CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 Practical Implications and Future Research

In summary, it can be stated that the anodic stripping voltammetry (ASV) in square-wave mode method used in this study provided a satisfactory means of determining Pb in whole blood. Voltammetric techniques present advantages and positive benefits including high sensitivity, simple sample preparation, low running costs, user-friendly instrumentation which allows for easy routine applications, as well as a wide range of application. Additionally, they give comparable quality of analytical performance in terms of detection limits in comparison with other methods of analysis like flameless atomic absorption spectroscopy. In view of these, the application of voltammetric analysis shows promise in monitoring trace metal concentrations (e.g., Pb) for exposure assessment purposes, surveillance, and epidemiologic studies in environmental as well as occupational health.

Quality assurance was done in order to ensure the reliability of the results obtained using the test method in this study. A correlation coefficient of 0.9792 was obtained when mean observed values for quality control (QC) materials were compared with mean expected values corresponding to other analytical methods employed in several laboratories. Moreover, less than 10% precision in terms of % CV was obtained in the analysis of three Blood Lead Level Reference System (BLLRS) standards of different Pb concentration levels. These further show the satisfactory performance of the method employed.

With regard to the blood lead (PbB) levels determined, the mean value of 8.1 μg/dl (n=87), was lower than the WHO threshold value of 20 μg/dl (WHO, 1987) for general populations. However, at least two of those tested had PbB >20 μg/dl (max = 21.9 μg/dl) and 25% of the study population had relatively high PbB levels (≥10

μg/dl). This still presents some degree of risk and although most participants have PbB levels within the threshold value, this must not be a reason for complacency. This is because at PbB ≥10 μg/dl, certain abnormalities have been identified in adults although their toxic significance is still obscure, e.g., elevated free erythrocyte protoporphyrin and marginal erythrocyte δ-aminolevulinic acid dehydratase (ALAD) inhibition (WHO, 1977 & 1987). This likewise presents a need to study the significance of these findings in relation to human health.

Moreover, in order that the phase out of leaded gasoline will have a greater public health impact, simultaneous measures to substantially reduce other sources of exposure as well as information dissemination on the subject must also be done. This would protect vulnerable groups from excessive exposure and consequent adverse health effects.

The PbB levels of traffic policemen were not associated to non-occupational variables rather, they were more influenced by work-related factors like the number of hours they work on the road and the type of masks they use. Factors like the use of cloth masks and ≥1 hour(s) traffic work increases the odds of having PbB ≥10 μg/dl by about 1.5-fold while smoking together with alcohol consumption increases the odds twice.

Comparison of the PbB levels in 1995 and 1996 indicate that no significant decline in PbB levels has taken place. This suggests that one year may be too short a period to observe any sizable decrease in PbB levels and further monitoring of a larger sample population may be necessary to get a better idea of the impact of using unleaded gasoline to human Pb exposure.

5.2 Limitations of the Study

The limitations of this study include low statistical power due to the rather small number of participants, and certain limitations on the coverage of the questionnaire. Additionally, ambient air Pb levels were not possible to determine.

5.3 Recommendations

Human beings are entitled to a healthy and productive life and should be able to live in harmony with nature. However, activities in the name of development, aimed to elevate the quality of life, have resulted in the deterioration of the very resources that are needed for sustaining life, such as food, water, air and soil. Deterioration and pollution of the environment -- the consequences of socioeconomic activities and natural change -- have been intensified by rapid industrialization and massive and uncontrolled urbanization, to name a few.

While the most advanced of the industrialized countries have introduced, over the past two decades, pollution control measures and established government services for the promotion of environmental health that are commensurate with the increase in industrial production and urban growth, this is not the case in the developing countries that have experienced rapid industrialization and socioeconomic change. Health hazards are thus created by toxic air emissions and increasing volumes of waste that contaminate water supplies and land. Though research on the issue has been scanty, there is increasing evidence that in the absence of regulation, current and future increases in manufacturing and transport in least developed countries will have serious consequences for public health. For instance, it is estimated that by the latter half of the 1980s, by WHO standards, 1.3 billion people lived in cities with unsafe level of airborne particulate matter and 1 billion were exposed to unacceptably high concentrations of sulfur dioxide (World Bank, 1992). Therefore, if the goal is to enhance and improve the health and well being of people, it must be realized that

health is closely related to development and the environment. And this calls for a proper linkage of health aspects with environmental health protection.

As any other developing country, Thailand has to balance its development priorities against effective environmental and health management. Appropriate planning decisions have to be made which will more than just prevent or counter the problem of environmental pollution. In addition, an active maintenance and promotion of health through improved social amenities and living as well as working environments is necessary.

The control of air pollution is only a part of a broader spectrum of issues that need to be addressed. Initiatives to control Pb emissions is only one aspect of reducing air pollution. In view of its significance to public health, however, its importance can not be overemphasized. The ban on the use of leaded gasoline in Thailand can be a significant step in reducing the risks of exposure to the metal. However, one cannot rely solely on pollution control regulations and/or policies set by governing bodies. More importantly, regulations need to be enforced and maintained. Moreover, given the many sources of Pb, a ban on leaded gasoline does not guarantee an automatic reduction in the total exposure of man. Therefore, if the government is to be consistent in its stand to reduce risks from Pb exposure, it must adopt an integrated approach in designing Pb exposure reduction programs. In this context, studies on the relative significance of the other sources of exposure are also needed. Specifically, identification and quantification of the other sources must accompany the phase out so that necessary restrictions to reduce or remove Pb contamination from other products like foods, cans, paints, solder and plastics can be made.

In relation to the present study, further research must be conducted, in particular, to examine the association between human exposure in terms of PbB levels and certain factors in relation to the use of unleaded gasoline in Thailand over a longer period of time. In Chiang Mai City, a larger sample size consisting of the general

population that can be grouped into different sociodemographic characteristics may be useful. Together with monitoring data of air Pb, drinking water Pb levels as well as information on dietary Pb intake, such an approach could help identify persistent sources of Pb contamination for which necessary measures will have to be addressed on.

Furthermore, as Chiang Mai continues on its path of rapid development other initiatives may be necessary. An efficient and reliable public transportation system must be developed and implemented in the area. This alternative must actually be considered in lieu of the fast-growing number of private vehicles (including motorcycles) in order to avoid traffic congestion and pollution in the immediate future. Market-based policy options such as better pricing policies for lead-free gasoline as well as tax schemes on vehicles that run on leaded fuel can be adopted. Additionally, the phase out of leaded gasoline must have a parallel program of phasing in catalytic converters in vehicles to control the emission of other pollutants (e.g., volatile organic compounds, etc.) which may be as harmful as Pb to human health. Lastly, additional incentives to adopt clean technologies may be provided through tax credits and subsidies specifically for industries in the area that release pollutants (e.g., Pb and other heavy metals) in their operations.