
*REVIEWS, CASE HISTORIES,
AND RESEARCH*

Health Effects of Pesticide Use
Among Indonesian Women Farmers:
Part II:
Reproductive Health Outcomes

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ABSTRACT. This retrospective cohort of 161 female spray operators and 352 age-matched women rice farmer controls was conducted in West Sumatra Indonesia. It was designed to assess the reproductive

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for spontaneous abortion were 2.0,¹⁻⁸ stillbirths 3.1,^{5,7-12} low birth weight 2.0,^{6,10,13} neonatal death 2.7-4.4^{8,11} and birth defects 1.9.^{1,6,7,12,13,15-17}

Since passive health surveillance systems will not be able to adequately identify either short- or long-term health effects of pesticides, policy must be informed through special studies. Indonesia is a case in point. Since women there are commonly involved in agriculture activities, questions have been raised about the effects of pesticides on women's health. Not only were the acute effects of concern but that of reproduction. Among the matrilineal, matriarchal culture of the Minang Kabau in Western Sumatra, women do most of the farming that is heavily dependent on pesticides. Given this opportunity, we were interested to document exposure patterns in women and estimate the acute effects they experience. The other question was, could any evidence of poor reproductive outcomes be found among this female population? With the support of the Food and Agriculture Organization of the United Nations we conducted studies spanning two years to assess these three research questions. This paper represents our findings related to reproductive outcomes.

METHODS

Design: The reproductive component of the study was a retrospective cohort. The study population was purposely selected based on pesticide and non-pesticide exposure. The study was retrospective in that we looked back at all the birth outcomes of the study population.

Sites: Two areas were selected for the study sites. Pesticide-using women were selected from the mountainous sub-district of Alahanpanjang in West Sumatra because it produces a large volume of vegetables and likewise uses high amounts of pesticides. Because almost everyone is involved in some sort of agricultural activity in this area, controls were not selected from the same community due to concerns of indirect exposure as well as exposure through the women's husbands. Therefore, another sub-district, Surian, that is a rice producing community and 45 minutes south of Alahanpanjang was selected for the controls. Data was gathered to control for any socio-economic or infectious disease rate differences (e.g., malaria) between the two communities that could effect reproductive outcomes.

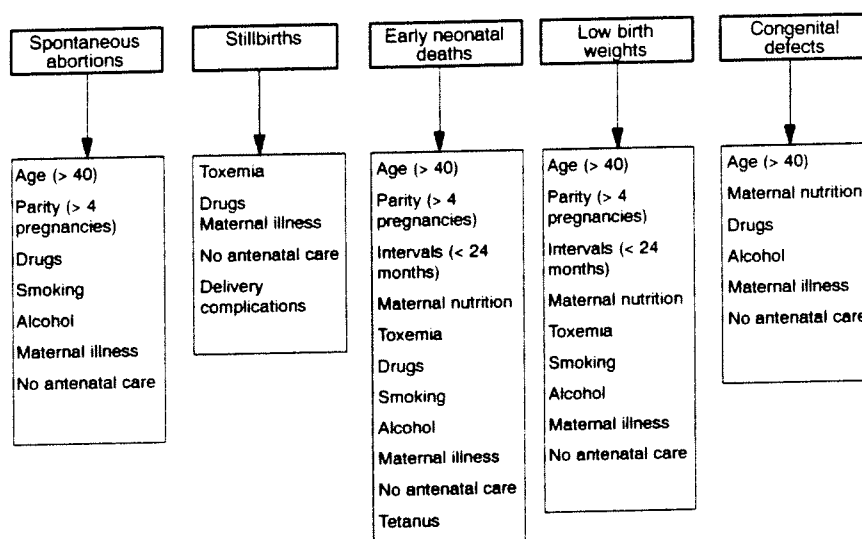
Sample size: Stillbirth was used as the primary outcome of interest to estimate sample size. It was selected because we presumed it would

on those more critical and reliably remembered by women. The relationship between maternal health risk factors and the birth outcomes of interest are listed in Figure 1.

Risk factors were defined and coded according to conventional definitions. They include maternal age less than 18 and over 35,* more than four previous pregnancies, a birth interval of less than two years, and less than two TT (tetanus toxoid) immunizations during the first pregnancy (or no booster for subsequent pregnancies up to five, according to the national schedule). Any history of smoking was regarded as a risk factor irrespective of quantity due to the difficulties in obtaining accurate smoking histories. Deliveries attended by a traditional birth attendant (TBA) were not classified as trained or untrained because we did not feel that mothers would know this distinction.

Current health was assessed as a proxy for general health of the mother at the time of delivery. Conjunctival pallor was used as an indirect measure of anemia because we did not include any invasive laboratory procedures in the study, such as hemoglobin. Body mass index was calculated by kilos/meters². Those less than 18.5 were

FIGURE 1. Risk Factors for Reproductive Health



*Note that Indonesia maternal health programs use a smaller age window; age risk is those women < 20 and > 30.

collecting information from respondents on at least two occasions prior to starting work in the field.

Quality control: Throughout the study each data collector was monitored collecting data four to five times. The study staff monitored 20% of all midwife interviews. Two staff members, who had conducted a previous acute effects study in Central Java, were brought in to monitor the exposure data, and each, in turn, was monitored by the study epidemiologist (H.H.M.). Twenty percent of the Alapahpanjang sprayers were monitored and 10% of the controls. Since there were fewer observations required of the controls (we only recorded the kind of work performed) and we had twice the population to observe, we felt 10% monitoring was the most practical and feasible. Parallel data was gathered by the monitor to validate the findings.

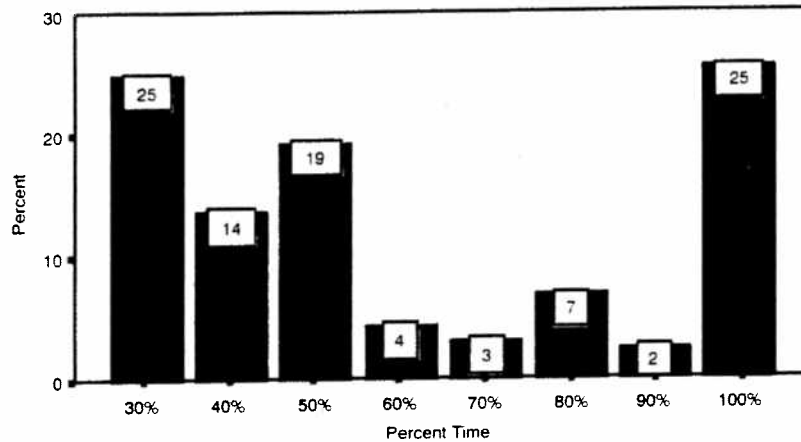
Questionnaires: The questionnaires were first field tested by the study staff then again during data collector training. Intra-observer variability testing was done twice as a training tool as well as to insure homogeneity between observers. Variability was 5-7% among the field data collectors and 0-5% among the midwives. The reproductive data that should not vary over time was also tested for reliability by interviewing respondents with the same midwife two days in a row. The lowest score was 97%.

Data analysis: Each questionnaire was checked by the study team when the form was turned in, then once again before data entry. Each questionnaire was entered into FoxPro twice by two data entry personnel and then validated using EPIINFO 6. Final editing was performed by the epidemiologist. Analysis was performed with SPSSPC for Windows.

RESULTS

Observed pesticide exposure: Our spraying cohort handled a mean of 13 different toxic products per week and mixed on average four different pesticides together in one tank. Forty percent use five to nine products per tank. They applied a mean of 69 liters of these mixes per week. Three quarters use a neurotoxin and all were using at least one product in their tank that WHO classifies as moderate, severe or extremely hazardous to human health. All women had direct skin exposure during mixing and application, while close to another 90% inhaled pesticide particulates during the spray operation. Twenty-two

FIGURE 2. Percent of Time Women Spray



The level of education was also similar between the two groups (Table 2). Very few farmers in both groups have access to adequate fecal disposal, an infectious disease risk for both areas.

Economic characteristics: The groups did differ economically (Table 3). Most of the economic indicators demonstrated that the women sprayers from Alahanpanjang were somewhat better off than their rice farmer counterparts in Surian. More women owned their land in Alahanpanjang. Ownership of televisions and those with cable services were higher in Alahanpanjang, as well as having some form of personal transportation. While land holding size was larger among the rice farmers, incomes were higher among the sprayers, likely related to better profits from vegetable cultivation. Household flooring was not correlated to the other economic variables and was not significantly different between the two groups.

Current health status: We looked at a few indicators of the women's current health status (Table 4) in order to assess the comparability of our two cohorts, although it is recognized that this does not necessarily reflect the woman's health at the time of delivery.

As maternal weight is a critical determinant of reproductive outcomes, we measured each woman's height, weight and calculated their body mass index (BMI). The sprayers in Alahanpanjang were nutritionally slightly better off than the rice farming women in terms of average BMI. Although a low number of women in both groups would

TABLE 3. Economic Indicators

	Rice Farmers (n = 353)		Sprayers (n = 161)		Significance
	n	%	n	%	Relative Risk (RR) (Confidence Interval)
Television (TV ± cable)	65	18.4	72	44.7	RR = .4 (.3-.5)*
• Cable	9	2.5	18	11.3	.00000*
• TV only	56	15.9	53	33.1	
• None	288	81.6	89	55.6	
Vehicles for transportation (any)	61	17.3	48	29.8	RR = .6(.4-.8)*
• Automobile	4	1.1	8	5.0	p = < .05*
• Motorcycle	18	5.1	22	13.7	
• Bicycle	39	11.0	18	11.2	
• None	292	82.7	113	70.2	
Flooring type (concrete)	185	52.4	92	57.1	RR = .9 (.8-1.1) ns
• Concrete	185	52.4	92	57.1	p = .32 ns
• Wood	158	44.8	66	41.0	
• Earth	4	1.1	2	1.2	
• Bamboo	6	1.7	1	.6	
Land ownership (some or all)	231	65.4	137	85.1	RR = .8 (.7-.9)*
• Rent	107	30.3	22	13.7	p = .45027 ns
• Own	167	47.3	111	68.9	
• Rent + own	64	18.1	26	16.1	
• Daily worker	5	1.4	2	1.2	
• None (Housewife)	10	2.8	-	-	
Land holding size (mean ha ± SD)	4.538 (± 6.442)		1.442 (± 1.442)		p < .000*
Income (Rupiah/month)					p < .00000*
• < 75	114	32.3	11	6.8	
• 75-100	135	38.2	30	18.6	
• 100-200	88	24.9	81	50.3	
• > 200	16	4.5	39	24.2	

* = statistically significant

All birth outcomes between the two groups had comparable risk factors in terms of the mother's age at the time of the pregnancy, birth order, and interval between pregnancies.

The only differences were smoking, delivery attendants and complications during labor and delivery. Slightly more of the rice farmers stated they were smoking during their pregnancy. While more of the

TABLE 5. Pregnancies at Risk

Pregnancies	Rice Farmers (n = 1519)		Sprayers (n = 773)		Significance
	n	%	n	%	Relative Risk (RR) (Confidence Interval)
Age < 18 or > 34	212	14.0	124	16.0	RR = .9 (.7-1.1) ns
Parity > 4	259	17.1	155	20.1	RR = .9 (.7-1.0) ns
Interval < 2 years	374	24.6	191	24.7	RR = 1.00 (.9-1.2) ns
Smoking	198	13.0	78	10.1	RR = 1.3 (1.0-1.7)*
Delivered by TBA	1195	78.7	680	88.2	RR = .9 (.7-.9)*
Other risk factors					
Illness during PG (non-specific)	85	5.6	48	6.2	RR = .1 (.6-1.3) ns
High risk illness/condition	19	1.3	7	.9	RR = 1.4 (.6-3.3) ns
• Typhoid	-		3		
• Typhus	-		2		
• Hepatitis	1		1		
• Malaria	2		-		
• Toxemia	8		1		
• Hypertension	5		-		
• Convulsion episode	3		-		
≥ 2 Tetanus immunizations	1190	78.9	580	76.7	RR = 1.1 (.98-1.1) ns
Delivery complications	180	11.9	48	6.2	RR = 1.9 (1.4-2.6)*
• Cephalic-pelvic disproportion	12		10		
• Hemorrhage	16		2		
• Asphyxia	1		-		
• Toxemia	-		3		
• Prolonged labor	115		14		
• Hydramnios	-		5		
• Malpresentation	14		8		
• Prolapsed cord	16		3		
• Retained placenta	3		1		
• Premature membrane rupture	1		-		
• Not specified	2		2		

* = statistically significant

outcome that was higher among the sprayers was the number of congenital defects. There were few in either group, thus the difference was not significant.

Associations to exposure and other factors: All reproductive outcomes among the spray operators were further analyzed by percent of time the women spray and the historical use variables. Amount of time

weights among our sprayers may have been associated to their higher socio-economic status and better nutrition although on stratification of the data, we could not demonstrate this effect. Furthermore, of all the measured outcomes, this was the softest data as it was based on maternal estimates and recall. Therefore it is open to a high error rate.

Reporting on spontaneous abortion is also difficult to validate. Up to twenty percent can occur early before a woman recognizes that she is pregnant. Also because intentional abortions are illegal and socially not sanctioned, women may not have reported spontaneous occurrences for fear of misinterpretation.

But one could expect a higher degree of validity in reporting stillbirths, early neonatal deaths and congenital defects. Mothers should not have trouble remembering or reporting these events. We could not demonstrate higher rates among our pesticide users with any of these outcomes except a slightly higher rate of congenital defects. The difference was not significant and whether they were true defects is not known. To date, the literature is weakest in demonstrating this effect. Therefore under these Indonesian conditions with a retrospective cohort study design, poor reproductive outcomes with pesticide use could not be demonstrated.

Can we therefore assume a relationship does not exist? Perhaps, but this flies in the face of the body of literature; assuming the latter designs were technically valid. On the other hand, all of these outcomes with the exception of low birth weight are relatively rare, opening up the question of sample size. The rates within both groups of poor outcomes were small, such that it was difficult to control other intervening risk factors such as the higher socio-economic status of our sprayers. Thus perhaps with a larger population of sprayers and more exposed pregnancies a difference might be detected.

While we did not detect higher poor reproductive outcomes among these pesticide-exposed Sumatran women compared to their rice growing colleagues, we felt morally obligated to warn them about the potential risks due to evidence demonstrated elsewhere. Certainly their current exposure was heavy and of great concern was the fact that so many spray during pregnancy. Through a series of meetings we presented to these women our study findings as well as a summary of the reproductive effects found elsewhere. As an alternative to pesticide-dependent farming, each woman was also offered enrollment into an Integrated Pest Management program sponsored by the Govern-

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