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The effects of exposure to pesticides on the fecundity status of farm workers resident in a rural region of Fars province, southern Iran

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PEER REVIEW

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Comments
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ABSTRACT

Objective: To investigate the prevalence of fecundity and other reproductive problems among a group of farmers in Kavar district of Fars province, southern Iran.
Methods: A total of 268 randomly selected married male farm workers were investigated. A questionnaire was devised and validated [Cronbach's α-coefficient (0.81)]. Subjects were directly interviewed and the questionnaire forms were completed for them.
Results: The prevalence of current primary infertility among the studied population was about 7.4% (P=0.001). Similarly, 6.3% of farm workers had offsprings with congenital malformations. Finally, 1.5% and 9% of farmers' wives had a history of stillbirth and abortion, respectively. It was concluded that the prevalence of current primary infertility were higher among farm workers families than in the normal population (P<0.05). Additionally, stillbirth and spontaneous abortion were more common in the wives of farm workers than in the normal population, although the difference did not reach statistical significance.
Conclusions: These effects are likely to be attributed to the exposure of farm workers to pesticides.

KEYWORDS
Infertility, Male farmers, Pesticides exposure, Iran

1. Introduction

Human fecundity is a very sensitive process which can be influenced by many factors including parental age, maternal status, cigarette smoking, alcohol and coffee use, socio-economic class, genetic attributes, hormonal imbalance and exposure to pesticides[1]. All of these affect the reproductive capability of couples. One of the best documents asserting the impaired fecundity role of pesticides on males belongs to Swan and colleagues[2]. Impaired fecundity is an ever increasing global health problem whose prevalence has risen by 50% over the last 16 years[3].

Pesticide refers to one kind of any agent known as herbicide, fungicide, insecticide, fumigants or rodenticide. Adverse impact on fecundity among men has various reasons which include endocrine impairments, epigenetic variations and

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genetic forms. Hormonal balance particularly that in sexual hormones is important in relation to fecundity process. Environmental disruptors of endocrine glands may impair hormonal balance which could result in fecundity impairment. A relatively high level of impairment caused by environmental factors is due to pesticides' exposure particularly among farm workers[4].

In developing countries, the deliberate and permanently non-selective use of various pesticides can affect the exposure and infiltration into different tissues of non-target organisms and mammals like humans leading to increased cancers and impaired fecundity. Since the use of pesticides in Iran is estimated to be about 20-25 kiloton per year, the rate of their usage is about 0.5% the rate at the worldwide level.

Several research studies have been reported on the occupational exposure to pesticides and their detrimental effect on human fecundity which may ultimately lead to delay in pregnancy without the use of preventive measures after 1 year (time-to-pregnancy, TTP), stillbirth or spontaneous abortion, low birth weight and growth impairments. A significant relationship between exposure to pesticides and TTP is observed[5]. Examples of the chronic effects of toxic chemicals on health include limb deformities (*e.g.* shortening of the limbs or phocomelia), reproductive defects, cancer, damaged immune defense system and disorders of the nervous system[2].

Studies have indicated that the effects of exposure to pesticides in agrarian environment on fecundity are not unambiguous. The relationship between occupational pesticides and birth weight, preterm birth, and sex ratio is often contradictory. Most studies have shown that there is a relationship between exposure to pesticides and a decline in fecundity. It also increases the risk of getting teratogenic offspring[2]. Studies on fecundity failures indicate that the risk of stillbirth and spontaneous abortion increases among women workers exposed to pesticides[6].

Considering the large volume of pesticides used annually in Iran and the fact that to the best of our knowledge no systematic studies have been carried out in this field in the region. The aim of this study was to determine the likely association between exposure to pesticides and the incidence of impaired fecundity, congenital anomalies, abortion and general reproductive health among farm workers in a rural area of Fars province, southern Iran.

2. Materials and methods

This cross-sectional study took place in Kavar district (52°43`41`` E, 29°11`32`` N at an altitude of about 1386 m above sea level) about 45 km to the south east of Shiraz, the capital city of Fars province in southern Iran, in 2010 (Figure 1). The sampling method was randomly performed on resident married male farm workers. Sampling selection involved visits to the local health houses and survey of those household files with farming job. From these, a total number of 268 individuals were randomly selected. They were located in the field and interviewed on site and a questionnaire was completed by them.

Figure 1. Map of Iran indicating the location of the study area in Kavar region situated in Fars Province, Iran.

This questionnaire form included data whose reliability and validity were authenticated based on the Cronbach's α-coefficient and using the statistical software SPSS version 16 by researchers. This form included four sections: personal attributes of individuals under study including age and literacy level; occupational attributes including job history and the frequency of spraying pesticides per year; used pesticide characters including name of pesticide, use of protective equipments during spraying, illness status due to pesticides and visit to health houses; and ultimately miscellaneous questions section which included smoking habit, use of family regulation tools, presence of disabled individual in the house, and other

questions related to fecundity status.

Each of these questions was examined as a variable. The impaired fecundity criterion was investigated in current primary infertility is applied to all couples who are subjected to lifetime primary infertility and have had no pregnancy case up to the study date[7,8].

The preventive measures consisted of drugs, intrauterine devices, ampoule, Norplant, condom and natural method. Patients suffering from diseases which caused infertility and single farm workers were removed from the study to reduce the confounding factors' effects. Finally, the acquired data were analyzed using SPSS version 16 software. Descriptive statistics were extracted, main attributes and the spread of quantitative variables were also determined so that research queries could be addressed. After explanation of the study aim, farm workers' consents towards interview were obtained to settle ethical issues.

3. Results

This study was conducted on 268 married male farmers in Kavar district of Shiraz, 43.7% of whom had one or more impaired fecundity problems among their family members (Table 1). The majority of cases were in the third and fourth decades of their life (65.7%) (Table 2). The literacy level was generally low with the largest proportion of cases (35.8%) having only elementary level education. The most of insecticide that was used by farmers were acetamiprid 20% SP, imidacloprid 35% SC (confidor), roundup (glyphosate) 41% SL, paraquat 22% SL, diazinon 60% EC, malathion 57% EC and cypermethrin 40% EC (Table 3). A remarkable proportion (88.1%) of farm workers conducted more than 10 spraying sessions per year. Most workers (68.7%) suffered from such symptoms as burning and dermal irritation, eye burn, headache, dizziness, nausea and vomiting during spraying while a small proportion (7.5%) visited a general practitioner. Among all cases, about 43.3% had a history of working with pesticides for two decades. The majority of farm workers (85.1%) were not equipped with personal protective means during spraying. In addition, only 28.4% had the habit of smoking cigarettes (Table 2). The proportion of couples having impaired fecundity with no history of using pregnancy prevention measures was 7.4% ($P<0.05$) (Table 1). The health status of farmers' children were also investigated which showed no significant difference between gender distribution ($P<0.05$). About 6.3% of the studied population had offspring with congenital anomalies. The farmers with impaired fecundity did not wear any protective cover during work with pesticides. In addition, 85% of them had >10 years history of working with insecticides. The study showed that there was no significant statistical difference between smoking and side-effects from exposure to pesticides ($P>0.05$).

Table 1

Reproductive health status among farm workers exposed to pesticides in Kavar district of Fars province, Iran.

Variable	Number	Percentage	CI (95%)
Infertile	20	7.4	4.0-10.0
Spontaneous abortion (<20 weeks)	24	9.0	6.0-12.3
Teratogenic	17	6.3	3.5-9.1
Stillbirth	4	1.5	0.1-2.9

CI: Confidence interval.

Table 2

Specific characters of farm workers in Kavar district of Fars province in 2010.

Attributes		Number [n (%)]
Spraying frequency/annum	>10	236 (88.1)
	<10	32 (11.9)
Occupation age (year)	<10	76 (28.4)
	10-20	76 (28.4)
	>20	116 (43.3)
Cigarettes smoking	Yes	76 (28.4)
	No	192 (71.6)
Use of pregnancy preventive tools	Yes	56 (21.0)
	No	112 (79.0)
Gender status of farmers' offspring	Male	65 (24.2)
	Female	83 (30.9)
	Both	120 (44.7)
Literacy level	None	28 (10.3)
	Primary	96 (35.8)
	Intermediate	88 (32.9)
	Advanced	56 (21.0)
Spraying symptoms	Yes	184 (68.0)
	No	84 (32.0)
General practitioner visit	Yes	20 (7.5)
	No	248 (92.5)
Age (year)	20-39	176 (65.0)
	40-59	64 (24.6)
	>60	28 (10.4)
Personal protection	Yes	40 (14.9)
	No	228 (85.1)
Pesticide group used	OP-PY-C- FC	248 (92.5)
	OC	20 (7.5)

OP: Organophosphorus, PY: Pyrethroid, OC: Organochlorine, C: Carbamate, FC: Fungicide.

Table 3

List of chemicals used by farmers in Kavar region and their toxicological effects.

Name of chemicals	Pesticides	Herbicides	Insecticides			Effects of toxicological			
			OP	PY	NC	DS	TTP	BDC	SB
Paraquat 22% SL		*				+	-	-	+
Roundup (Glyphosate) 41% SL		*				+	+	+	+
Acetamiprid 20% SP					*	+	-	-	+
Imidacloprid 35% SC (confidor)					*	+	-	+	+
Nicosulfuron 4% SC		*				+	-	-	+
Fenpropathrin 10% EC				*		+	-	-	+
Lufenuron (match 5% EC)	*					+	-	+	+
Topaz 200 EW	*					+	-	+	+
Diazinon 60% EC			*			+	+	+	+
Malathion 57% EC			*			+	+	+	+
Cypermethrin 40% EC				*		+	+	-	-

OP: Organophosphate, OC: Organochlorine, PY: Pyrethroids, NC: Neonicotinoid. DS: Diminishing of sperm, SB: stillbirth, TTP: Time to pregnancy, BDC: Birth defects in children.

4. Discussion

In this study, impaired fecundity was investigated with current primary infertility index. Most studies on impaired fecundity have used this approach before[8]. Impaired fecundity among public community in Iran was 3.4%. This impaired fecundity among residents of Fars province in Iran was 3.5%[9]. In the present study, the impaired fecundity rate among farm workers exposed to pesticides was 7.4% (confidence interval or CI=4-10%) which was significantly higher than that of the normal population (P<0.05). Based on this result, it was indicated that exposure to pesticides resulted in an increased impaired fecundity rate.

Spontaneous recurrent abortion refers to three or more aborted cases in the first half time period of pregnancy. Its global prevalence is 0.3%, but in Iran, it is 0.7%[10]. In a study on the prevalence rate of abortion in Iran in the last decade, from 2 470 women investigated, 775 (45.7%) were reported to have had at least one abortion in their lives. From these, 74.2% had spontaneous abortion[11]. In our study, the abortion rate among farmers exposed to pesticides was 9%.

The present study showed that the rate of stillbirth was 1.5% which in comparison with 1.2% among Rafsanjan community was higher[12]. In addition, a study on 15-49 year old Iranian women from 1957 to 1996 showed the rate of stillbirth to be 12.8 per thousand and the same study reported this to be 18 per thousand among prim gravid females[13]. The rate of stillbirth among Kurdish population was reported as 0.5%, while the corresponding rates in America and Pakistan were 0.07% and 3.6%, respectively[14].

Although there were no clear statistics on the national teratogenic birth rate, our study indicated that 6.3% of farmers exposed to pesticides had teratogenic offspring. There was a significant difference (P>0.05) between the proportion of symptomatic cases in this study (68%) compared with that in a western Iranian province (25.2%)[15].

In a study on the occupational exposure of infertile men, cases were categorized in different groups according to the type of their exposure and occupation. It was found that 22% of men with impaired fecundity had a history of exposure to pesticides, 28% to solvents, 34% heat and 16.5% others and their occupation[15]. The role of environmental factors on male reproductive effectiveness was recognized some 30 years ago when farm workers who were exposed to the rodenticide dibromochloropropane showed serious damage to their spermatogenesis[16]. According to some studies, the average sperm count in men has been reduced within the last five decades. The main indirectly implicated culprits could be environmental toxins and chemical agents[17]. The occupational toxins directly damage testicular cells or indirectly impair the hormonal regulation of spermatogenesis and sperm production. These impairments are reflected in a reduction of sperm production, increase in defective sperm production and disruption in androgen production[18,19]. Considering the low literacy level among farm workers, the lack of knowledge on pesticides' side-effects is an issue which threatens their health. It is thus important to enhance health education among farmers. This will reduce the symptoms due to pesticides' exposure. Collectively, our findings revealed that the prevalence of primary infertility was significantly higher among married farm workers than in the normal population.

Conflict of interest statement

We declare that we have no conflict of interest.

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Comments

Background

Human fecundity is a very sensitive process which can be influenced by many factors including parental age, maternal status, cigarette smoking, alcohol and coffee use, socio-economic class, genetic attributes, hormonal imbalance and exposure to pesticides. All of these affect the reproductive capability of couples.

Research frontiers

This study was to determine the likely association between exposure to pesticides and the incidence of impaired fecundity, congenital anomalies, abortion and general reproductive health among farm workers in a rural area of Fars province, southern Iran.

Related reports

Impaired fecundity among public community in Iran was 3.4%. This impaired fecundity among residents of Fars province in Iran was 3.5%[9]. In the present study, the impaired fecundity rate among farm workers exposed to pesticides was 7.4% (confidence interval or CI=4-10%) which was significantly higher than that of the normal population (P<0.05).

Innovations and breakthroughs

Pesticide refers to one kind of any agent known as herbicide, fungicide, insecticide, fumigants or rodenticide. Adverse impact on fecundity among men has various reasons which include endocrine impairments, epigenetic variations and genetic forms. Hormonal balance particularly that in sexual hormones is important in relation to fecundity process. In the present study, authors have demonstrated relations between pesticide exposure and fecundity.

Applications

From the literature survey it has been found that several research studies have been reported on the occupational exposure to pesticides and their detrimental effect on human fecundity which may ultimately lead to delay in pregnancy without the use of preventive measures after 1 year (time-to-pregnancy), stillbirth or spontaneous abortion, low birth weight and growth impairments.

Peer review

This is a valuable research work in which authors have demonstrated the proportion of couples having impaired fecundity with no history of using pregnancy prevention measures was 7.4% (P<0.05). About 6.3% of the studied population had offspring with congenital anomalies.

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