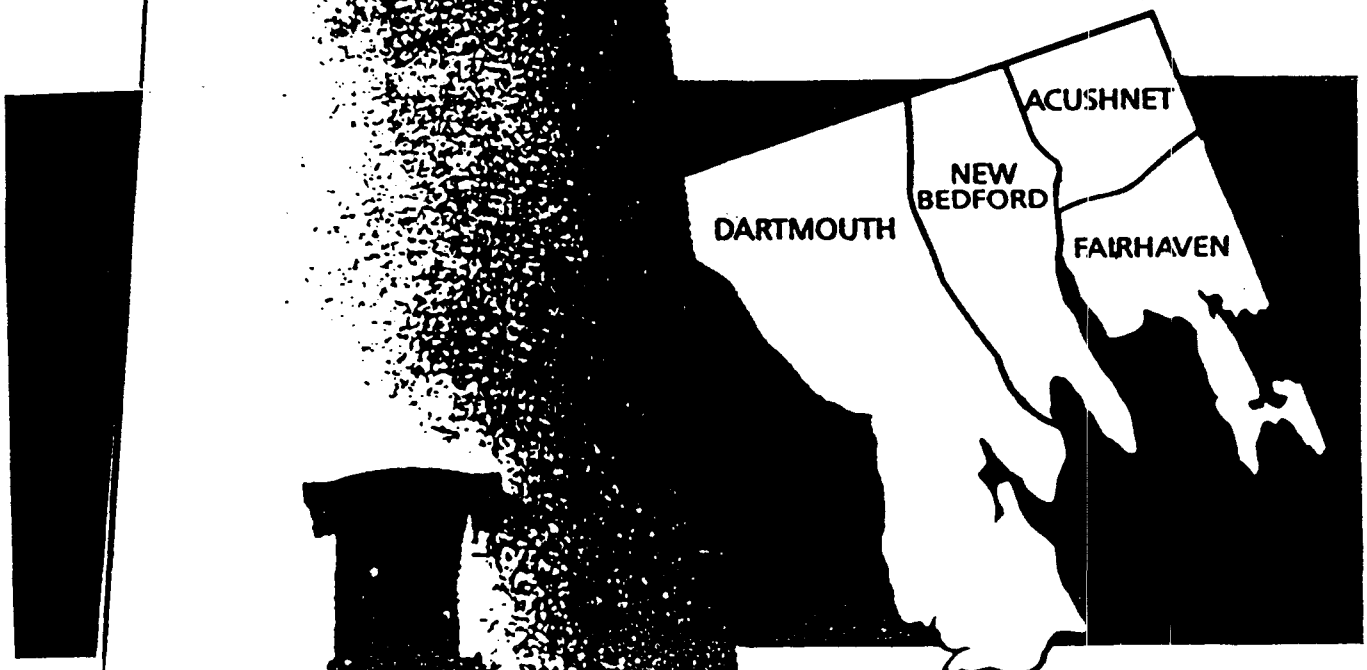
The Greater New Bedford PCB Health Effects Study 1984-1987

Executive Summary

A Collaborative effort of:

- The Massachusetts Department of Public Health
- The Massachusetts Health Research Institute
- The U.S. Centers for Disease Control



GREATER NEW BEDFORD PCB HEALTH EFFECTS STUDY

EXECUTIVE SUMMARY

JUNE 1987

This work was conducted by the Massachusetts Department of Public Health (MDPH) and the Massachusetts Health Research Institute (MHRI), with the assistance of the Center for Environmental Health, Centers for Disease Control, U.S. Public Health Service. Partial funding was provided by the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Public Health Service, from the Comprehensive Environmental Response, Compensation, and Liability Act trust fund (Superfund), through an interagency agreement with the Environmental Protection Agency (EPA).

Additional information on this project may be obtained by writing:

Greater New Bedford Health Effects Study
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Greater New Bedford (PCB) Health Effects Study

Executive Summary

INTRODUCTION

The Greater New Bedford PCB Health Effects Study (GNBHES) was a collaborative effort of the Massachusetts Department of Public Health (MDPH), the Massachusetts Health Research Institute (MHRI) and the U.S. Centers for Disease Control (CDC). This investigation was funded through the Agency for Toxic Substances and Disease Registry, U.S. Public Health Service with monies provided by the U.S. Environmental Protection Agency Superfund Office.

In late 1977 the U.S. Environmental Protection Agency (EPA) discovered the presence of polychlorinated biphenyls (PCBs) in the New Bedford harbor and the Acushnet River Estuary. In 1979 the Massachusetts Department of Public Health (MDPH) promulgated regulations to restrict all fishing activities in and around New Bedford harbor.

In 1981 and 1982 the MDPH, with assistance from CDC, conducted two small pilot studies to estimate serum PCB levels in residents of New Bedford and to determine the feasibility of conducting a large-scale, two phase epidemiological investigation designed to determine the prevalence of PCB exposure and possible related health effects among residents of Greater New Bedford (i.e. Acushnet, Dartmouth, Fairhaven and New Bedford).

METHODS

The study was designed in two phases. Phase I sought to determine the

prevalence of elevated serum PCB levels in a cross-sectional random sample of residents of Greater New Bedford and to determine whether or not serum PCB level is associated with level of systolic/diastolic blood pressure. An elevated serum level was defined as $\geq$ 30 parts per billion (ppb) PCB. Phase I also sought to identify two groups of 150 individuals each with serum PCB levels $\geq$ 30 ppb and $\leq$ 10 ppb. These individuals would then be invited to participate in the Phase II investigation which would test relationships between serum PCB level and a variety of health outcomes by analysis of data collected for the two aforementioned groups (i.e., exposed residents with serum PCB levels $\geq$ 30 ppb and unexposed $\leq$ 10 ppb). The Phase I protocol also called for a second study involving recruitment of residents at greater risk of exposure if it became apparent that the method of random selection would not identify a sufficient number of exposed residents necessary for proceeding to Phase II of the Greater New Bedford PCB Health Effects Study. After review of the first 322 serum PCB analyses (Table 1) it was determined that random selection would not identify enough exposed residents (serum PCB levels $\geq$ 30 ppb) for proceeding to the Phase II investigation. Only 1.2% of these 322 residents had serum PCB levels $\geq$ 30 ppb.

Preliminary analyses of data from these 322 residents revealed that those individuals with serum PCB levels $\geq$ 15 ppb had ingested moderate to large quantities of locally caught seafood (i.e., from the contaminated areas). As a means of identifying individuals who were likely to consume moderate to large quantities of locally caught seafood, records of fishing/lobstering licenses were obtained from the Massachusetts Division of Marine Fisheries as well as from Greater New Bedford city/town halls. It was likely that this group of individuals was at greater risk of

Table 1.

Serum PCB Results for 322

Greater New Bedford Residents

PCB level	Aroclor 1254	
	n	%
30 + ppb	4	1.2
20 - 29.99 ppb	4	1.2
10 - 19.99 ppb	28	8.7
0 - 9.99 ppb	286	88.8

n = number of respondents

% = percent of results on 322 respondents

ppb = parts per billion

exposure and would have higher serum PCB levels. This part of the Phase I investigation was called the Enrichment Study.

A refusal questionnaire was also designed and administered to individuals who were randomly selected for participation in the prevalence study but refused to participate. The response rate for this group of people was approximately 89%. Refusers did not differ significantly from participants with regard to age, sex, residence, seafood consumption or employment in an electrical manufacturing concern. Therefore, respondents were considered to be comparable to the total sample of the Greater New Bedford population.

RESULTS

Figure 1 presents the disposition of the randomly selected Phase I participants. A 57% (n=840) response rate was observed and was determined statistically adequate to detect a doubling of the prevalence of elevated serum PCB levels of 1% in the typical U.S. population to 2% or more (in the New Bedford population) at a .05 significance level and a power of .80.

PREVALENCE STUDY

Serum PCB Level: Table 2 presents the distribution of serum PCB levels among participants of the prevalence study for males, females and the total prevalence group. Only 1.3% of the total participants had serum PCB levels $\geq$ 30 ppb. The range in serum PCB levels was 0.40 to 154.2 ppb. For males and females respectively the range in serum PCB levels were 0.50 to 60.9 ppb and 0.40 to 154.2 ppb.

FIGURE 1

FINAL DISPOSITION OF THE RANDOM SELECTION PROCESS
FOR
THE GREATER NEW BEDFORD HEALTH EFFECTS STUDY

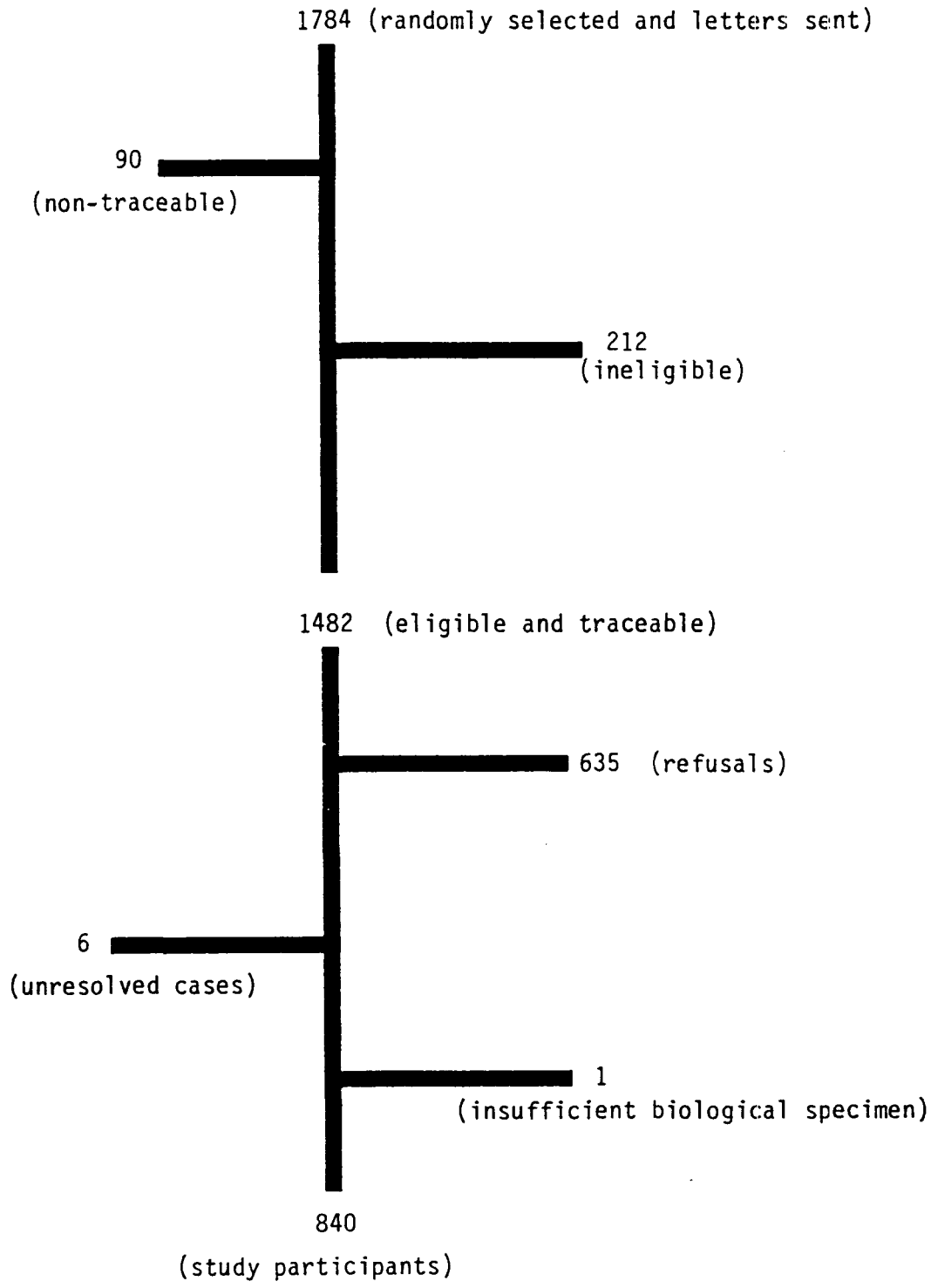


TABLE 2.

Distribution of Serum PCB Levels
Prevalence

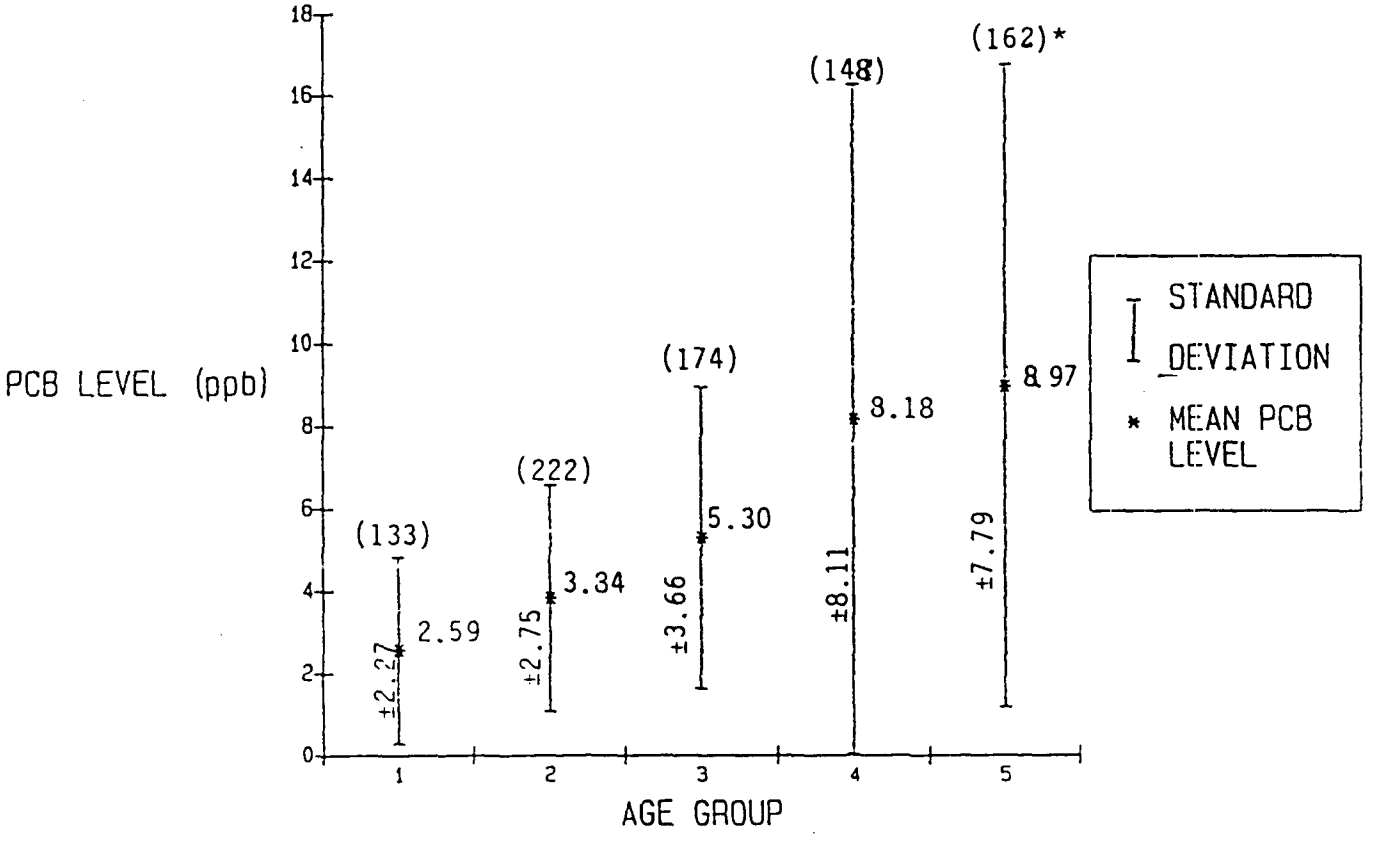
Serum PCB Level*	Males n=391		Females n=449		Total n=840	
	n	%	n	%	n	%
0.0 - 1.49	30	7.8	26	5.8	56	6.7
1.5 - 2.99	93	23.8	120	26.7	213	25.4
3.0 - 4.49	91	23.3	111	24.7	202	24.1
4.5 - 5.99	62	15.9	63	14.0	125	14.9
6.0 - 7.49	24	6.1	40	8.9	64	7.6
7.5 - 8.99	27	6.9	30	6.7	57	6.8
9.0 - 10.49	18	4.6	20	4.5	38	4.5
10.5 - 11.99	4	1.0	10	2.2	14	1.7
12.0 - 13.49	10	2.6	3	.7	13	1.5
13.5 - 14.99	7	1.8	3	.7	10	1.2
15.0 - 16.49	4	1.0	3	.7	7	.8
16.5 - 17.99	6	1.5	6	1.3	12	1.4
18.0 - 19.49	1	.3	3	.7	4	.5
19.5 - 20.99	4	1.0	1	.2	5	.6
21.0 - 22.49	2	.5	1	.2	3	.4
22.5 - 23.99	2	.5	2	.5	4	.5
24.0 - 25.49	-	-	1	.2	1	.1
25.5 - 26.99	-	-	-	-	-	-
27.0 - 28.49	-	-	-	-	-	-
28.5 - 29.99	1	.3	-	-	1	.1
30+	5	1.3	6	1.3	11	1.3
NEXT TO HIGHEST		45.68		61.72		61.72
HIGHEST		60.92		154.20		154.20
MEAN		5.92		5.77		5.84
MEDIAN		3.88		3.88		3.88
STANDARD DEVIATION		6.24		8.92		7.78
25TH		2.68		2.63		2.67
75TH		6.83		6.44		6.65

*PCB measured in parts per billion.

FIGURE 2

MEAN and STANDARD DEVIATION
SERUM PCB LEVEL[1] by AGE GROUP

PREVALENCE



( ) = number of persons in age group

1 = 18-24 years old
2 = 25-34 years old
3 = 35-44 years old
4 = 45-54 years old
5 = 55-64 years old

* One outlier was eliminated as the level was more than twice the second highest.

1 PCB measured in parts per billion

Serum PCB Level and Ages: Figure 2 shows the relationship of serum PCB level to age among prevalence participants (n = 840). In the five age groups into which participants were categorized (i.e., 18-24, 25-34, 35-44, 45-54, 55-64) the mean serum PCB levels were: 2.6, 3.8, 5.3, 8.2, and 9.0 ppb respectively.

Serum PCB Level and Seafood Consumption: Prevalence study participants were shown a map (Figure 3) of local harbor/estuary contamination areas to ensure that each participant was using the same local boundaries to identify fishing areas. A relationship was observed between serum PCB level and consumption of locally caught contaminated seafood after controlling for occupational confounders. Figure 4 compares mean serum PCB levels by age between consumers of locally caught versus general (i.e., other than from the closed areas) seafood consumption.

Serum PCB Level and Blood Pressure: Blood pressure measurements (systolic and diastolic readings) were taken three times during the interview process. The readings of both systolic and diastolic blood pressure measurements differed significantly ($p = .001$) and therefore all subsequent statistical analyses were completed with each of the three blood pressure measurements.

The mean systolic reading and standard deviations for the prevalence sample ($n = 840$) were 115.26 ± 18.85, 113.69 ± 17.62 and 114.28 ± 11.41. The mean diastolic readings and standard deviations for the prevalence sample were 72.19 ± 10.94, 73.19 ± 10.95 and 73.17 ± 10.94. The prevalence sample data did not demonstrate significant patterns among the correlations of independent variables found to be predictive of serum PCB levels from

FIGURE 3

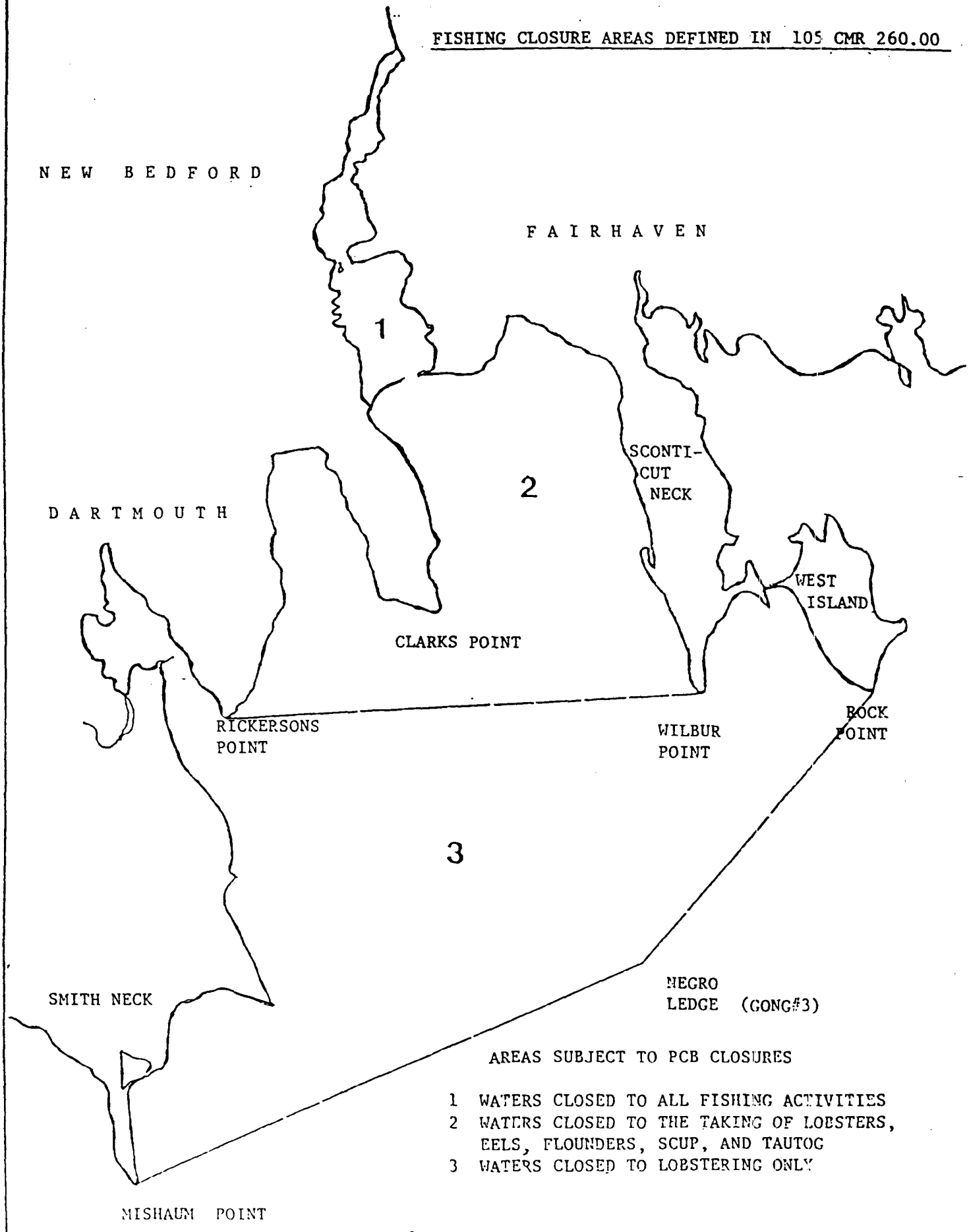
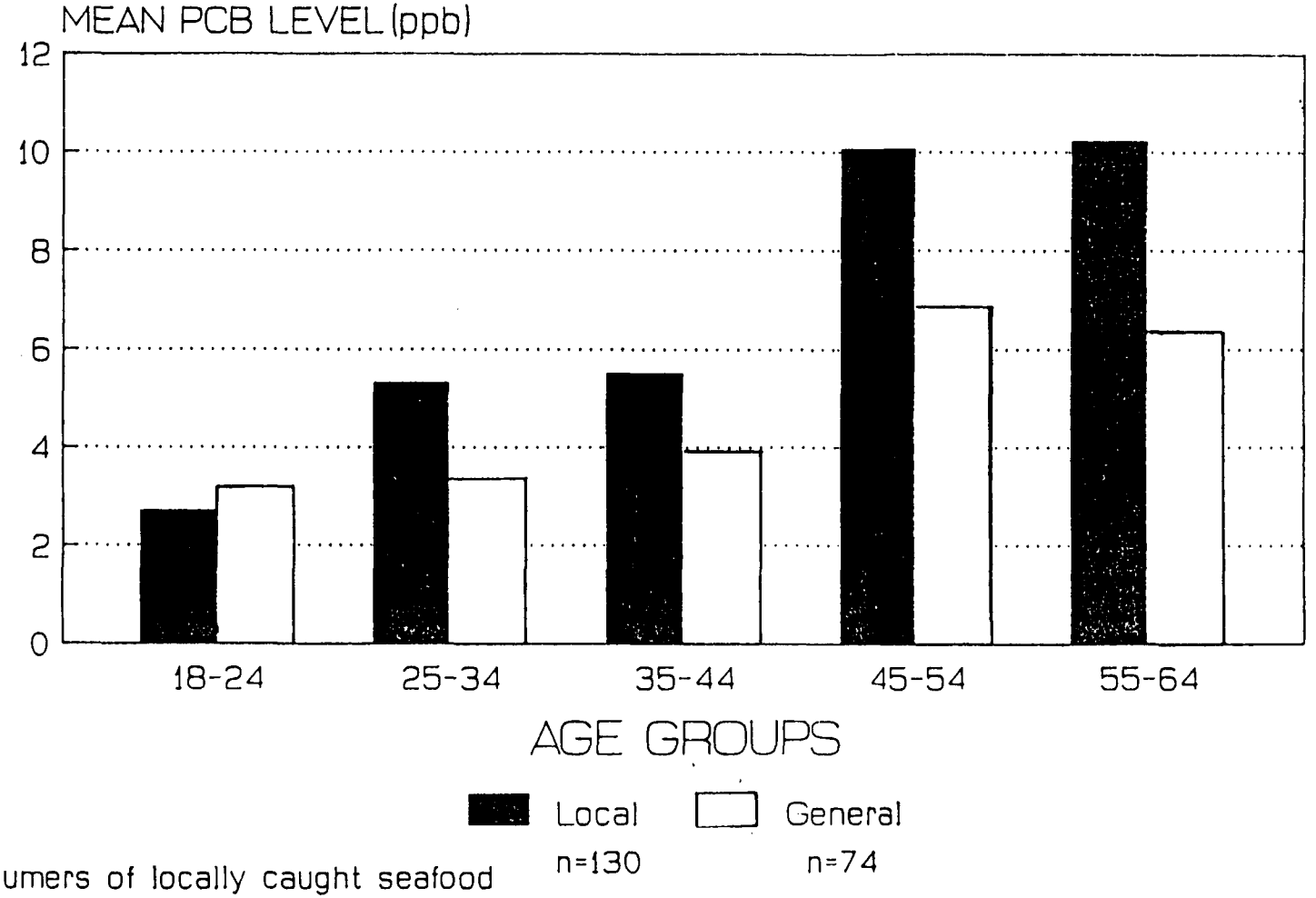

FISHING CLOSURE AREAS DEFINED IN 105 CMR 260.00
NEW BEDFORD
FAIRHAVEN
1
2
SCONTI-
CUT
NECK
DARTMOUTH
WEST
ISLAND
CLARKS POINT
RICKERSONS
POINT
WILBUR
POINT
ROCK
POINT
3
SMITH NECK
NEGRO
LEDGE (GONG#3)
AREAS SUBJECT TO PCB CLOSURES
1 WATERS CLOSED TO ALL FISHING ACTIVITIES
2 WATERS CLOSED TO THE TAKING OF LOBSTERS,
EELS, FLOUNDERS, SCUP, AND TAUTOG
3 WATERS CLOSED TO LOBSTERING ONLY
MISHAUM POINT

FIGURE 4

COMPARISON OF LOCAL AND GENERAL SEAFOOD CONSUMPTION FOR PREVALENCE SAMPLE



1 consumers of locally caught seafood
2 consumers of general but not locally caught seafood

the literature.

ENRICHMENT STUDY

Serum PCB Level Distribution: The distribution of serum PCB levels among participants of the enrichment study is shown in Table 3. The range in serum PCB levels for this sample was 1.40 ppb to 88.0 ppb with a mean level of 13.3 ppb and a median of 9.5 ppb.

PREVALENCE VERSUS ENRICHMENT

Serum PCB Level: To better assess the comparison of serum PCB levels of the randomly selected sample (i.e., the prevalence) to the enrichment sample, the staff programmer selected a control group of equal size (n = 110) from the prevalence sample matched with the enrichment group on age and sex. This was accomplished by utilizing a Statistical Analysis System (SAS) random number generator program.

Figure 5 presents a comparison of the distribution of serum PCB levels between Prevalence and Enrichment Study participants.

It is not unexpected that the enrichment group (individuals with known exposure to local seafood) shows greater numbers of people in the upper range of serum PCB levels due to the criteria set for entry into the Enrichment Study.

Exposure to Lead, Arsenic and Mercury: Specimens of urine and blood were also collected from participants in both the prevalence and enrichment

Table 3.

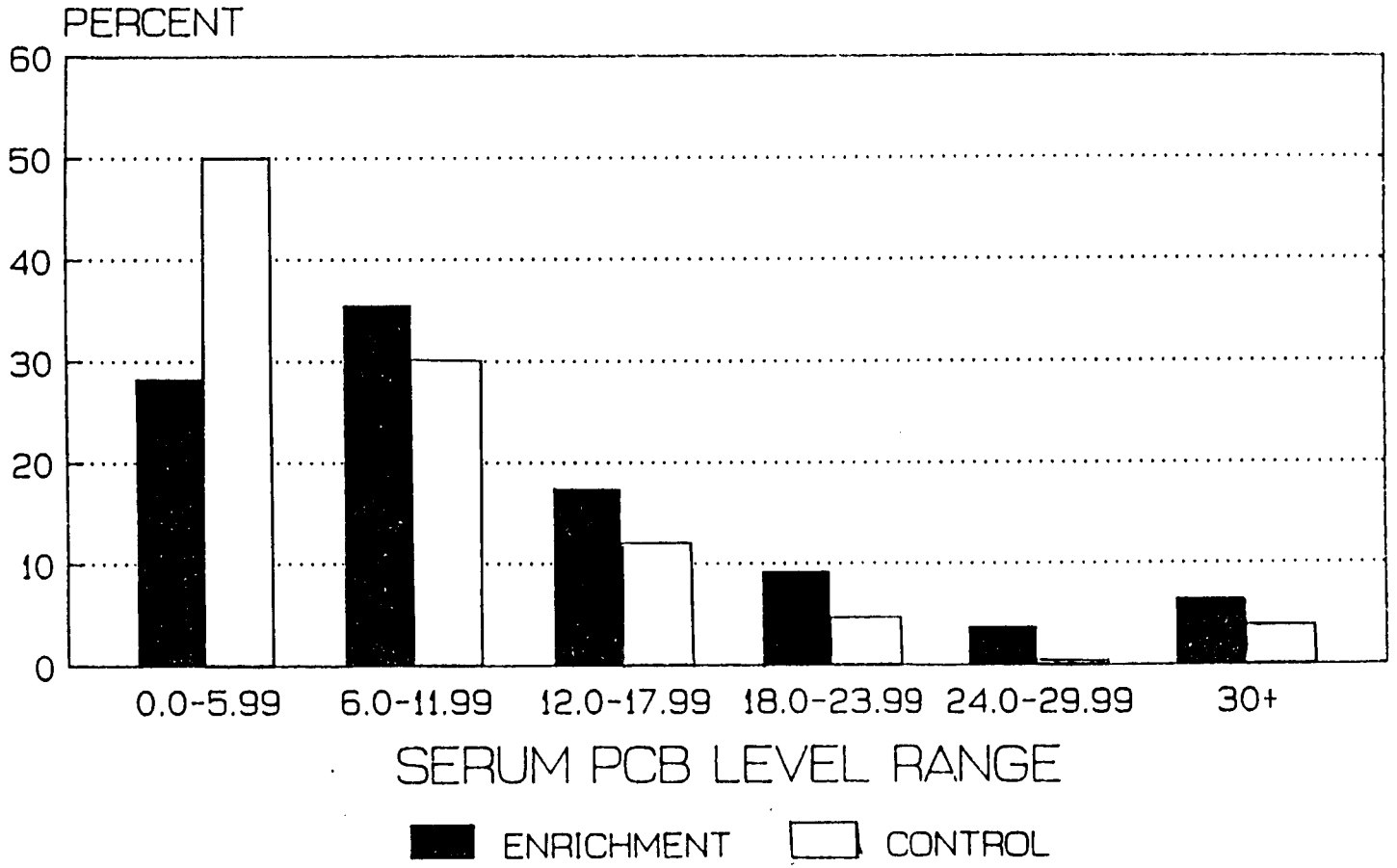
Distribution of Serum PCB Levels
Enrichment

Serum PCB Level*	MALES n=89		FEMALES n=21		TOTAL n=110	
	n	%	n	%	n	%
0.0 - 1.49	-	-	1	4.8	1	.9
1.5 - 2.99	-	-	2	9.5	2	1.8
3.0 - 4.49	14	15.7	2	9.5	16	14.6
4.5 - 5.99	12	13.5	-	-	12	10.9
6.0 - 7.49	14	15.7	1	4.8	15	13.6
7.5 - 8.99	6	6.7	1	4.8	7	6.4
9.0 - 10.49	6	6.7	2	9.5	8	7.3
10.5 - 11.99	5	5.6	4	19.1	9	8.2
12.0 - 13.49	6	6.7	-	-	6	5.5
13.5 - 14.99	2	2.3	1	4.8	3	2.7
15.0 - 16.49	5	5.6	1	4.8	6	5.5
16.5 - 17.99	3	3.4	1	4.8	4	3.6
18.0 - 19.49	1	1.1	1	4.8	2	1.8
19.5 - 20.99	2	2.3	1	4.8	3	2.7
21.0 - 22.49	2	2.3	-	-	2	1.8
22.5 - 23.99	2	2.3	1	4.8	3	2.7
24.0 - 25.49	1	1.1	-	-	1	.9
25.5 - 26.99	2	2.3	-	-	2	1.8
27.0 - 28.49	1	1.1	-	-	1	.9
28.5 - 29.99	-	-	-	-	-	-
30.0 +	5	5.6	2	9.5	7	6.4
NEXT TO HIGHEST		63.76		55.70		83.99
HIGHEST		87.97		83.99		87.97
MEAN		12.63		16.34		13.34
MEDIAN		8.46		10.74		9.48
STANDARD DEVIATION		12.48		19.33		14.02
25TH PERCENTILE		5.57		5.39		5.59
75TH PERCENTILE		15.79		17.58		15.93

*PCB measured in parts per billion

FIGURE 5

FREQUENCY DISTRIBUTION TABLE COMPARING ENRICHMENT WITH PREVALENCE CONTROLS



pcb measured in parts per billion

n=110

n=110

studies for analysis of blood lead, urinary arsenic, and urinary mercury. A 10% subset of these specimens was tested to determine if there was evidence of excessive exposure to these metals. This was also done to rule out the possibility that health effects from these metals would confound interpretation of symptoms from PCB exposure. No evidence was found of excessive exposure to toxic forms of any of the elements tested.

CONCLUSIONS

It is noteworthy that relatively few persons had elevated serum levels of PCB. This seems to indicate very little evidence of above normal exposure to PCBs among residents of the Greater New Bedford area. The findings suggest that both the 1979 EPA ban of open-system use of PCBs and the MDPH closure of New Bedford Harbor to fishing coupled with the considerable publicity over the hazards of eating locally-caught seafood have contributed to reductions of exposure via the food chain in recent years. It is also noteworthy that of those residents that were randomly selected (for determination of prevalence) less than 15% reported eating locally trapped lobster five or more times in their life and less than 2% report eating locally-caught eel; of those residents selected for participation for purposes of enrichment 63% reported eating locally-trapped lobster five or more times in their life and 25% reported eating locally-caught eel. These particular species were found to contain high levels of PCBs in the late 1970's, with concentrations in eels of up to 730 ppm and concentrations in lobster as high as 68 ppm and frequently greater than 10 ppm. Almost all individuals who were identified as being at the greatest risk of exposure via contaminated seafood intake, had relatively

low serum PCB levels.

The risk of occupational exposure to PCBs has also greatly diminished since 1977. The serum PCB level analyses by quartile for occupational and material exposures for respondents of the enrichment study showed a higher frequency in the upper quartiles for those employed in electrical manufacturing. Exposure to certain types of materials are also seen with greater frequency in upper quartiles.

Observations among participants of the prevalence sample indicated higher frequencies in upper quartiles for those employed in manufacturing. Weak trends were also observed among males exposed to lubricants and rubber. Because there is little consistency between the two study groups and because data cells had very low frequencies, occupational exposures were not seen as an important contributor to elevated PCB body burdens in Greater New Bedford.

The conclusions to be drawn from the Greater New Bedford PCB prevalence investigation are: 1) that the general prevalence of elevated serum PCB levels among residents of Greater New Bedford is low; 2) even the residents at highest risk of PCB exposure from locally caught seafood consumption, for the most part, had levels within the typical range of the U.S. population; and 3) low and moderate serum levels of PCBs in this population do not appear to be associated with elevated blood pressure measurements. Enrichment sample analyses support the finding of the prevalence study with regard to decline in PCB levels. It is possible that this group of individuals with "higher" serum PCB levels during the 85-86 investigation, may have had even greater levels if the investigation been conducted several years earlier, prior to the ban of open-system PCB use and fishing in and around the New Bedford harbor.

The data have shown (Figure 2) that the age of an individual is correlated with serum PCB level. A relationship between age and serum PCB level was observed among participants of the prevalence study. As data for each ascending prevalence age group was reviewed, the mean PCB levels increased proportionally among the five age intervals. It should be noted that although the relationship of age to serum PCB level was significantly correlated, age did not predict PCB level in the regression model. This relationship (age and serum PCB level) was supported in studies conducted by Kreiss et al in 1982 (14) among farmers from Michigan.

There are conflicting studies as to whether PCB exposure is related to blood pressure, independent of age and body mass. A study in Triana, Alabama showed a positive correlation after controlling for age, sex and Hollingshead index. The findings from that study differ from the New Bedford prevalence study in two important aspects:

(1) The levels of both blood pressure and serum PCB level were considerably higher in Triana than in New Bedford and,

(2) The rates of borderline and definite hypertension in Triana were 30% higher than those found in the National Health Survey, while those in New Bedford were within the normal U.S. range.

In addition, 21.4% of the Triana subjects had serum PCB levels greater than 30 ppb. It would appear that if there is a relationship between PCB serum level and blood pressure it is possible that there exists a threshold for the level of PCB that effects blood pressure. Any variation in blood pressure levels among participants of both the prevalence study and the enrichment study may be explained by age and body mass.

Because the literature on the half-life of PCBs in humans is so sparse, it is not possible to estimate how much higher serum PCB levels may

have been several years ago. We conclude that low and moderate serum levels of PCBs do not appear to be associated with increased blood pressure readings. It should be noted that the residents of Triana were also heavily exposed to DDT and that serum PCB levels were correlated strongly with serum DDT levels, although DDT showed no effect in the regression model. Other studies have shown correlations between exposure to organochlorine pesticides in association with higher levels of blood pressure. Further studies should be attempted in populations with heavier PCB exposure which is not confounded by pesticide exposure to rule out the effects on blood pressure at higher exposure levels than were seen in the Greater New Bedford PCB Health Effects Study.

Although some of our findings support positive trends with past occupational and industrial exposures among those in the highest quartile of PCB level, the majority of those respondents still had levels within the typical U.S. range and it is likely that these levels will decrease over time as well. The GNBHES has generated a large data base that merits continued analysis.

RECOMMENDATIONS

(1) The current ban on fishing in and around the New Bedford harbor (i.e., the closure areas) should remain in effect until measurements in aquatic life decline to acceptable standards. Monitoring should be targeted on those species found to be consumed with the greatest frequency by the Greater New Bedford population.

(2) The Phase II study should not be conducted due to lack of a sufficient sample-size of 150 persons with serum PCB levels $\geq$ 30 ppb.

(3) Residents should refrain from obtaining and consuming recreationally caught seafood from the closure areas.

(4) Data collected for the GNBHES should be subjected to further analysis.

(5) Small scale follow-up studies, including surveillance of high risk individuals should be designed and conducted by MDPH to pursue certain areas of health research.