Infant Mortality: Is Lead The New Leading Killer?

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A World View of Mathematics and Data Analysis

by

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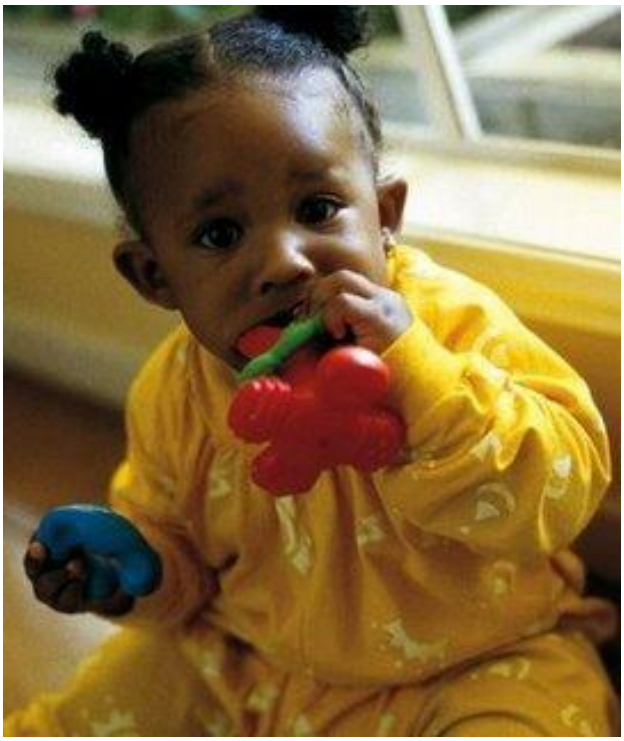


Abstract

Infant Mortality rates in the Unites States have seemed to steadily decline year after year. Granted, there have such been many advances in medical procedures and technologies, which have contributed to the lower infant mortality rates in the United States. While succeeding to achieve lower infant mortality rates, a new trend in the recalling of children's toys has also emerged. According to the United States Consumer Product Safety Commission, CPSC, when studying the past 15 years, lead contamination has progressively become a greater cause for recall. Infants are highly susceptible to lead poisoning, which has very harmful effects on the growth and development of children. Highly excessive amounts of lead can even be fatal. As lead continues to be used in the making of many children's toys, these children are being presented with an even greater risk of growth and/or development problems, and in some cases, death. From the years 1995-2009, analyzing the recalls of children's' toys provides insight into the growing threat of lead poisoning among infants and how this affects infant mortality rates as a whole. Through hypothesis testing, this study showed insignificant information regarding a linear correlation between the number of infant deaths and the number of recalls on children's toys; however, more critical information on the recent trends of lead contamination in toys was discovered. Within the 5 most recent years, lead contamination has quickly become the leading cause for recalling children's toys, putting children in the United States at the terrifying risk of danger and even death.

Background

Lead is a heavy metal that is naturally in the soil and air (Illinois Department of Public Health, 2009). Although lead is very useful in making everyday products, it is also very hazardous. When the body contains excessive amounts of lead, this is considered lead poisoning (Illinois Department of Public Health, 2009). Lead can enter the body from eating certain things containing lead or by breathing it in as dust (Illinois Department of Public Health, 2009). Since lead is used in many common products, ingesting amounts of lead would not be very difficult or even that noticeable. "Given its wide use, lead is ubiquitous-found in air, soil, dust, paint, and water contaminated by corroding pipes. (Lead dust and lead paint are considered the most prevalent source of contamination)" (McCarthy, 2004, p. 2). The largest source of lead is paint manufactured before 1978 and the dust created when it decays: this paint was used in making toys (Illinois Department of Public Health, 2009). Lead contamination of children's toys is a highly important issue that needs to be better monitored in order to protect children and infants from unintentional, but sometimes unavoidable, dangers. Imported toys are also sources that may contain high levels of lead (Illinois Department of Public Health, 2009).

Lead can have very adverse effects on the body. The body registers lead simply as it would calcium, so it is not recognized as toxic (McCarthy, 2004). Since lead is not seen as a harmful substance to the body, it gets into the blood stream very easily. "…coursing through the blood, finding its way into soft tissues of the liver, kidneys, and the brain, where it may disrupt normal function; settling into bones and teeth, where it can be stored for decades" (McCarthy, 2004, p. 2).

It is very interesting to investigate who exactly gets lead poisoning and whether or not a certain group of people are more prone to getting lead poisoning. The truth is that anyone can

get lead poisoning (Illinois Department of Public Health, 2009). Children's small bodies absorb higher levels of lead than adult bodies, so they are at greater risk of getting lead poisoning (Illinois Department of Public Health, 2009). Children are also are more harmfully affected by the substance. Lead targets children's brains and nervous systems of the still developing bodies (Illinois Department of Public Health, 2009). Children, and especially infants, unintentionally put themselves at greater risk mainly because of their behavior. They place their hand as well as objects inside their mouths making it more likely for them to absorb lead dust (Illinois Department of Public Health, 2009).

"In 1976 nearly 20 percent of American children ages 1 to 5 had blood levels of lead higher than 10 micrograms per deciliter-the standard of "concern" recognized by the Centers of Disease Control" (McCarthy, 2004, p. 2). The Environmental Protection Agency's legal limit of the amount of lead is 15 parts per billion (McCarthy, 2004). As of October 16, 2009, national surveys concluded that 3 million children 6 years and younger had lead poisoning (Illinois Department of Public Health, 2009).

Symptoms of lead poisoning often go unnoticed without much concern. They resemble symptoms of the flu (Illinois Department of Public Health, 2009). The complications involved with lead poisoning range from learning disabilities, mental retardation, behavioral problems, lowered intelligence, stunted growth, and hearing impairment (Illinois Department of Public Health, 2009). Blood levels of 70 micrograms per deciliter, mcg/dL, are considered extreme cases of lead poisoning (McCarthy, 2004). At this level, convulsions, coma, and death can result (Illinois Department of Public Health, 2009). As a precaution, children should be tested for lead poisoning. Blood tests are given and any level of 10 mcg/dL or higher are considered unsafe (Illinois Department of Public Health, 2009). In order to prevent harmful effects, medication

called chelators (Illinois Department of Public Health, 2009). "Some recent studies claim that childhood lead poisoning can contribute to problems later in life, such as academic failure, juvenile delinquency, and high blood pressure" (Illinois Department of Public Health, 2009). Since children are so often put in situations of possible exposure to lead, the presence of lead in toys is just another major issue where children can possibly be poisoned. The adverse effects of lead are too hazardous to be played with, so recalls on toys containing lead are very useful; however, they might not be useful enough.

Research Question/Problem

The question being analyzed while researching this topic is whether or not lead contamination in children's toys has increased over the past 15 years, 1995-2009, in the United States. Upon answering this, the question of how this increase has any effect on infant mortality rates will then be answered. The number of recalls of children's toys from 1995-2009 will be analyzed to determine if there is a linear trend. A trend from year to the number of infant deaths will also be used to conclude if there is any linear correlation. Using the information about number of recalls of children's toys and the number of infant deaths, a comparison will be made to establish a relationship between these two factors. Focusing on mainly the number of recalls of children's toys in the past 15 years, the causes for recall will be analyzed in order to determine the leading causes. The past 5 years will be looked into further in order to conclude what the latest causes for recall are. Discovering this trend in the past 5 years will allow for a prediction of number and cause for recall and how those might/will affect the number of infant mortality rates. Is lead poisoning becoming a greater threat to infants every day simply in their playrooms, and how are the increases in the chances of infants becoming exposed to the fatal consequences affecting toy recalls and ultimately infant mortality rates?

Methods

When retrieving correct information on the number of infant deaths from each year in the 15 year span being analyzed, the infant mortality rates from these years were first needed. The rates were obtained from a website with various collections of data involving current issues. The rates were listed as a number out of every 1000 deaths. The populations were thus needed to accurately convert the data into the actual number of deaths rather than rates. The populations of the United States over the past 15 years were collected from three different websites, allowing for each year to be counted. With these data sets, a relationship was created between the years and the number of infant deaths in each year.

The number of recalls on children's toys was investigated next. In order to accurately obtain the information needed to investigate recalls of children's toys, the data was collected from the US Consumer Product Safety Commission website. Listed there was the current list of recalls on children's toys from February of 1974 to June of 2010. Posted were links that detailed further information concerning the reason for recalling each toy and a description of each toy, to help consumers recognize the recalled toys. In most cases, incidents concerning the recalled toys, in which children were harmed, would also be detailed in hopes of explaining the dangers that the toys could result in. In this investigation, the recalled toys from years 1995 to 2009 were counted and the causes for recall were recorded. A relationship was then created between years and the number of toy recalls.

With all of this information gathered, the number of infant deaths in a year was compared with the number of toy recalls to conclude if there was any correlation between the two. A regression hypothesis test was performed for the number of children's toys recalls versus the

number of infant deaths from 1995 to 2009. With this information a linear regression equation was formed. With their relationship determined, this information could then be used to make prediction values of either data set based on the other.

Taking the data on the number of recalls on children's toys a step forward involved investigating the individual causes for recalls on the toys. Looking at the past five years allowed for a more accurate account of the most recent trends in the data. This is when the main focus started to shift to the analysis of the lead contamination of the toys. The percentage of the causes lead contamination being the cause for recall was determined as well as for the other leading causes for a comparison. A confidence interval for the percentage of lead contamination being the cause for recall was then calculated. The total number of toy recalls was then compared with the number of toy recalls that involved lead contamination to establish a relationship for later predicting values.

The information on the linear relationships between the data sets is useful in predicting the trends of the toy recalls and recalls concerning lead contamination. These help to track the progress of lead contamination in toys in recent years and determine whether or not they have any effect on the number of infant deaths.

Results

The number of infant deaths from the years of 1995 to 2009 (see table 1) resulted in having slightly poor linear correlation, meaning that within that 15 year time span, the number of infant deaths does not seem to progress in a linear trend.

= 120 = 56,105,800,000,000

= 1240 = 231,183,220

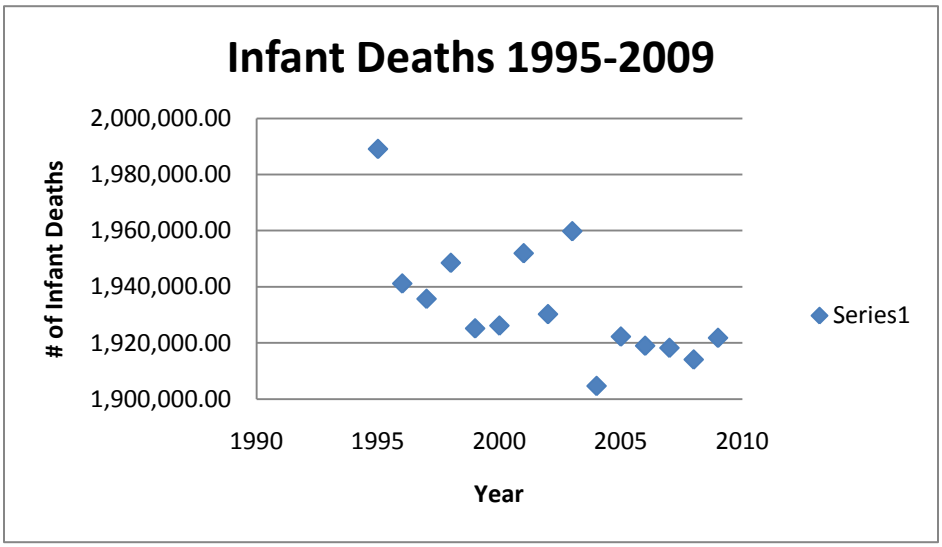
= 29,008,453.28 n=15

=280

= 6,442,553,471

= -.6584817859

The scatter plot below displays the relationship between year and number of infant deaths as described by the above preliminary data:



When comparing the 15 year time span with the number of children's toy recalls (see table 2), there again seemed to be very poor linear correlation, if any at all; however, the number of recalls appeared to increase within the last 5 years, from 2005-2009.

= 120 = 52596

= 1240 = 7162

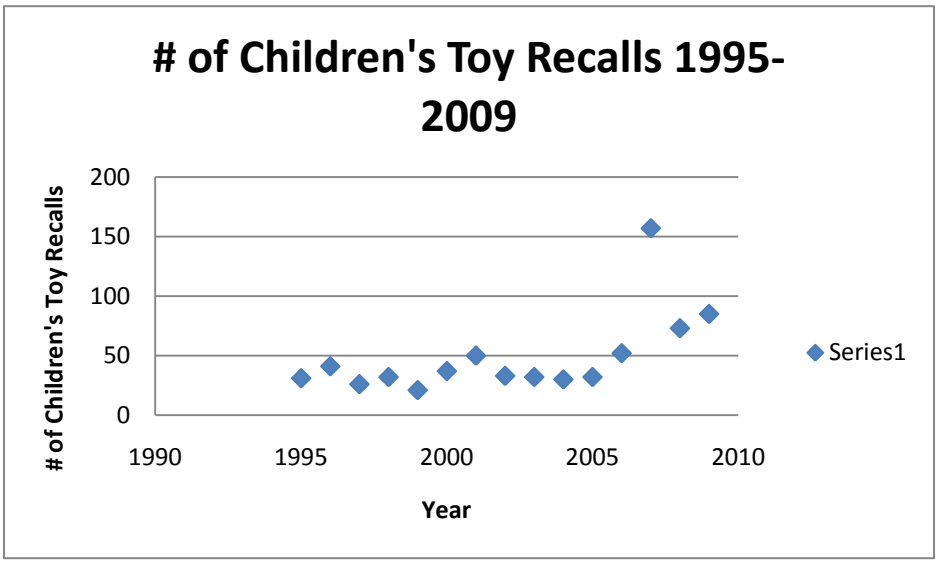
= 732 n=15

.6008277618

16874.4

1306

The scatter plot below displays the relationship between year and the number of recalls on children's toys as described by the above preliminary data:



The next main focus was to compare the data regarding the number of recalls on children's toys and the number of infant deaths (see Table 3). The preliminary data was first gathered to calculate the correlation coefficient, "r". Once the "r" value was calculated, a regression hypothesis test was performed to determine whether or not there was any correlation between the number of recalls on children's toys in a year and the number of infant deaths in a year.

= 732 = 56,105,800,000,000

= 52596 = 1,412,344,905

= 29008453.28 n=15

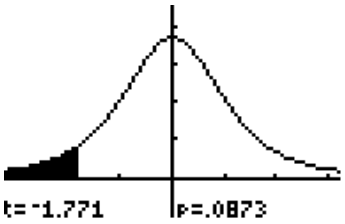
6,442,553,471

-3267615.064

Linear regression hypothesis test for the number of recalls on children's toys and the number of infant deaths:

H_o: **$\alpha = .05$**

H_a: **> 0 (claim)**



$t^* = \frac{\quad}{\quad}$ $t^* = \frac{\quad}{\quad} = -1.189892549$

The test statistic of -1.189892549 does not fall in the shaded rejection region.

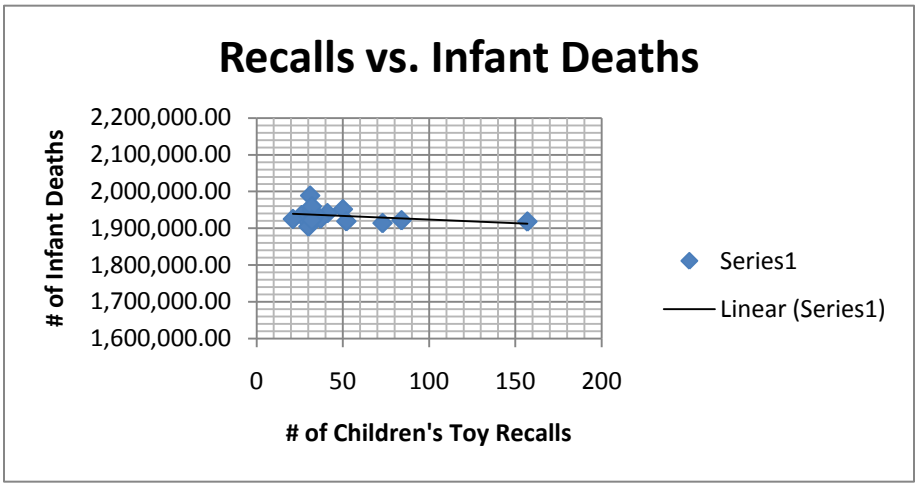
Decision: Fail to reject null hypothesis.

Conclusion: there is insufficient evidence at the α-level of .05 to conclude that there is negative linear correlation between the number of recalls in a year and the number of infant deaths in a year.

The "r" value, -.3133918541, for the correlation between number of recalls in a year and the number of infant deaths in a year suggest that there is very poor negative linear correlation, but based on the regression hypothesis test, there is no negative correlation at all. This means that based off of the number of recalls on children's toys in a year, you cannot accurately determine the number of infant deaths in that same year.

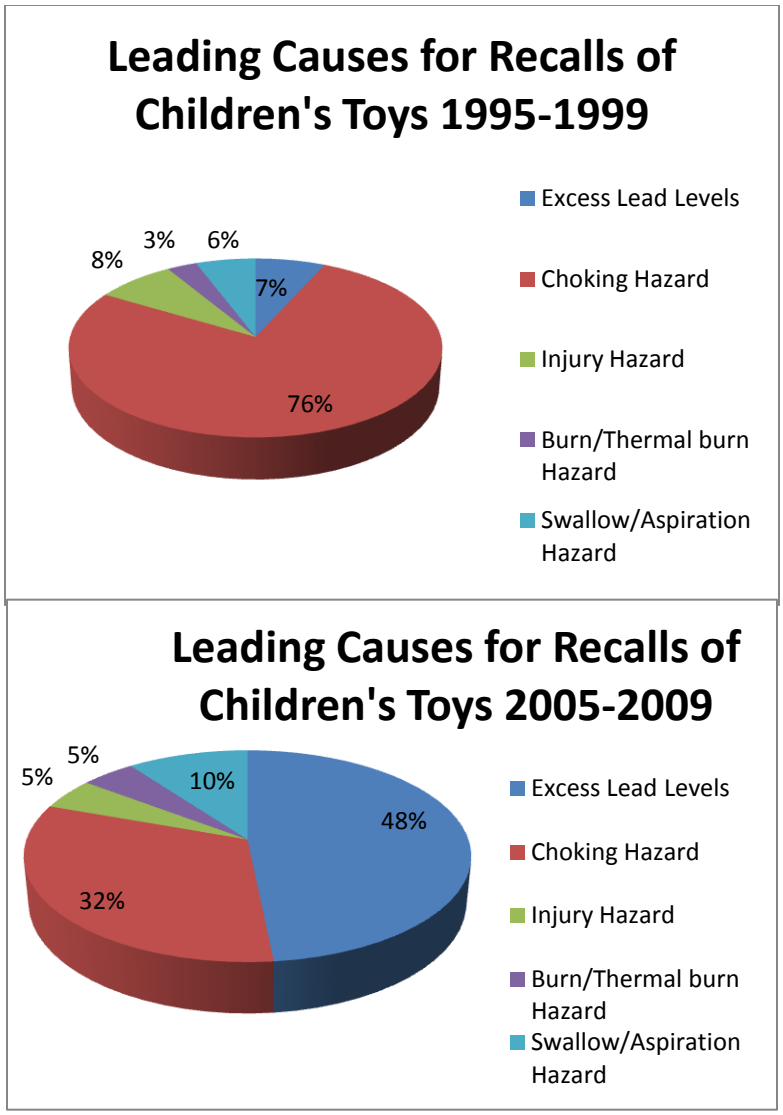
Based on looking at the graph below, the data seems to be located in mainly one area to the left. This suggests that the number of recalls on children's toys as well as the number of infant deaths usually tend to be stay in a certain range of values for each year.

The scatter plot below displays the relationship between the number of recalls on children's toys and the number of infant deaths:



Switching the focus to the causes of children's toy recalls allowed for a comparison to be made regarding which were the leading causes from the first 5 years of the 15 year time span and which were the leading causes from the last 5 years. The graph below details the most common occurring causes for recall and the percentage of all the recalls for the years 1995-1999. Within this time span, recalls were often decided on because of possible choking hazards with 76 percent. Lead only amount to 7 percent of the causes for recall in these years. When compared to the next graph below, the leading causes for the 5 most recent years in the time span investigated, a significant shift in leading causes occurred. Lead contamination now amounts to 48 percent of the cause for recall, the majority, and choking decreased to only 32 percent.

This data is explained by the pie charts below:



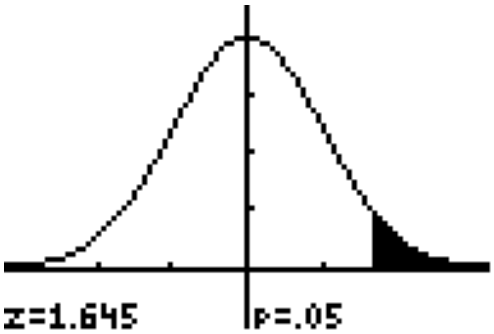
Based on the data from the above pie charts, a mean comparison hypothesis test could now be useful to detail the "improvement" of lead poisoning becoming a new leading cause for recalling of children's toys. The hypothesis test was performed by the following:

Group 1: 1995-1999	Group 2: 2005-2009
$\hat{p}_1$=.0463576159	$\hat{p}_2$= .4536340852
$n_{1=}$ 399	n_2= 151
x_1= 181	x_2= 7

Mean comparison hypothesis test for the difference in toy recalls based on lead contamination from 1995-1999 and 2005-2009:

H_o: $P_1 - P_2 \leq .30$ **$\alpha = .05$**

H_a: $P_1 - P_2 > .30$ (claim)



$$\bar{p} = \frac{x_1 + x_2}{n_1 + n_2} = \frac{181 + 7}{399 + 151} = .3418181818$$

$$\bar{q} = 1 - \bar{p} = .6581818182$$

$$z^* = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{\bar{p}\bar{q}(\frac{1}{n_1} + \frac{1}{n_2})}} = \frac{(.0463576159 - .4536340852) - (.30)}{\sqrt{(.3418181818)(.6581818182)(\frac{1}{399} + \frac{1}{151})}} = 2.367641769$$

The test statistic of 2.367641769 does fall in the shaded rejection region.

Decision: Reject null hypothesis

Conclusion: There is sufficient evidence at the alpha level of .05 to conclude that the difference in percentage of lead recalls from 1995-1999 to 2005-2009 in the United States is greater than 30 percent.

Conclusion

In conclusion, by analyzing the number of infant deaths and the number of recalled children's toys from the years 1995 to 2009 there is not concrete proof that the number of recalled children's toys is correlated with the number of infant deaths that will occur in the same year. However, this study did result in interesting findings about lead and its recent emergence as the leading cause for recall in the past 15 years. From 1995 to 1999 the leading cause of recall was choking hazards, but over only a course of 5 to 10 years the leading cause for recalling children toys became lead contamination. 30 percent of the recalls of children's toys from 2005 to 2009 were recalled because of lead contamination. This knowledge is very important, because it can be used to inform people of the true risks of lead poisoning that everyone, especially children and infants are faced with everyday. A simple toy that a child plays with for entertainment can actually be a source of lead. After repeated use of contaminated toys, children are at risk of obtaining extremely high levels of lead in their blood. A good way to avoid the risk of children becoming exposed to lead in toys is to not allow them to play with and mouth toys from vending machines (Illinois Department of Public Health, 2009). From the data collected, lead is not shown to affect the number of infant deaths; however, it is commonly used in children's toys. Lead contamination can easily go undetected, so it is important to keep up with recalls to know what toys to avoid and how to protect children and infants from easily undetected lead in the hands of our countries playful children.

Appendix

Year	# of Infant Deaths
1995	1,989,130.66
1996	1,941,189.29
1997	1,935,721.12
1998	1,948,552.36
1999	1,925,197.14
2000	1,926,183.08
2001	1,951,973.35
2002	1,930,269.92
2003	1,959,812.24
2004	1,904,679.21
2005	1,922,271.87
2006	1,918,996.30
2007	1,918,261.46
2008	1,914,095.27
2009	1,921,820.00

Table 1

Year	# of Toy Recalls
1995	31
1996	41
1997	26
1998	32
1999	21
2000	37
2001	50
2002	33
2003	32
2004	30
2005	32
2006	52
2007	157
2008	73
2009	85

Table 2

# of Toy Recalls	# of Infant Deaths
31	1,989,130.66
41	1,941,189.29
26	1,935,721.12
32	1,948,552.36
21	1,925,197.14
37	1,926,183.08
50	1,951,973.35
33	1,930,269.92
32	1,959,812.24
30	1,904,679.21
32	1,922,271.87
52	1,918,996.30
157	1,918,261.46
73	1,914,095.27
84	1,921,820

Table 3

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