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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impacts of pesticide use. Exposure was determined through detailed field observations and interviews about historical pesticide use. Data was gathered on socio-economic characteristics, maternal health risk factors and reproductive outcomes by teams of local midwives trained for the study. Reproductive outcomes were compared between the exposed and nonexposed cohorts as well as those pregnancies among the sprayers before and after commencing pesticide use. The rates of stillbirths, abortions, early neonatal deaths, and low birth weight were not greater among the pesticide users. Although there were more cases of undocumented birth defects, the difference was not significant. Controlling for other independently associated maternal risk factors and socio-economic factors did not alter the results.

KEYWORDS. Pesticides, reproduction, maternal health, stillbirths, birth defects

INTRODUCTION

Over the last decade there has been growing concern about the reproductive health effects of pesticides. Estimating the scope of these problems is difficult because of the time lag between exposure and outcomes. Thus the linkage is not readily seen. Another technical problem is that there are many other factors that influence reproduction. Identifying the causal link between pesticides and poor reproductive outcomes through the maze of other influences on maternal health presents a challenge.

This is particularly the case in developing countries where access to health care services may be limited. Furthermore, infectious diseases, high parity and poor nutrition play a strong role in putting women's health at risk in these countries. Yet it is in developing countries that research needs to be conducted because it is here that pesticides are used indiscriminately with few precautions.

Approximately 39 studies were found in the literature on reproductive health, only nine of which have been conducted in developing countries. Reproductive outcomes of interest have been spontaneous abortions, stillbirths, low birth weights (from either prematurity or intrauterine growth deficiencies), early neonatal deaths, and birth defects. Of the 25 studies that showed a significant relationship between pesticide exposure and poor reproductive outcomes, the median risks

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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

be easily remembered by a mother. Data on the incidence of stillbirths (5.69 prevalence rate) also existed locally from a West Java study.[18] To detect a relative risk of 2.5 (median risk in literature is 3.0) with 95% confidence and power of 80%, our minimum sample using a 2:1 ratio of controls to sprayers was calculated at 306 and 153, respectively. Additional participants were selected to cover a 10% drop-out rate.

Selection: To find our sprayers, approximately 1,239 households were interviewed in Alahanpanjang yielding a total of 161 respondents. Another 2,005 households in Surian were interviewed for 353 controls. Selection criteria for our exposed cohort included being a married woman farmer, spraying at least 30% of the time, and previous pregnancies that occurred after first starting to use pesticides. Those selected as controls had to be married woman farmers with no previous use of pesticides personally or on the part of their husbands. Sprayers and controls were matched by five-year-age groups to minimize the effect of age on reproduction.

Study variables: Current, indirect and historical pesticide exposure was documented among both our sprayers and the absence thereof, among our controls. We observed women spraying to characterize current exposure. Detailed spray histories were collected on all our exposed cohorts as well as that of their husbands; the latter due to the evidence that male exposure has an impact on their wives' reproductive outcomes.[19-20] Years of use, age when women first started using pesticides, and the percentage of time women spray (as opposed to their husbands) were the key indicators. Potential water and food contamination in the home was defined as indirect exposure and documented through household inspection of pesticide storage areas. We made the assumption that exposure through food residuals would be equal for both the control and spray populations in that their food products came from the same market sources. Therefore, household foods were not tested. We questioned our sprayers about their bathing and laundry practices on two occasions: at home, and after the spray session, as another indirect route of exposure.

Both cohorts (sprayers and rice farmer controls) were interviewed twice to be sure that both were truly exposed and unexposed. The household survey among the controls was particularly critical to validate the absence of any pesticides or other toxic agent use.

Because there are other numerous maternal health risk factors that are independently associated to poor birth outcomes, we gathered data

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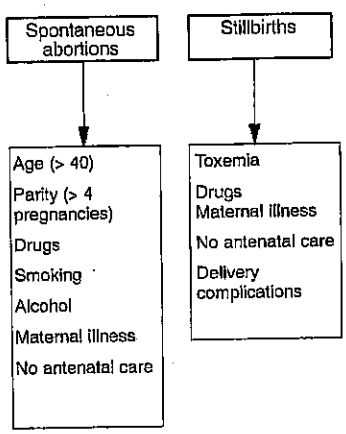


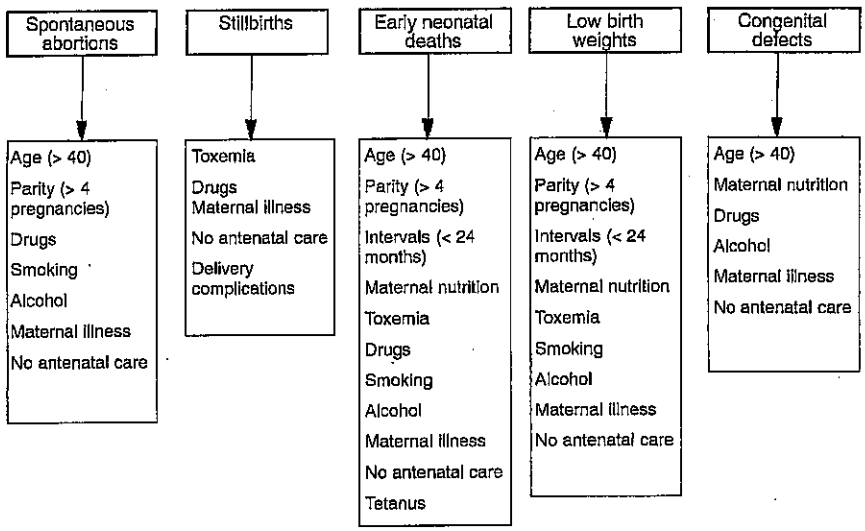
*Note that Indonesia matern
risk is those women < 20 and >

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/meters^2. 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.

considered at nutritional risk as defined by the national department of nutrition.

A variety of socio-economic measures were used based on local conditions. They included monthly income (local recommendation), land ownership and size, vehicle and television ownership and type of household flooring. Highest obtained educational degree was used for education. Means of fecal disposal was used as a sanitation indicator, critical to a variety of infectious diseases, and an indirect economic measure. The groups were all Minang Kabau, so ethnicity was not considered an issue.

We assessed five reproductive outcomes: abortion, stillbirth, low birth weight, early neonatal mortality and congenital defects. Abortion (miscarriages) was defined as the products of conception that were spontaneously expelled at or before 20 weeks. We did not try to differentiate between induced and spontaneous because the former is illegal in Indonesia and a sensitive issue. Low birth weight is formally defined as a birth weight of less than 2500 grams. Only recently have babies been routinely weighed by birth attendants and if weighed, mothers tend not to remember the numeric value. Therefore, we used only the mother's estimation as a proxy of whether the infant appeared normal in size. No attempts were made to discriminate between IUGR (intrauterine growth retardation) and pre-term (< 37 weeks). Stillbirths were defined as the birth of a dead fetus after 20 weeks. Data was gathered on all neonatal mortality then defined as early (0-7 days) and late (7-28 days) based on the assumption that pesticide related neonatal mortality was more likely in the early period whereas late mortality would be more likely associated with infectious diseases.

Data collectors, training and questionnaires: Two cadres of staff were hired to collect the data. Midwives collected the retrospective reproductive and maternal risk factor plus socio-economic data without knowledge of the woman's specific exposure history. Only brief review training for one week was required because they had already conducted their own cross-sectional survey on all deliveries during 1996 in both study sites for a pilot reproductive outcome study. Non-medical local women farmers with at least a junior high school education were selected to do the field observations and collect the historical pesticide use information. They were meticulously trained at two different times for a total of two weeks. Each data collector was observed

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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

percent had oral contact with the pesticide mixture by blowing through the spray nozzle to clear obstructions. Protective masks, goggles, non-permeable gloves and footwear were rarely used and most, at the end of their spray session, had wet clothing (for details see Part I: Characteristics of Use and Acute Effects).

Historical use of pesticides: Our cohort of 161 women from Alahanpanjang had an average spraying history of 11 years with a range of 2-26. Over 50% had been spraying for more than 10 years. Not all women consistently spray; some share the task with their husbands (Table 1).

Only a quarter of the women sprayed full-time (Figure 2), while over half (58%) sprayed less than fifty percent of the time. Therefore exposure was inconsistent. The small distributions between 60-90 percent are likely because these discrete discriminations were hard for women to estimate.

Half of the women reported that they would spray even during pregnancy. Of the 773 pregnancies among these women, 35% occurred before the year they first started using pesticides (Table 1). Some pregnancies (37%) would have had pesticide exposure both through their husband's and the woman's spraying. Another small proportion of pregnancies were only exposed by the fact the husband was spraying during the time of her pregnancy.

Group characteristics: The average age and age categories of sprayers and rice farmer control groups did not differ significantly.

TABLE 1. Historical Use of Pesticides

	n = 161	%
Years of use (mean ± STD range)	11 ± 5.4	(2-26 years)
• 2-5 yrs	29	18.0
• 5-10 yrs	50	31.1
• 11-15 yrs	41	25.5
• > 15 yrs	41	25.5
Spraying during pregnancy	81	50.0
Pregnancies exposed to pesticides	n = 773 pregnancies	
• no exposure	269	34.8
• only woman sprayed	143	18.5
• only husband sprayed	72	9.3
• woman and husband sprayed	289	37.4

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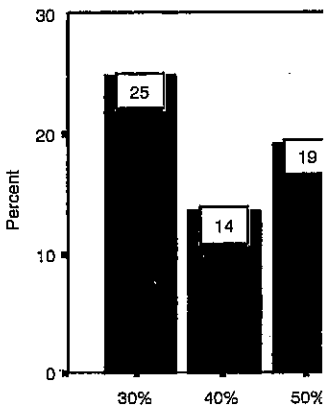

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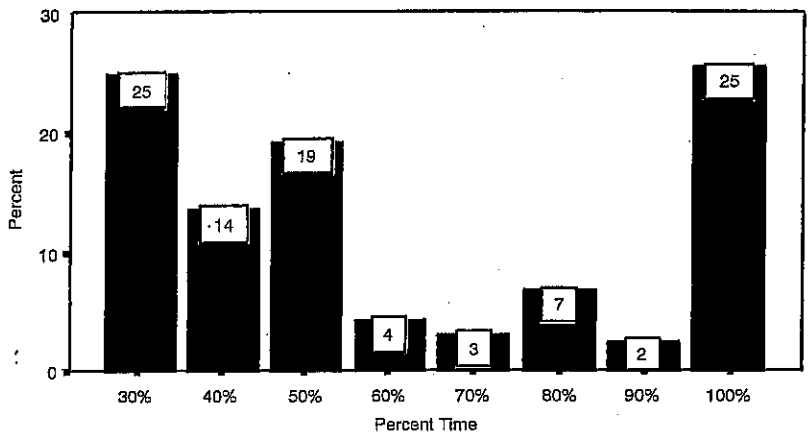
FIGURE 2. Percent of Time Women Spray



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 2. Group Characteristics

	Rice Farmers (n = 353)		Sprayers (n = 161)		Significance
	n	%	n	%	Relative Risk (RR) (Confidence Interval)
Age (mean)	32.9 (±7.7)		32.1 (±7.1)		p = .246 **ns**
• < 20	5	1.4	1	.6	
• 20-24	44	12.5	23	14.3	
• 25-29	74	21.0	36	22.4	
• 30-34	75	21.2	38	23.6	p = .33980 **ns**
• 35-39	70	19.8	29	18.0	
• 40-44	52	14.7	24	14.9	
• 45-49	21	5.9	6	3.7	
• 50-54	12	3.4	4	2.5	
Education (≥ primary)	143	40.5	67	41.6	RR = 1.0 (.8-1.5) **ns**
• None	210	59.5	94	58.4	
• Primary	89	25.2	49	30.4	p = .79040 **ns**
• Junior High (7-9)	35	9.9	8	5.0	
• Senior (10-12)	19	5.4	10	6.2	
Sanitation (WC)	18	5.1	13	8.1	RR = .06 (.3-1.3) **ns**
• Pour flush (WC)	18	5.1	13	8.1	
• River	327	92.6	136	84.5	p = .07588 **ns**
• Pond	5	1.4	3	1.9	
• Household container	3	.8	9	5.6	

be considered malnourished (BMI < 18.5), a larger proportion fell into this category among the rice farmers. This difference was not significant because of the small numbers. Women from Alahanpanjang felt they had gained weight since their pregnancies, again indicating a potential nutritional advantage among the sprayers. Contrary to these findings was the higher rate of anemia as measured indirectly by conjunctival pallor found among the sprayers. This may be related to the same false negatives demonstrated in the Surian pilot study in which we had blood hemoglobin levels with which to compare the conjunctival exams. The chronic disease rates did not differ between the two groups.

Maternal health risk factors: Information on risk factors for each pregnancy was gathered to control for the their potential influence on the pregnancy.

TABLE

	R
Television (TV ± cable)	
• Cable	
• TV only	
• None	2
Vehicles for transportation (any)	
• Automobile	
• Motorcycle	
• Bicycle	
• None	2
Flooring type (concrete)	1
• Concrete	1
• Wood	1
• Earth	
• Bamboo	
Land ownership (some or all)	2
• Rent	
• Own	
• Rent + own	
• Daily worker	
• None (Housewife)	
Land holding size (mean ha ± SD)	4
Income (Rupiah/month)	
• < 75	
• 75-100	
• 100-200	
• > 200	

* = statistically significant

All birth outcomes bet
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ayers 161)	Significance
%	Relative Risk (RR) (Confidence Interval)
(±7.1)	p = .246 **ns**
.6	
14.3	
22.4	
23.6	p = .33980 **ns**
18.0	
14.9	
3.7	
2.5	
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58.4	
30.4	p = .79040 **ns**
5.0	
6.2	
8.1	RR = .06 (.3-1.3) **ns**
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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	
• TV only	56	15.9	53	33.1	.00000*
• 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	
• Motorcycle	18	5.1	22	13.7	p =< .05*
• 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	
• Wood	158	44.8	66	41.0	p = .32 **ns**
• 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	
• Own	167	47.3	111	68.9	
• Rent + own	64	18.1	26	16.1	p = .45027 **ns**
• 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)					
• < 75	114	32.3	11	6.8	
• 75-100	135	38.2	30	18.6	p < .00000*
• 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 4. Current Health Status

	Rice Farmers (n = 353)		Sprayers (n = 161)		Significance
	n	%	n	%	Relative Risk (RR) (Confidence Interval)
Body Mass Index (kg/m^2)	21.4 (±2.8)		22.4 (±2.8)		p = .000*
• Malnourished (< 18.5)	40	11.3	9	5.6	RR = .6 (.3-1.0) ns
Current weight vs. pregnancy weight					
• More	64	18.8	57	35.6	
• Less	206	60.6	91	56.9	p < .0000*
• Same	70	20.6	12	7.5	
Pale conjuctiva	63	17.8	42	26.1	RR = .7 (.5-.96)*
Chronic diseases/conditions	15	4.2	9	5.6	RR = .8 (.5-1.5) ns
• Asthma	3		–		
• Hemiplegia	–		2		
• Hepatitis	4		1		
• Hypertension	3		3		
• Arrhythmia	1		–		
• Kidney stones	1		–		
• Rheumatic disease	3		1		
• Tuberculosis	–		2		

* = statistically significant

deliveries were attended by traditional birth attendants among the sprayers than rice farmers (88% versus 79%, respectively), conversely less sprayers remembered some sort of delivery complication by almost one-half–6.2 in Alahanpanjang versus 11.9 in Surian.

Reproductive outcomes: There were a total of 1,519 pregnancies among the 353 rice farmers and 773 among the 161 sprayers (Table 5). There were slightly more pregnancies per woman sprayer than rice farmer (4.8 versus 4.3, respectively). Therefore among these two 'ever pregnant' cohorts, exposure to pesticides did not appear to influence fertility.

The number of stillbirths, abortions and neonatal deaths were slightly higher among the rice farmers but these differences were not significant (Table 6). More women delivered infants estimated to be under-weight among the rice farmers compared to the sprayer cohort. The difference was significant by 3.6 times higher the rate. The only

TABLE

	R
Pregnancies	
Age < 18 or > 34	2
Parity > 4	2
Interval < 2 years	3
Smoking	1
Delivered by TBA	11
Other risk factors	
Illness during PG (non-specific)	
High risk illness/condition	
• Typhoid	
• Typhus	
• Hepatitis	
• Malaria	
• Toxemia	
• Hypertension	
• Convulsion episode	
≥ 2 Tetanus immunizations	1
Delivery complications	
• Cephalic-pelvic disproportion	
• Hemorrhage	
• Asphyxia	
• Toxemia	
• Prolonged labor	
• Hydramnios	
• Malpresentation	
• Prolapsed cord	
• Retained placenta	
• Premature membrane rupture	
• Not specified	

* = statistically significant

outcome that was higher a
genital defects. There wei
was not significant.

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yers 161)	Significance
%	Relative Risk (RR) (Confidence Interval)
(±2.8)	p = .000*
5.6	RR = .6 (.3-1.0) ns
35.6	
56.9	p < .0000*
7.5	
26.1	RR = .7 (.5-.96)*
5.6	RR = .8 (.5-1.5) ns

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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

TABLE 6. Reproductive Outcomes

	Rice Farmers (n = 353)		Sprayers (n = 161)		Significance
	n	%	n	%	Relative Risk (RR) (Confidence Interval)
Total number pregnancies	1519		773		
Pregnancies (mean ± SD)	4.3 (±2.6)		4.8 (±2.6)		$p < .05$
Abortions	76	5.0	36	4.7	RR = 1.1 (.7-1.6) **ns**
Still births	30	2.0	13	1.7	RR = 1.2 (.6-2.2) **ns**
Small size (proxy LBW)	169	11.7	24	3.3	RR = 3.6 (2.4-5.4)*
Neonatal deaths					
• < 7 days	43	3.0	18	2.4	RR = 1.2 (.7-2.1) **ns**
• 8-28 days	21	1.5	9	1.2	RR = 1.2 (.6-2.6) **ns**
Congenital anomaly	5	.3	7	.9	RR = .4 (.12-1.1) **ns**
• Hand deformity	2		1		
• Neuro-muscular weakness	1				
• Cleft plate/lip	1		3		
• Skin lesions			3		

* = statistically significant

spent in spraying, years of use, whether they spray during pregnancy and pregnancies after the years they started using pesticides versus before use, did not demonstrate any reproductive outcome differences.

To find out if other factors were operating as an explanation of the differences between the sprayers and control rice farmers, all other factors were tested against the reproductive outcomes. While there were striking socio-economic differences between the populations, none of these variables proved significant in regression analysis. Current health and maternal risk factors by pregnancy were generally more significant among the sprayers; thus their relationship to poor outcomes showed no correlation. The risk factors that were greater among the rice farmers (smoking and delivery complications) did not play a significant role.

DISCUSSION

The study was inconsistent with other reproductive studies which have associated pesticide use with poor outcomes. The better birth

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yers 161)	Significance
%	Relative Risk (RR) (Confidence Interval)
73 (±2.6)	$p < .05$
4.7	RR = 1.1 (.7-1.6) ns
1.7	RR = 1.2 (.6-2.2) ns
3.3	RR = 3.6 (2.4-5.4)*
2.4	RR = 1.2 (.7-2.1) ns
1.2	RR = 1.2 (.6-2.6) ns
.9	RR = .4 (.12-1.1) ns

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-

ment of Indonesia. Armed with this information about the potential health hazards of pesticide use and methods to reduce pesticide use, we hoped they could make more informed decisions about future agrochemical use.

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