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Comparison of Findings among Residents on Michigan Dairy Farms and Consumers of Produce Purchased from These Farms

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Consumers who had purchased farm products from both quarantined and nonquarantined farms were examined during the cross-sectional clinical survey of 1,029 Michigan residents. Since PBB had inadvertently contaminated cattle and other farm animals, ingestion of meat, milk, eggs and other farm products was thought to have possibly resulted in significant PBB body burdens in some consumers. Findings were considered in comparison with those made among farm residents.

Prevalence of symptoms in consumers of farm products from quarantined farms (CQ) was similar to that found in farmers on quarantined farms (FQ); the prevalence was lower in consumers of products from nonquarantined farms (CNQ).

Liver function abnormalities were found with similar prevalence in dairy farmers and consumers. Distribution, mean and median values of PBB serum levels in consumers were found to be similar to those of dairy farmers.

These results indicate that significant body burdens of PBB had been accumulated by some consumers of farm products in Michigan and that prevalence of symptoms and liver function abnormalities resembled those found among dairy farm residents.

Introduction

The accidental addition of polybrominated biphenyls (PBBs) as FireMaster BP-6, instead of magnesium oxide, to farm feed in Michigan in 1973 resulted in widespread contamination of farm animals (cattle, hogs, sheep, chickens, etc.) (*1–3*). Butter, cheese, dry milk products, eggs had to be removed from the commercial market, and tens of thousands of animals had to be destroyed.

Meat, milk, butter, eggs and cheese containing PBBs, entered the human food chain before the nature of the Michigan problem was identified in 1974, i.e., before it was known that the cause of widespread disease in farm animals was the accidental contamination of their feed with PBB. The sampling program for various food products started after the identification of the problem. Given the technically difficult and demanding testing procedures and the large number of samples to be tested, PBB analyses of various products (meat, milk, butter, cheese, etc.) was relatively limited and often delayed and, since the decision on the quarantined status of a farm was dependent on PBB levels considered excessive identified in products of that specific farm, various farms were quarantined at different times.

Information for PBB absorption and body burden in humans has been meager (*4–6*). A Michigan Department of Public Health study analyzed PBB levels in over 100 persons residing on quarantined farms and a comparable number of residents on nonquarantined farms. PBB serum levels up to 0.02 ppm were detected in the group from nonquarantined farms. Levels in fat were, as expected, consistently higher than those in serum.

Another study of the Michigan Department of Public Health, conducted in 1976 (*7*) by using a ran-

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dom sampling method, found that 96% of 53 women in the lower peninsula excreted PBB in their breast milk; the proportion was lower, but still impressive (43%), in a group of 42 women from the upper peninsula, which many had considered spared from major PBB exposure.

The pattern of absorption, distribution, metabolism, and excretion of PBBs, although not yet completely clarified, is nevertheless known to parallel quite closely that of polychlorinated biphenyls. Important characteristics are the marked accumulation of these compounds, mainly in fat tissue, but also in tissues with a relatively high lipid content and the very slow rate of metabolic degradation and very limited excretion. Cumulative body burden with continued ingestion is therefore a major feature of the metabolic model for polybrominated biphenyls. This is of interest, since with such toxic substances adverse health effects may occur either as a result of short-term, high levels of absorption, or as a consequence of long-term, repeated absorption of relatively small amounts.

At the time the accidental Michigan contamination occurred, only fragmentary data were available concerning PBB toxicity. Effects in various species of animals indicated, nevertheless, high potential for toxicity; species differences were noted, and no extrapolation as to the relative susceptibility of humans was warranted.

Therefore, in the clinical field study conducted by the Environmental Sciences Laboratory (*8*), farmers and their families from both quarantined and nonquarantined farms were included. Consumers of products from these quarantined and nonquarantined farms were also invited, since it was thought that, given the sequence of events, i.e., the time interval (at least 9 months) until the identification of PBBs as the contaminant, the schedule for testing of various food products, the time constraints associated with deciding whether a farm was quarantined or not and the changes in the FDA action levels for PBB in meat, milk, etc., it was theoretically possible for consumers to have ingested undetermined amounts of PBB.

Methods

The medical examination protocol used is given in detail by Anderson et al. (*8*). After the information was collected, for the purpose of this analysis, four groups were considered: farmers residing on quarantined farms (FQ); consumers of dairy farm products from these quarantined farms (CQ); farmers residing on nonquarantined farms (NQF); consumers of dairy farm products from these nonquarantined farms (CNQ). It was believed that a comparison of findings among farmers residing on quarantined farms with those among farmers residing on nonquarantined farms would be of interest in evaluating the dimensions of the potential problem of adverse human health effects due to PBBs. Of similar interest, and of potentially wider significance, would be the comparison between farmers and consumers of farm products.

The prevalence of symptoms, liver function tests abnormalities, the distribution of PBB serum levels, the mean and median PBB values in serum, were compared for the four subgroups of the population studied.

Results

Symptoms were grouped into four major categories, defined as dermatologic, neurologic, musculoskeletal, and gastrointestinal.

The neurologic syndrome was the most prominent and was marked by tiredness and fatigue, an important decrement in the individual's capacity for physical or intellectual work and a significantly increased requirement for sleep (14–18 hr/day); other symptoms such as headache, dizziness, and irritability were often associated (*9*).

The gastrointestinal syndrome included loss of appetite, weight loss, abdominal pain (with no characteristic pattern), and diarrhea. These symptoms were most often found in conjunction with the neurologic syndrome, especially with tiredness and hypersomnia. It is noteworthy that hepatomegaly was not a prominent finding, nor was liver tenderness on palpation.

The musculoskeletal syndrome consisted of arthritislike changes: swelling of the joints with deformity, pain, and various degrees of limitation of movement. The knees and ankles were generally most affected, but the small joints of fingers and hands were also frequently involved. Tendonitis, with swelling, pain and crepitation, most often affecting the extensor and flexor muscles of the hands, was also found in some cases with joint involvement.

The dermatologic changes will be reported in detail elsewhere.

Prevalence of symptoms among farmers living on quarantined farms did not differ significantly from that among farmers on nonquarantined farms for any of the four groups of symptoms considered. All were at least as prevalent among farmers on nonquarantined farms as in those on quarantined farms. Furthermore, the prevalence of symptoms among consumer of dairy farm products was similar to that found in farmers; only among consumers of products from nonquarantined farms were neurologic

symptoms less frequently reported (Fig. 1).

The neurologic symptoms had the highest prevalence in all population groups considered; they were followed by musculoskeletal symptoms.

Liver function test abnormalities (alkaline phosphatase, SGOT, SGPT, and LDH) were also compared (Table 1). Liver function abnormalities were found with similar prevalence in farmers from quarantined and nonquarantined farms, and in corresponding consumers. The prevalence of abnormal SGOT and alkaline phosphatase levels was especially high in the subgroup of consumers of products from quarantined farms.

The distribution of PBB serum levels was compared (Table 2). A striking similarity of distribution patterns in farmers from quarantined farms and consumers of products from these farms was found (Fig. 2). When farmers from nonquarantined farms were compared with consumers of products from nonquarantined farms, the distribution patterns were, again, very similar (Fig. 3).

The median values for PBBs in serum (Fig. 4) reflected the similarities in distribution pattern.

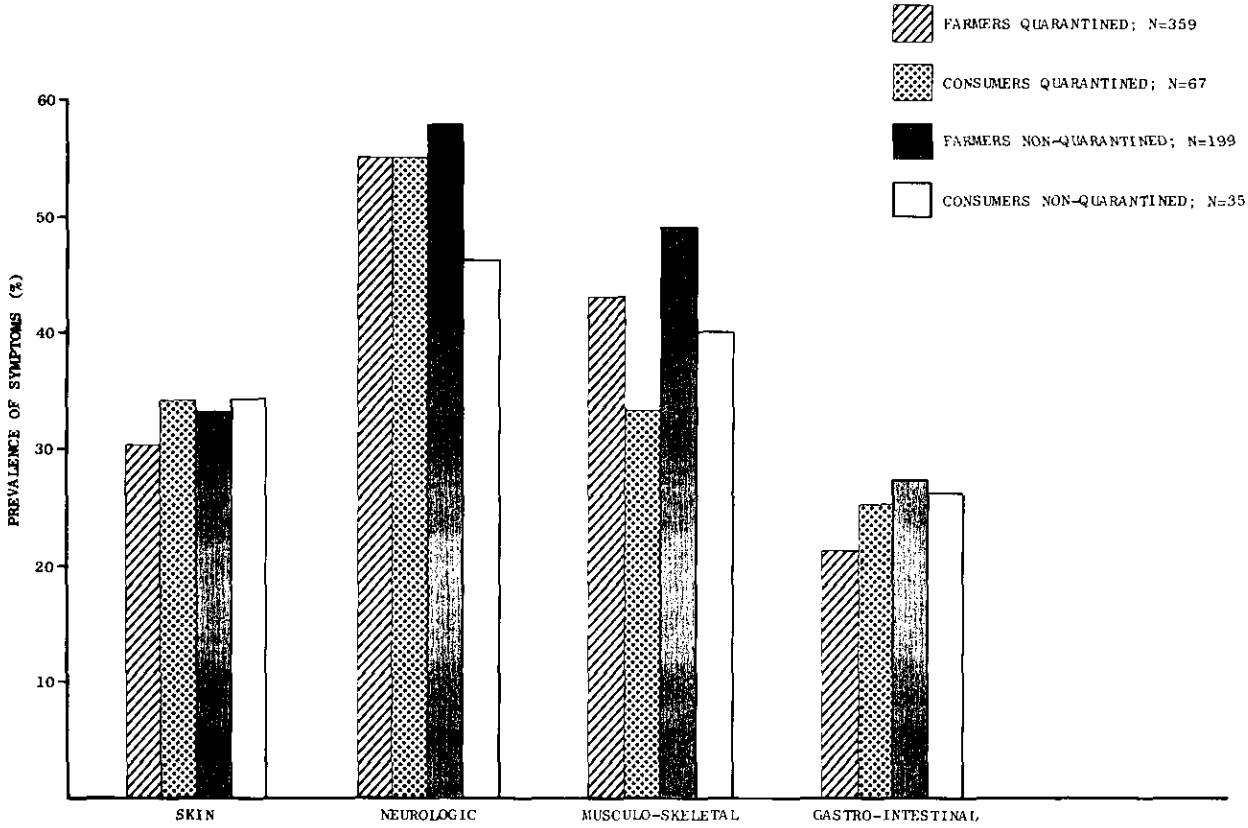

FIGURE 1. Prevalence of symptoms among farmers and consumers of dairy farm products in Michigan.

Table 1. Liver function test abnormalities among Michigan farmers and consumers of farm products.

	Number examined	SGOT > 41		SGPT > 45		LDH > 225		Alk. Phos. > 95	
		No.	%	No.	%	No.	%	No.	%
Farmers, quarantined farms (FQ)	326	27	8.3	31	9.5	24	7.3	30	9.2
Consumers of products from quarantined farms (CQ)	65	13	20.0	10	15.4	4	6.2	12	18.5
Farmers, nonquarantined farms (FNQ)	174	23	13.2	21	12.0	11	6.3	21	12.0
Consumers of products from nonquarantined farms (CNQ)	33	3	9.1	4	12.1	2	6.1	4	12.1

Table 2. Distribution of PBB serum levels in Michigan farmers and consumers of dairy farm products.

PBB serum level, pbb	Farmers, quarantined farms		Consumers of products from quarantined farms		Farmers, nonquarantined farms		Consumers of products from nonquarantined farms	
	No.	%	No.	%	No.	%	No.	%
0.01 (ND)	0	0	0	0	2	1.3	0	0
0.2 (LD)	9	3.2	0	0	5	3.3	4	14.3
0.3–1.0	34	12.0	6	15.0	51	33.3	6	21.4
1.1–4.9	122	43.1	17	42.5	74	48.4	13	46.4
5.0–9.9	49	17.3	5	12.5	14	9.1	2	7.2
10.0–49.9	46	16.3	6	15.0	7	4.6	3	10.7
50.0–99.9	7	2.5	1	2.5	0	0	0	0
100.0–999.9	14	4.9	5	12.5	0	0	0	0
> 1000	2	0.7	0	0	0	0	0	0
	283		40		153		28	

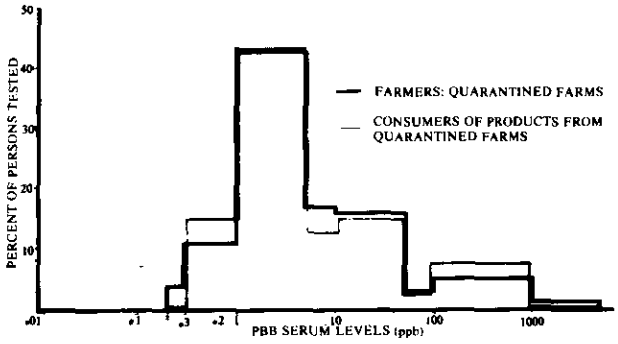

FIGURE 2. Distribution of PBB serum levels in Michigan farmers (quarantined farms) and consumers of dairy farm products (from quarantined farms).

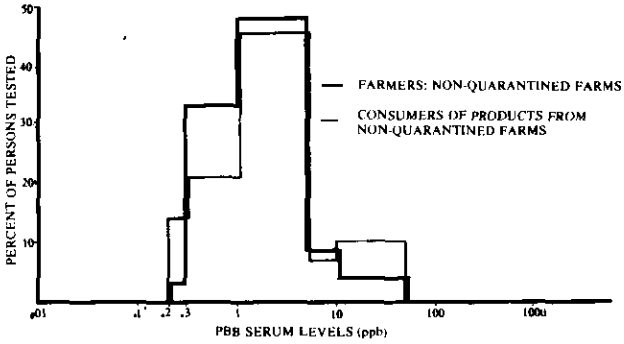

FIGURE 3. Distribution of PBB serum levels in Michigan farmers (nonquarantined farms) and consumers of dairy farm products (from nonquarantined farms).

Discussion and Conclusions

The results indicate that significant body burdens of PBBs, as reflected in the serum PBB level, have been accumulated by at least some consumers of farm products in Michigan. Although the number of consumers examined was relatively small, the data suggest that this conclusion is warranted.

Similarities in prevalence of symptoms and liver function abnormalities in consumers of farm products, with those among dairy farm residents in Michigan, and the fact that these far exceeded those found in Wisconsin dairy farmers (8) indicate that adverse health effects due to PBB toxicity should be considered among segments of the Michigan population, other than dairy farmers.

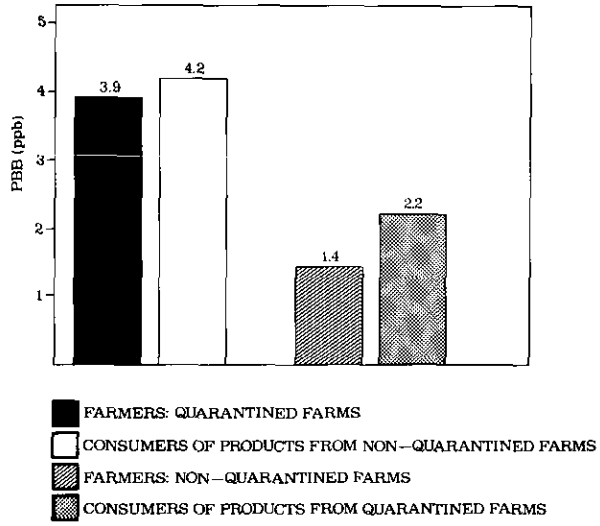

FIGURE 4. PBB in serum (median values) in farmers and consumers of dairy farm products.

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