

## Organochlorine Pesticide Residues in Mother's Milk in Swaziland, 1996–1997

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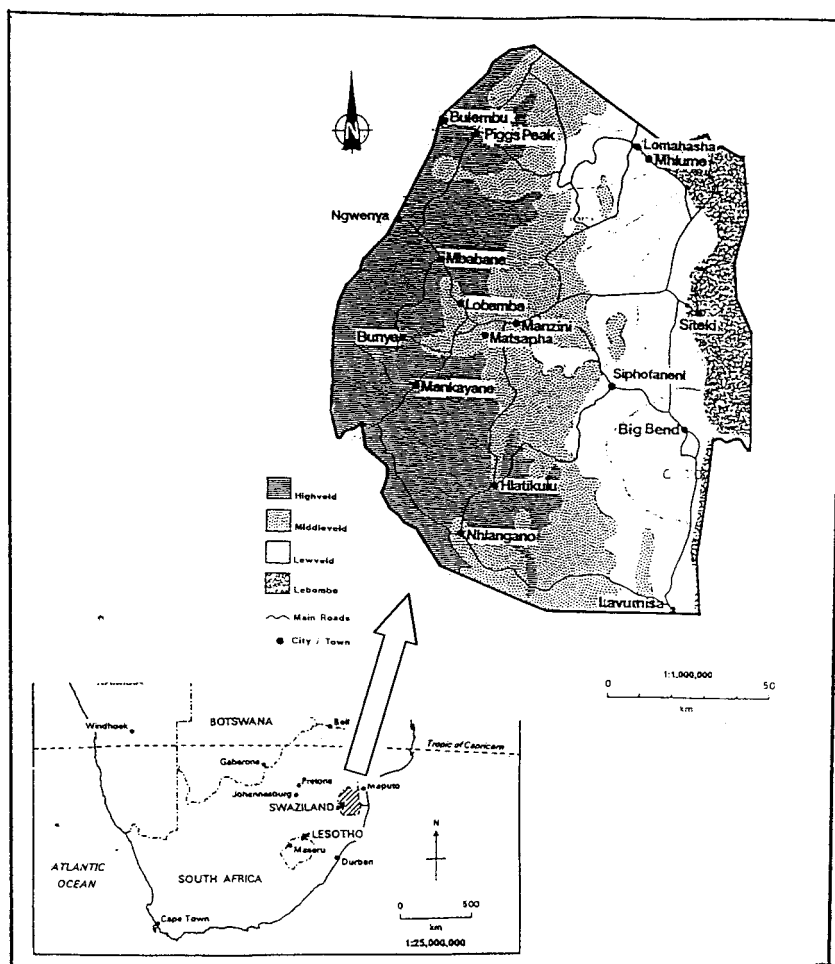
Since the first report of DDT contamination of human milk in 1951 by Laug *et al.*, considerable attention, particularly over the past 10 years or so has been given to studies regarding DDT and related organochlorine pesticides as contaminants in human milk and their deleterious effects on breast-fed infants worldwide (Matuo *et al.* 1980; Hofvander *et al.* 1981; Jensen, 1983; Slorach and Vaz 1983; Kanja *et al.* 1986; Okonkwo *et al.* 1999).

Swaziland is landlocked, bounded on the north, west and south by South Africa and on the east by Mozambique as shown in Figure 1. The chosen study area, Siphofaneni, is located in the Lowveld region, the largest region, covering about 37% of Swaziland as can be seen in Figure 1. Elevations within the lowveld region range between 150m and 500m. The climate is subtropical with mean annual temperatures ranging from 16.7°C to 25.6°C. The warm climate experienced in the region particularly during the summer period, October–December, encourages the breeding of mosquitoes in the region. Consequently, insecticides such as DDT are applied to the inner walls of huts within the region and the adjacent eastern region of Lubombo.

We have already reported (Okonkwo *et al.*, 1999) the levels of DDT and its metabolites in human milk in Siphofaneni Swaziland, and that the levels obtained exceeded the FAO/WHO recommended limits. The present report shows the distribution of DDT residues and percentage extractable fat in the villages studied. The results are also discussed in the context of worldwide reports.

### MATERIALS AND METHODS

Between January 1996 and November 1997, 103 human breast milk samples were collected from individual donors residing in the village around Siphofaneni area in Swaziland. The map of Swaziland showing the sampling area is shown in Figure 1. The samples were collected from donors between days 14–21 after giving birth. The donors were between 18–36 years of age, and all had had normal deliveries. At the time of sampling, information was requested on length of residence within the area, number of children, occupation, frequency of spray, occupation and dietary habits. Comprehensive experimental detail on the method of sample collection, preparation and analysis have been described previously.



**Figure 1.** Map of Southern Africa (bottom left) and Swaziland (top right) showing the location of Swaziland and sampling area, Siphofaneni respectively.

## RESULTS AND DISCUSSION

Residue of DDT estimated on mother's milk from eight villages in Siphofaneni, Swaziland is summarized in Table 1. p,p' -DDT, o,p'-DDT and p,p' -DDE were detected in all the samples from the eight villages. From Table 1, differences existed from one sampling site to another. The highest residue levels range from 0.01-6.47 mg/kg, 0.07-3.90 mg/kg and 0.01-0.61 mg/kg for p,p' -DDT, o,p'-DDT and p,p' -DDE respectively.

**Table 1.** Residue levels (mg/kg whole milk ) of p,p'-DDT, o,p'-DDT and p,p'-DDE in mothers' milk from eight villages in Swaziland 1996-1997.

| DDT residues |    |       |           |           |             |             |
|--------------|----|-------|-----------|-----------|-------------|-------------|
| Village      | N  |       | p,p'-DDT  | o,p'-DDT  | p,p'-DDE    | Total       |
| Mphaphati    | 14 | Range | 0.13-4.52 | 0.07-3.90 | 0.01-0.06   | 0.91-8.39   |
|              |    | M±SD  | 2.25±2.17 | 0.95±1.57 | 0.025±0.009 | 3.22 ± 3.75 |
| Kamkhweli    | 1  | Range | 0.05-4.41 | 0.02-1.49 | 0.01-0.61   | 0.09-5.91   |
|              |    | M±SD  | 1.43±1.38 | 0.55±0.65 | 0.10±0.09   | 2.08 ± 2.13 |
| Gucuka       | 13 | Range | 0.02-4.88 | 0.02-1.61 | 0.01-0.48   | 0.23-6.51   |
|              |    | M±SD  | 1.0±1.50  | 0.87±0.79 | 0.05±0.23   | 1.92 ± 2.53 |
| Mandlenya    | 12 | Range | 0.01-6.47 | 0.01-1.60 | 0.01-0.05   | 0.01-6.13   |
|              |    | M±SD  | 1.02±0.99 | 0.41±0.79 | 0.01±0.02   | 1.44 ± 1.80 |
| Ngcamphalala | 13 | Range | 0.08-4.22 | 0.01-1.42 | 0.01-0.03   | 0.11-6.67   |
|              |    | M±SD  | 0.57±1.40 | 0.20±0.40 | 0.02±0.001  | 0.79 ± 1.80 |
| Lanjane      | 9  | Range | 0.08-0.44 | 0.02-0.60 | 0.01-0.03   | 0.11-1.06   |
|              |    | M±SD  | 0.24±0.21 | 0.14±0.19 | 0.02±0.01   | 0.40 ± 0.41 |
| Thandiveni   | 12 | Range | 0.01-0.77 | 0.01-0.27 | 0.01-0.02   | 0.01-0.96   |
|              |    | M±SD  | 0.30±0.48 | 0.09±0.15 | 0.01±0.12   | 0.40 ± 0.76 |
| Siphofaneni  | 14 | Range | 0.01-0.71 | 0.01-0.25 | 0.01-0.03   | 0.01-0.88   |
|              |    | M±SD  | 0.25±0.26 | 0.10±0.12 | 0.01±0.01   | 0.36 ± 0.43 |

N = number of samples

M = mean

SD = standard deviation

The mean levels were 3.22, 2.08, 1.92, 1.44, 0.79, 0.40, 0.40 and 0.36 mg/kg (whole milk basis for total DDT from Mphaphati, Kamkhweli, Gucuka, Mandlenya, Ngcamphalala, Lanjane, Thandiveni and Siphofaneni respectively. These total DDT residue levels obtained from different sites exceeded the FAO/WHO acceptable daily intake (ADI) of 0.02 mg/kg. Differences in dietary habits, socioeconomic status, metabolism rate of the donors as well as the frequency of spray of the insecticide may have contributed to the wide differences in the residue levels of DDT obtained from the various villages. The high levels of o,p'-DDT observed in the present study are indicative of low quality DDT used in the spraying programme, although no analysis was carried out to confirm this claim.

The range total DDT residue level (whole milk basis) reported herein is significantly higher than that reported in India, as shown in Table 2.

**Table 2.** Mean concentrations of o,p'-DDT, p,p'-DDT and p,p'-DDE in mothers' milk in various countries.

| Country   | Period  | No of Samples | Mean concentrations (mg/kg) |                          |          | Ref.                             |
|-----------|---------|---------------|-----------------------------|--------------------------|----------|----------------------------------|
|           |         |               | o,p'-DDT                    | p,p'-DDT                 | p,p'-DDE |                                  |
| Canada    | 1975    | 100 W         | -                           | 0.006                    | 0.035    | Mes & Davis (1979)               |
| Finland   | 1973-4  | 49 W          | -                           | 0.015                    | -        | Vuori <i>et al</i> (1977)        |
|           |         | F             | -                           | 0.41                     | -        |                                  |
| Greece    | 1974-5  | 50 W          | -                           | 0.086                    | 0.258    | Panetsos <i>et al</i> (1975)     |
|           |         | F             | -                           | 2.630                    | 7.380    |                                  |
| Hawaii    | 1979-80 | 50 F          | -                           | 0.160                    | 2.000    | Takahashi <i>et al</i> (1981)    |
| India     | 1979    | 75 W          | -                           | 0.26                     | 0.25     | Kalra <i>et al</i> (1981)        |
| India     | 1985    | 24 W          | -                           | 0.006-0.431 <sup>☆</sup> |          | Ramakrishnan <i>et al</i> (1985) |
| Israel    | 1975    | 29 W          | -                           | 0.0122                   | 0.0217   | Polishuk <i>et al</i> (1977)     |
| Kenya     | 1979    | 302 F         | -                           | 1.1-18.7 <sup>◇</sup>    |          | Kanja <i>et al</i> (1986)        |
| PNG       | 1990    | 41F           | -                           | 0.06-3.05 <sup>☆</sup>   |          | Spicer & Kereu (1993)            |
| Spain     | 1991    | 51F           | -                           | 0.000012                 | 0.60     | Hernández <i>et al</i> (1993)    |
| Sweden    | 1976-7  | 97W           | -                           | 0.010                    | 0.043    | Westoo & Noren (1978)            |
| Swaziland | 1996-97 | 103 W         | 0.48                        | 1.13                     | 0.02     | Okonkwo <i>et al</i> (1999)      |
| Swaziland | 1996-97 | 103 W         |                             | 0.01-8.39 <sup>☆</sup>   |          | present paper                    |
| UK        | 1979-80 | 102 W         |                             | 0.003                    | 0.041    | Coilins <i>et al</i> (1982)      |

W = expressed on whole milk basis. F = expressed on fat basis. PNG = Papua New Guinea. ◇ = range mean sum DDT. ☆ = range total DDT.

It can also be seen from Table 2, that the mean concentration (whole milk basis) of p,p'-DDT from previous report (Okonkwo *et al*) is about 10-40 times and 100-300 times greater than those found in Greece and Israel, Sweden, Canada and the UK respectively. However, the level of p,p'DDE obtained in previous study (Okonkwo *et al*) is lower than those reported in the above-mentioned countries. From Table 2, the level of DDT exceeds that of DDE only in Swaziland. This observation suggests very recent exposure prior to sampling. However, DDT has since been replaced with the pyrethroids.

The total extractable fat varied from 1.3-8.0% in all the samples as shown in Table 3. The average percentage was 5.1 for Mphaphati, 4.1 for Lanjane, 3.7 for Kamkhweli, Gucuka and Mandlenya, 3.4 for Ngcamphalala and Siphofaneni, and 3.1 for Thandiveni.

**Table 3.** Extractable fat in mothers' milk

| Villages     |               | % extractable fat |
|--------------|---------------|-------------------|
| Mphaphati    | Range         | 2.2-8.0           |
|              | Mean $\pm$ SD | 3.5 $\pm$ 1.49    |
| Kamkhweli    | Range         | 2.1-5.3           |
|              | Mean $\pm$ SD | 3.3 $\pm$ 0.68    |
| Gucuka       | Range         | 1.5-5.8           |
|              | Mean $\pm$ SD | 3.8 $\pm$ 1.16    |
| Mandlenya    | Range         | 2.3-4.1           |
|              | Mean $\pm$ SD | 3.5 $\pm$ 0.45    |
| Ngcamphalala | Range         | 1.3-5.5           |
|              | Mean $\pm$ SD | 3.5 $\pm$ 0.90    |
| Lanjane      | Range         | 2.7-5.5           |
|              | Mean $\pm$ SD | 3.6 $\pm$ 0.81    |
| Thandiveni   | Range         | 2.1-4.1           |
|              | Mean $\pm$ SD | 3.4 $\pm$ 0.40    |
| Siphofaneni  | Range         | 2.6-4.2           |
|              | Mean $\pm$ SD | 3.3 $\pm$ 0.47    |

SD = standard deviation

The daily intake of total DDT residue in babies calculated for the sampling villages is shown in Table 4. The intake values are significantly higher when compared with the acceptable daily intake (ADI) as recommended by FAO/WHO (FAO/WHO, 1970).

Thus the level of DDT residue estimated in the present study is high and may pose a danger to breast-fed infants. However, because of the well-recognized advantages of breast-feeding, this practice should not be discouraged. The present report should be applied to introduce better practice in the use of organochlorine pesticides in developing countries.

**Table 4.** Daily intake of total DDT residue (mg/kg body weight) for nursed infant through breast milk based on a daily intake of 0.6 kg and a body weight of 5 kg.

| Village      | Residue level (mg/kg) |
|--------------|-----------------------|
| Mphaphati    | 0.386                 |
| Kamkhweli    | 0.249                 |
| Gucuka       | 0.230                 |
| Mandlenya    | 0.173                 |
| Ngcamphalala | 0.090                 |
| Lanjane      | 0.048                 |
| Thandiveni   | 0.048                 |
| Siphofaneni  | 0.043                 |

The introduction of synthetic pyrethroids such as deltamethrine in Swaziland is a step taken so far to phase out the use of DDT for mosquito control. Integrated vector management programme incorporating techniques such as bednet is still in its infancy in Swaziland.

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