018/10/04	N/A	2018/11/23	N/A
KOR-8	Brand 3	yellow	1	13,000	2018/08/20	N/A	2018/11/23	N/A
KOR-9	Brand 3	red	1	15,700	2018/08/08	N/A	2018/11/23	N/A
KOR-10	Brand 4	white	1	10,000	2018/11/15	N/A	2018/11/23	N/A
KOR-11	Brand 4	yellow	1	10,000	2018/11/15	N/A	2018/11/23	N/A
KOR-12	Brand 4	red	1	10,340	2018/11/15	N/A	2018/11/23	N/A
KOR-13	Brand 5 (Anti-corrosive Paint)	red	4	60,000	2018/11/23	N/A	2018/11/23	N/A
KOR-14	Brand 6 (Anti-corrosive Paint)	red	4	19,660	2018/10/29	N/A	2018/11/23	N/A
KOR-15	Brand 7	white	1	14,000	2018/05/04	N/A	2018/11/23	N/A
KOR-16	Brand 7	yellow	1	15,000	2018/11/22	N/A	2018/11/23	N/A
KOR-17	Brand 7	red	1	18,000	2018/11/22	N/A	2018/11/23	N/A
KOR-18	Brand 8	yellow	0.75	20,500	2018/06/20	N/A	2018/11/23	N/A
KOR-19	Brand 9	yellow	4	28,000	2018/11/21	N/A	2018/11/23	N/A
KOR-20	Brand 10	white	1	11,000	2018/11/15	N/A	2018/11/23	N/A
KOR-21	Brand 10	yellow	1	11,000	2018/11/15	N/A	2018/11/23	N/A
KOR-22	Brand 10	red	1	11,000	2018/11/15	N/A	2018/11/23	N/A
KOR-23	Brand 11 (Anti-corrosive Paint)	red	4	17,600	2018/08/17	N/A	2018/11/23	N/A

TABLE 3. RESULTS OF LABORATORY ANALYSIS OF SOLVENT-BASED PAINTS FOR HOME USE.

Sample No.	Brand	Color	Lead Content, Dry Weight (ppm)	Country of Brand Headquarters	Country of Manufacture	Is there information on can about lead content of paint?
KOR-1	Brand 1	white	Below 60	Korea	Korea	No
KOR-2	Brand 1	yellow	Below 60	Korea	Korea	No
KOR-3	Brand 1	red	Below 60	Korea	Korea	No
KOR-4	Brand 2	white	Below 60	Korea	Korea	No
KOR-5	Brand 2	yellow	Below 60	Korea	Korea	No
KOR-6	Brand 2	red	Below 60	Korea	Korea	No
KOR-7	Brand 3	white	Below 60	Korea	Korea	No
KOR-8	Brand 3	yellow	Below 60	Korea	Korea	No
KOR-9	Brand 3	red	Below 60	Korea	Korea	No
KOR-10	Brand 4	white	Below 60	Korea	Korea	No
KOR-11	Brand 4	yellow	44,000	Korea	Korea	No
KOR-12	Brand 4	red	Below 60	Korea	Korea	No
KOR-13	Brand 5 (Anti-corrosive Paint)	red	230,000	Korea	Korea	No
KOR-14	Brand 6 (Anti-corrosive Paint)	red	5,100	Korea	Korea	No
KOR-15	Brand 7	white	Below 60	Korea	Korea	Yes. "Free of heavy metal such as Pb"
KOR-16	Brand 7	yellow	Below 60	Korea	Korea	Yes. "Free of heavy metal such as Pb"
KOR-17	Brand 7	red	Below 60	Korea	Korea	Yes. "Free of heavy metal such as Pb"
KOR-18	Brand 8	yellow	Below 60	Denmark	Denmark	No
KOR-19	Brand 9	yellow	Below 60	Korea	Korea	No
KOR-20	Brand 10	white	Below 60	Korea	Korea	No
KOR-21	Brand 10	yellow	Below 60	Korea	Korea	No
KOR-22	Brand 10	red	Below 60	Korea	Korea	No
KOR-23	Brand 11 (Anti-corrosive Paint)	red	190	Korea	Korea	No

TABLE 4. DISTRIBUTION OF LEAD CONCENTRATION BY BRAND.

Brand	No. of Samples	No. of Samples Above 90 ppm	No. of Samples Above 10,000 ppm	Minimum Lead Content (ppm)	Maximum Lead Content (ppm)
Brand 1	3	0	0	Below 60	Below 60
Brand 2	3	0	0	Below 60	Below 60
Brand 3	3	0	0	Below 60	Below 60
Brand 4	3	1	1	Below 60	44,000
Brand 5 (Anti-corrosive Paint)	1 (red)	1	1	230,000	230,000
Brand 6 (Anti-corrosive Paint)	1 (red)	1	1	5,100	5,100
Brand 7	3	0	0	Below 60	Below 60
Brand 8	1 (yellow)	0	0	Below 60	Below 60
Brand 9	1 (yellow)	0	0	Below 60	Below 60
Brand 10	3	0	0	Below 60	Below 60
Brand 11 (Anti-corrosive Paint)	1 (red)	1	0	190	190

TABLE 5. DISTRIBUTION OF LEAD CONCENTRATION BY COLOR.

Color	No. of Samples	No. of Samples Above 90 ppm	No. of Samples Above 10,000 ppm	Minimum Lead Content (ppm)	Maximum Lead Content (ppm)
White	6	0	0	Below 60	Below 60
Yellow	8	1	1	Below 60	44,000
Red	9	3	1	Below 60	230,000

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