Response to External Reviews of Leaded Aviation Gasoline Exposure Risk at Reid-Hillview Airport in Santa Clara County, California

Mountain Data Group

August 13, 2021

External Reviews

Dr. Mark Cullen Review

From: Dr. Mark Cullen

Sent: Sunday, April 11, 2021 1:38 PM

To: McClinton-Brown, Rhonda

Cc: Dr. Rebecca Anthopolos

Subject: Re: Draft of Report

I have now had a chance to peruse the report from Dr. Zahran and his group looking at the contribution of air traffic at the Reid-Hillview Airport to environmental lead exposure. As you are aware, the team found evidence of an increment in blood levels in the range of 0.2-0.5 micrograms/per 100 cc in young children living downwind within half mile of the runway. Overall, I think the report is technically very well done, and very coherently presented.

I have only one very small technical concern in the effort to tease out the proportion of blood level attributable to airplane fuel exposure, which is the impact of season. Unfortunately, almost all of the sources of lead in the child's environment rise in the summer, a time when there is also much more air traffic and virtually no variation in wind direction, rendering the sensitivity tests the team has done just shy of completely convincing. Although I don't for a moment suspect it will change the result, I would like to see a couple of additional sensitivity tests run, at least one with a seasonal fixed effect (although this might well "swallow" the finding altogether) and perhaps a test using some arbitrary "runway location" points to better exclude the possibility that families who end up residing so close to where planes take off may have one or unmeasured risks for higher exposure to lead than those living elsewhere, even those living upwind from the pollution and noise the airport also generates.

But assuming (as I do) that the result is robust, I would opine that this finding is not

a crisis. Although reference is made in the report to the debacle in the Flint drinking water several years ago, and the incremental lead effect is quantitatively similar, there are some important differences. The population impacted is relatively small, the impact is seasonal, and most importantly, only 1-2% of the measured levels, even with the attributable exposure, reached the "action level" for removal from exposure if I understood correctly. While the view that no level of exposure is safe is currently the predominant view among experts, there remains debate about how steep the effect on IQ is in the very low range, which is the basis for the cost estimate in terms of impact on lifetime earnings of the "airport effect". There are many environmental factors in SCC which negatively impact future earnings of poor children, and the cost-benefit of potential interventions should be broadly considered before amelioration decisions are made. I am also mindful of the risk that the airport could become an undue focus of community anxiety about health, when there may be better targets for this energy in the pandemic era. I would be happy to help the Department in any way you would like with such deliberations.

Response to Dr. Mark Cullen

First, we wish to thank Dr. Cullen for his kind remarks on the technical merits of the analysis and report coherence, and especially for his time, expertise, and thoughtful and constructive feedback. We begin by addressing Dr. Cullen's "small technical concern" pertaining to seasonality.

We deploy three tests that, by design, limit confounding from seasonality. The first such test is described in Section 5.2 PEA Traffic Exposure × Residential Distance, Equation 6. Here, we test the responsiveness of the BLLs of sampled children to changes in piston-engine aircraft traffic by residential distance. Given census block fixed-effects that capture unobserved conditions present in a child's neighborhood that may influence BLL outcomes (like soil lead accumulation), this test reasonably presupposes that non-aviation-related and season-specific sources of lead exposure are similarly active in the lives of

children residing near and far from RHV.

The second test is described in Section 5.3 PEA Traffic Contraction, Equation 7. Recall, piston-engine aircraft traffic declined measurably at Reid-Hillview Airport over the months of February to July of 2020, corresponding with the timing of interventions to limit the spread of COVID-19. Intriguingly, PEA traffic at Reid-Hillview Airport returned to historically normal levels in August to December of 2020. These dynamics in piston-engine aircraft operations at Reid-Hillview Airport therefore presented us with an exogenous natural experiment. Importantly, whereas PEA traffic is meaningfully perturbed in this moment, other sources of lead exposure like the re-suspension of lead-contaminated soils operate normally, and arguably, exposure to lead-based paint increases as children spend more time at or around their homes.

The third test – described in Section 5.4 Relative School Distance, Equation 8 – exploits the quasi-random movement of school-aged children in their commuting behavior toward and away RHV to attend nearby neighborhood schools. Again, this test reasonably presupposes that non-aviation-related and season-specific sources of lead exposure operate similarly on children that commute away and toward RHV.

All that said, in our final version of the report, we add seasonal controls to all models.

With respect to Dr. Cullen's second point on families living near RHV having "one or more unmeasured risks for higher exposure to lead" as compared to other families more distant from RHV, we first restate results in Table 1 of our final report. We write: "Before estimating regression coefficients pertaining to residential distance we compare sampled children in the inner orbit of proximity to Reid-Hillview Airport (< 0.5 miles) against children in outer orbits (0.5-1.5 miles) with respect to aviation gasoline exposure variables, and observable demographic and neighborhood characteristics. Table 1 shows means by distance categories on variables of interest, with computed p-values pertaining to one-tailed t-tests. The purpose here is to assess comparability of children by airport proximity. Sampled children are statistically similar with respect gender, resi-

dential near angle, age, PEA traffic exposure, sample order, and year or timing of blood draw, where $p > 0.05$. We do observe statistically significant differences with respect to the proportion of children sampled by capillary method (0.24 vs 0.26, $p = 0.024$), the percentage of neighborhood homes built prior to 1960 (23.8 vs 27.94, $p < 0.001$), the count of lead-emitting TRI facilities within 2 miles of a child's residence (2.38 vs 2.51, $p < 0.001$), and neighborhood socioeconomic status (-0.21 vs -0.25, $p = 0.006$). On variables where statistically significant differences are observed, all function to inflate the BLLs of sampled children in outer orbits as opposed to sampled children most proximate to Reid-Hillview Airport. Therefore, whatever differences in estimated BLLs that may obtain between sampled children by residential distance in regression analyses that follow, we may regard these differences as possibly attenuated." Second, all statistical models use census-block fixed-effects to address potential unmeasured risks present in a child's neighborhood.

Finally, with respect to Dr. Cullen's assessment of the implications of reported results, we agree fully with the spirit of his remarks that one must be judicious in the allocation of scarce resources in attending to questions of population health and welfare. We agree with all of his distinctions between the Flint Water Crisis – that we use to contextualize the meaning of observed "airport" effects throughout – and exposure to lead-formulated aviation gasoline at RHV. One important distinction that may alter the balance of benefits and costs of potential interventions is that unlike the Flint Water Crisis which was episode in time, the exposure to aviation gasoline near RHV is continuous and ongoing. Like Dr. Cullen, our team is happy to assist the County of Santa Clara with the necessary benefit-cost deliberations on options to limit lead exposure from aviation-related sources.

Dr. Rebecca Anthopolos Review

From: Dr. Rebecca Anthopolos

Sent: Wednesday, May 5, 2021 6:42 AM

To: McClinton-Brown, Rhonda

Cc: Dr. Mark Cullen

Subject: Re: Draft of Report

I am very impressed by the report. Congratulations on such a comprehensive examination of a very important topic.

The analytical approach does not appear to adjust standard errors for repeated BLL measurements to the same child. I am unclear of the extent to which children have repeated BLL measurements. I suspect that BLL measurements to the same child will be highly positively correlated.

The empirical methods describes comparisons of 0.5-1 mile and 1-1.5 mile to the reference level of 0.5 miles. The statistical results do not suggest a difference of these two categories with respect to the reference level. For example, the coefficients for the residential distance terms compared to the reference level are very similar. This makes me wonder how these cutoffs were selected and whether other cutoffs would be more illuminating. I would like to see BLLs modeled as smoothed function of distance to RHV overlaid on the observed data. The author states that this was conducted, but the results are not shown. The same applies to the other continuously measured exposures of interest (e.g. PEA trafffic).

I would like more information about but the distance threshold for 1.5 miles for the study inclusion criteria. I understand that this threshold was selected based on previous research (Note that no reference are given.). However, no other details are given. Was sensitivity analysis conducted examining children farther away from the RHV? What is a reasonable maximum distance threshold that allows included individuals some probability of being exposed?

The presentation of results focuses on the regression coefficients and predictions. However, I did not see any model diagnostics/checks. To what degree does the model cap-

ture the patterns in the data? I would like to have confidence that the inferences from the model are well-supported by the data. To this end, model diagnostics are key.

I would like to see descriptive statistics of individual level risk factors by the categories for the distance to the airport. Our goal is to compare two individuals with different, say, distance to the airport, but who are similar on other risk factors. Are children who live within 0.5 miles from RHV similar to children who live, say, 1 to 1.5 miles from the airport on other risk factors? If we think of the different levels of residential proximity as treatment levels, then I would like to see the distribution of individual level risk factors across the treatment levels. To this end, the author may want to comment on why matching strategies were not used.

Response to Dr. Rebecca Anthopolos

First, we wish to thank Dr. Anthopolos for her supportive remarks on the comprehensiveness of our report, and for her close reading of the technical elements of analysis.

With respect to Dr. Anthopolos's point on clustering of standard errors, in our revised report we include this requested exercise (alongside others) in the Appendix section entitled A.1 Robustness Tests: Restrictions and Clustering. It should be noted that all regression analyses account for heteroeskedasticity (that may arise from repeated sampling) and relaxation of distributional assumptions with bootstrapped standard errors. While the report is aiming for coefficients throughout, with respect to Dr. Anthopolos's point on model diagnostics, this is standard practice. Under bootstrapped errors, we render Wald Chi-Square, Prob > Chi-Square and Root MSE tests for all statistical models rendered.

With respect to Dr. Anthopolos's point on cut points, we provide logic in our revised report in footnote 5, stating: "Our inner orbit of exposure risk at < 0.5 miles conforms to previous research. Recall, Miranda et al. (2011) find that children at 500m to 1km from a general aviation airport in North Carolina are at highest at-risk of presenting with

elevated BLLs. Zahran et al. (2017a) find that sampled children within 1km of 448 airports in Michigan are at greatest risk. The EPA (U.S. Environmental Protection Agency, 2020) maintains that children within 500m of PEA-servicing airports are at highest risk of exposure to aviation-related atmospheric lead. Our inner distance of < 0.5 miles sits between the consensus range of exposure risk at 500m to 1km."

Moreover, in our revised report we include requested analyses pertaining to BLLs modeled as smoothed function of distance. We write: "Table 4 reports results involving the estimation of a series of linear models with residential distance measured continuously and applying various transformations to both distance and child BLLs. All things held equal, we find that no matter the measurement or transformation – distance measured linearly, log or square root transformed and child BLLs measured linearly or log transformed – child BLLs decrease statistically significantly with residential distance from Reid-Hillview Airport." With respect to piston-engine aircraft traffic, we analyze traffic both continuously and by division into terciles to study potential non-linear relationships.

With respect to the decision to limit the outer perimeter at 1.5 miles, we had two reasons. First, existing studies indicate that risk exposure substantially dissipates beyond this point. Second, our design aim was to limit differences on observable individual and neighborhood characteristics in our study population by distance. As shown in Table 1 of our revised report, children proximate to RHV are statistically highly similar to children more distant from RHV. We write: "Before estimating regression coefficients pertaining to residential distance we compare sampled children in the inner orbit of proximity to Reid-Hillview Airport (< 0.5 miles) against children in outer orbits (0.5-1.5 miles) with respect to aviation gasoline exposure variables, and observable demographic and neighborhood characteristics. Table 1 shows means by distance categories on variables of interest, with computed p-values pertaining to one-tailed t-tests. The purpose here is to assess comparability of children by airport proximity. Sampled children are statistically similar with respect gender, residential near angle, age, PEA traffic exposure, sample order, and year or timing of blood draw, where $p > 0.05$. We do observe statistically

significant differences with respect to the proportion of children sampled by capillary method (0.24 vs 0.26, $p = 0.024$), the percentage of neighborhood homes built prior to 1960 (23.8 vs 27.94, $p < 0.001$), the count of lead-emitting TRI facilities within 2 miles of a child's residence (2.38 vs 2.51, $p < 0.001$), and neighborhood socioeconomic status (-0.21 vs -0.25, $p = 0.006$). On variables where statistically significant differences are observed, all function to inflate the BLLs of sampled children in outer orbits as opposed to sampled children most proximate to Reid-Hillview Airport. Therefore, whatever differences in estimated BLLs that may obtain between sampled children by residential distance in regression analyses that follow, we may regard these differences as possibly attenuated." This table also addresses Dr. Anthopolos's request for information on individual risk factors by distance.

Final Report to Rhonda McClinton-Brown

From: Dr. Sammy Zahran
Sent: Monday, July 19, 2021 12:30 PM
To: McClinton-Brown, Rhonda
Subject: Re: Feedback on Study

Hi Rhonda,

I hope all is well. Please find attached our revised report incorporating feedback from Drs. Cullen and Anthopolos. Key revisions made include:

1) The addition of seasonal controls in all models (to accommodate Dr. Cullen's request).

2) The addition of detection limit indicators to all models (to accommodate CPDH reviewers).

3) A robustness exercise involving the use of robust clustered errors by repeated sample (to accommodate Dr. Anthopolos).

4) The use of continuous measures of distance (in original units, log transformed, and square rooted) to support the categorical distances used (as requested by Dr. Anthopolos).

5) We report a table (with accompanying text), showing the children more distant from the airport are effectively identical to children proximate to the airport on observable characteristics or individual-level risk factors (to accommodate Dr. Anthopolos's questions on sample similarities).

There is more throughout, including analyses limiting to children 6 and under (as requested by the CDPH) and demonstration of the robustness of results to imputation measures addressing possible bias from test detection limits, among other things.

Please share the revised report with Drs. Cullen and Anthopolos and thank them again for their very useful feedback. Many thanks, Sammy