The Personal Statement of Douglas Wilmore, M.D.

Summary:
I have been a physician for over 50 years and an active medical scientist and health investigator for 45 years. I have approached the problem of health and pesticides using scientific methods in an effort to provide direction for further investigations, if indicated. My conclusions based on available group data and using statistical methods are summarized below.

Analysis of group data from five areas of Kauai suggests that pesticide use may be associated with adverse health events. Coffee and seed company spraying occurs in association with an increase in specific detrimental health conditions that are related to major variations in the health of populations in different geographic areas of Kauai. This information strongly suggests that further studies be performed by acquiring health and life-style data from individuals in these five communities combined with environmental data (e.g., soil, dust, air and water) to ascertain the causal effects of pesticides on Kauai’s populations.
The Evidence:

This evaluation focuses on group data from five geographic areas in Kauai. To examine the relationship between pesticides and health, reliable and accurate information was required. This was found in the *State of Hawaii Needs Assessment Data Book 2012* which provided both data on mortality (defined as death, a certified event due to investigation of each death by the county health officer --- see box for definition) and morbidity (defined as the occurrence of disease, events verified by the HDOH, the U.S. Dept. of Commerce and the U.S. Census Bureau). In addition, the data was comprised of group averages over five years ranging from 2006-2010. (See pages 6-7 of the above-cited monograph to review the primary data). The population areas that are discussed are shown below.

![Kauai Map](image)

In order to make comparisons between these areas a metric (measurement tool) was needed that could be used repeatedly to compare data. If this same measurement tool was used in all comparisons it is known as a “constant variable”. In many of the medical reports related to pesticide exposure, health effects are determined by drawing concentric rings around the fields where pesticides were used and expressing the health effects as the distance from the central area. That approach could not be used in Kauai because of the central mountain ranges, the agricultural fields and populations located on the costal plains and towns sometimes separated by mountains. To solve our unique problem I adopted the highway distance from Waimea, with Waimea being the center of pesticide spraying and designated as 0. At the other end of the highway was Hanalei designated as 66 miles from Waimea. Koloa (26 miles from Waimea), Lihue (34 miles) and Kapaa (45 miles) were towns in between the two ends of the highway. The relationship between towns and distance from Waimea is shown below.
An internet-based statistical program called StatCrunch was utilized for this analysis. Standard p-values were calculated and it was assumed that levels at $p<0.05$ were *significant* and that $p<0.1$ indicated a *trend* (see Box). Please appreciate that in using statistical analysis with small data groups between only 5-10 numbers, finding significant (low) p-values are unusual. When they are apparent this often suggests that differences exist. Also, small population size, like those found in Waimea, hamper accurate health analysis. With a population 2-3 times larger such as those found in Mainland agricultural communities, adverse health trends may have been identified. We overcame this problem by including the entire population of Kauai in our analysis, and differences began to emerge.

Also, r-values were calculated, which are referred to as *correlation coefficients*. An r-value is a number between -1 and +1 that represents how strong the relationship is between two groups of numbers. An r-value of $\pm 1.0$ is a perfect correlation that is rarely achieved. It is generally accepted that r-values of greater than $\pm 0.6-0.7$ are meaningful correlations.

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**Definitions:**

**mortality** --- Death, expressed as a value per a fixed population size, usually 100,000, so that comparisons can be made between groups. If this number is greater than the general population it means that the number of people that died each year was increase, but it also indicates that at any age, more individuals die when compared to the average group.

**morbidity** --- This term describes how often a disease occurs in a specific population, expressed as a % or adjusted to a standard population size such as 100,000.
**p-value** --- The probability that a group of numbers is different because of the effect studied rather than a chance event. A p < 0.05 determines that the numbers have a 1 in 20 possibility of occurring by chance.

**r-value** --- This value, also called the correlation coefficient, ranges from -1 to +1 and mathematically expresses the relationship between two groups of numbers. For example, comparing the genes between identical twins would have an r of 0.99, between fraternal twins r= about 0.5 and between two individuals in the general population r equals <0.2.

Five health events (low birth weight, diabetes, cancer deaths, overall deaths and obesity) that were related to adverse health outcomes associated with pesticides (see the primary text of this report for these references plus Google “pesticide induced diseases: cancer”) were included in the data set. Pesticides may be one of a number of causes of each of these adverse health events. This retrospective data may therefore serve as a marker of pesticide effects on the health of a population. However, pesticides should not be considered as the sole cause any of these illnesses. An example of the calculation of each variable is shown below for cancer mortality (deaths).

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**Cancer Deaths**  
(Deaths per 100,000)

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Figure 2. Cancer deaths are plotted as a function of distance from Waimea. As the population is evaluated from Waimea to Hanalei the number of deaths per 100,000 people falls as indicated by the regression line. The slope of the line is a mathematical method to describe this event.

The individual data obtained from the five adverse health events is shown below on Table 1.
### Table 1

<table>
<thead>
<tr>
<th>Category</th>
<th>Slope of line</th>
<th>R value</th>
<th>P value of slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Birth Weight (%)</td>
<td>-0.022</td>
<td>-0.30</td>
<td>0.63</td>
</tr>
<tr>
<td>Diabetes (%)</td>
<td>-0.67</td>
<td>-0.61</td>
<td>0.28</td>
</tr>
<tr>
<td>Cancer Deaths (per 100,000)</td>
<td>-0.55</td>
<td>-0.82</td>
<td>0.09</td>
</tr>
<tr>
<td>Overall Death (per 100,000)</td>
<td>-0.054</td>
<td>-0.85</td>
<td>0.07</td>
</tr>
<tr>
<td>Obesity (%)</td>
<td>-0.20</td>
<td>-0.88</td>
<td>0.048</td>
</tr>
</tbody>
</table>

Table 1. All adverse events related to pesticide exposure show a negative slope of the regression line meaning that there is a decrease in the specific disorder as one examines populations from Waimea to Hanalei. The last three events ---cancer mortality, overall deaths and obesity --- all have high r-values showing good correlation with distance from Waimea and have p-values suggestive of a trend toward being significantly different from a horizontal line.

But these health differences between communities may be related to other factors such as economic security, educational background and life style influences. To evaluate some of these influences with the data available, non-pesticide adverse health events were evaluated. If these events also showed a decline based on the distance from Waimea, then factors such a life style and economics could be playing a role to influence these results. Therefore, the effect of cardiovascular disease, the major cause of death in Hawaii and the U.S. which is highly associated with life-style activities such as diet, exercise and smoking, was evaluated in a similar manner across the 5 population groups of Kauai. A plot of cardiac deaths as a function of distance from Waimea is shown in Figure 2.
Figure 2. Cardiac deaths are plotted as a function of distance from Waimea. Note the random scatter of the data points (which represent towns), the low r-value, the non-significant p-value and the comparability of the values plotted for Waimea and Hanalei. All these factors point to the fact that cardiac mortality does not decrease as the distance from Waimea increases.

The analysis of the three individual cardiovascular events that are unrelated to pesticide exposure is shown below on Table 2.

<table>
<thead>
<tr>
<th>Category</th>
<th>Slope of line</th>
<th>R value</th>
<th>P value of slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Disease (per 100,000)</td>
<td>-0.08</td>
<td>-0.08</td>
<td>0.90</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>+0.19</td>
<td>+0.19</td>
<td>0.76</td>
</tr>
<tr>
<td>Stroke (per 100,000)</td>
<td>-0.17</td>
<td>-0.17</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Table 2. Non-pesticide related adverse health events and distance from Waimea. The low r-values for all three events and the non-significant p-values demonstrated these disorders are randomly distributed across the island and may be little or inconsistently effected by variations in life-style events attributed to different communities in Kauai.
This information suggests that lifestyle and economics, as reflected in group data, are not likely reasons for the increase in mortality (overall deaths), cancer deaths and obesity that is highest in Waimea and decreases as one lives further away.

To appreciate the differences between adverse events, the two groups previously discussed were compared. The first group had medical conditions related to pesticides (see Table 1). The other group had medical conditions unrelated to pesticide exposure (Table 2). The percent change for each event was calculated and the events combined in their specific group. The results are shown below.

Figure 3. The percent changes for each medical mortality or morbidity was calculated and the group data aggregated. Pesticide-related medical events decreased about 30% as the population analysis moved from Waimea to Hanalei. In contrast, no change was observed in across the island when analyzing non-pesticide related events.

The next step in my analysis examined the frequency of commercial pesticide spraying as they were related to adverse health events. Ideally, this step would compare the amount of pesticide sprayed
for each mile traveled away from Waimea. However, the seed companies have failed to provide this data making this comparison impossible. Another approach was to evaluate the effect of pesticide spraying is to compare the length of time (in months per year) that pesticides are sprayed within the specific geographic area where spraying occurs. Duration of time of spraying is therefore a substitute marker for the pounds of pesticides introduced into the environment. This comparison is provided in Figure 4.

**Months of Spraying**

**Percentage Decrease in Pesticide-Related Events**

Figure 4. The bars depict the months of the year that pesticide spraying occurs and the general location where this is done on the island (the West side and around Lihue). No industrial agricultural spraying is performed between Kapaa and Hanalei. Note the relationship between the duration of spraying and the occurrence of adverse pesticide medical events as depicted by the regression line.

Finally, to confirm the actual presence of pesticides in the environment the data that is part of a student presentation by Ritikaa Kumar and her sponsor Carl Berg is cited (see the Garden Isle, Jan 22, 2016 and Science Fair presentation 24 Feb. 2016). They found high concentration of glyphosate (the major chemical in Roundup and a chemical commonly used in industrial spraying) in the honey harvested from the West side (range of concentrations 90-100 parts/billion) compared to levels of 0-14 when taken from areas stretching from Lihue to Hanalei.

Thus, the data presented demonstrates that group data reflecting pesticide-related adverse medical events generally decline as the distance from Waimea increases. This phenomenon does not occur
with non-pesticide related cardiovascular diseases. The length of time of spraying and the presence of pesticide in honey also follows this same pattern (high on the West side and low as the distance from Waimea increases), establishing potential associations between the pesticides in the environment and adverse pesticide-related medical events in Kauai populations. These suggestions are based on group data that needs to be verified by collecting health and life-style information from individuals. Finally, we would like to reemphasize that these potential associations do not confirm cause. However, this analysis suggests that further studies are necessary to determine potential variations in health outcomes in the five major Kauai communities.

**Conclusion:**
Scientific discovery frequently moves forward in small steps. This data is a first step that suggests an **association** between adverse health outcomes using group data and industrial agricultural pesticide spraying in Kauai. These group associations need to be confirmed by gathering health and life-style data from individuals and correlating similar changes with environmental exposure data (e.g., soil, dust, air and water) and toxicological information. State agencies must be more engaged in this process. In addition, available data should be obtained from insurance company records to determine the occurrence of specific cancers and other diseases. By including life-style data with health information, we can more accurately determine the effects of a variety of factors, including pesticides, on the variations in health and disease that may be occurring on Kauai.

I would like to thank the three epidemiologists who reviewed this work and provided appropriate comments that were incorporated into this statement.