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## Effects of dangerous chemicals present in the environment on the health of rural people in the South Western region of Punjab

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### Abstract

The Malwa region of Punjab, India, is facing an unprecedented crisis of environmental health linked to indiscriminate, excessive and unsafe use of pesticides, fertilizers and poor groundwater quality. International evidence is indicative of the fact that agriculture revolution has generated the much needed food security and at the same time it has raised alarming signs for the ecology also. Punjab, being the granary state of India, has been the leader of the Green Revolution. Punjab is the leading state in terms consumption of chemical fertilizers and pesticides per hectare. Studies of this region have also highlighted a sharp increase in many other pesticide-related diseases, such as mental retardation, cancer and reproductive disorders. The most affected individuals are the agricultural workers who are directly exposed to pesticides. There is a higher concentration of bromine in the water samples in the south-west Punjab. The high use of pesticides, along with environmental and social factors, is responsible for the high concentration of pesticide residues in the food chain of this region. Moreover, many banned and restricted pesticides are still in use in this region, warranting People need to be sensitized regarding the judicious use of natural resources to minimize the risk caused by unmindful human endeavor. The present review describes environmental and social factors associated with chemicals used in the south western region of Punjab.

**Keywords:** Malwa region of Punjab, green revolution, cancer, reproductive and neurological disorders.

### Introduction

The agrarian sector of Punjab had undergone a radical change in the last half century since the advent of green revolution in the state. It made the country self-sufficient in food grains but at a humongous human cost that is taking its toll now (Singh 2017) [37]. The Malwa region of Punjab, India, was facing an unprecedented crisis of environmental health linked to indiscriminate, excessive and unsafe use of pesticides, fertilizers and poor groundwater quality. The region has been described as India's “cancer capital” due to abnormally high number of cancer cases, which have increased 3-fold in the last 10 years. The high use of pesticides, along with environmental and social factors, is responsible for the high concentration of pesticide residues in the food chain of this region. Moreover, many banned and restricted pesticides are still in use in this region, warranting strict periodical health checkups and other interventions (Kaur 2013, Mittal *et al* 2014, Pandhi 2012, Singh *et al* 2013, Singh 2017) [31, 32, 33, 36, 37, 38].

Ever rising urbanization, industrial pollution, undesirable lifestyles, poverty abundance syndrome and social stress and strains has contributed to rising incidence of non-communicable diseases (NCDs) like the cancer, heart diseases, diabetes, hypertension, arthritis, mental disorders, respiratory disease and accidents (Reddy *et al* 2011, Thakur *et al* 2008) [23]. Amongst non-communicable diseases, the onset of cancer is attributed both to the internal factors as well as external factors. Ecological degradation which has impacted air, water, soil and the residual impact of unprecedented use of pesticides, insecticides and chemical fertilizers which has badly affected the immunity system constitutes the external factors (Aggarwal *et al* 2015, Kaur 2013, Singh 2008, Singh 2011) [22, 23, 31].

Sedentary lifestyle, food full of preservatives, tobacco and alcohol consumptions and radiations are other external factors held directly or indirectly responsible for cancer.

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Study by WHO (2008) [39] held tobacco responsible for 22 percent of global cancer cases and around three fourth of global lung cancer cases (World Health Organization 2008) [38]. Studies have reported that three fourth of the cancers of colon are because of intake of faulty diets (Anand *et al* 2008) [28]. These days various studies have reported that the use of plastic bowls for storing and heating liquid and semi-solid food is also another reason for increasing cases of breast and prostate cancers and bis-phenol and adhesive used in making plastic containers get dissolved with hot food, resulting in transfer of carcinogens to food (Durando *et al* 2007 and Ho *et al* 2006) [29].

#### South Western belt of Malwa region of Punjab

The Malwa region of Punjab, locally called “*Makheon Meetha* (Sweeter than Honey) *Malwa*” for its rich agricultural produce and cotton farming, is one such part that is facing an unprecedented crisis of adverse human health events related to indiscriminate use of synthetic pesticides. The *Malwa* region is the largest part of the three main divisions (the other two being Majha and Doaba) of the present Punjab state of India. The *Malwa* region geographically lies between 29° – 30’ and 31° –10’ North latitudes and 73° –50’ and 76° –50’ East longitudes and has been best described as the southern part of Punjab partitioned by the Sutlej River. It includes the districts of Fazilka, Bathinda, Mansa, Moga, Faridkot, Patiala, Sangrur, Barnala, Ferozepur, Muktsar, Roopnagar, Fatehgrah Sahib, SAS Nagar (Mohali) and Ludhiana (14 districts) that comprise an area of 32,808 km<sup>2</sup> (65.1% of Punjab’s area). The total population of the Malwa region is 14.3 million (52% of Punjab’s population), with nearly 62% being the rural population (The Indian Census 2011) [25]. Out of a total area of 30200 km<sup>2</sup> in the Malwa region, approximately 86.5% is under cultivation (net sown area in year 2016–2017). Climatically, this region has two seasons; the Rabi season, which is characterized by winter to mild summer and the Khariff season, having summer to mild winter. Paddy, wheat and cotton are the major crops with a net sown area of 1996, 2403 and 331 ha, respectively (area as per year 2010–2011) (Anonymous 2018) [28].

#### Health Effects of Pesticides in the Malwa Region of Punjab, India

The consequences of unbridled use of these chemicals are faced mostly by the directly linked farmers’ communities in the Malwa region. The following health effects have been reported by various researchers working in the Malwa region of Punjab, India.

#### Deaths Due to Pesticide Poisoning

There is evidence related to pesticide poisoning and deaths in the Malwa region. During the year 2001–2002, the maximum number of deaths due to pesticide poisoning occurred in the month of June (21%), which may be due to spraying of pesticides on the crops in this month whereas the minimum number of deaths were recorded in September (2%) in this region (Singh *et al.* 2003). Of the 31.6% insecticide poisoning cases, 32.9% were males and 26.3% were females admitted to the emergency medical ward of the Adesh Institute of Medical Sciences and Research (AIMSR), Bathinda, from 2007 to 2009 (Garg and Verma 2010) [8]. A total of 61 persons died after inhaling pesticides between the years 2004–2008 in the Bathinda district while spraying on their farms (Dhonti 2010). Deaths due to pesticide poisoning have been reported

worldwide and are a well-known fact. The WHO has estimated that every year 3 million cases of acute pesticide poisonings occur globally and out of this 10% die (Gunnell and Eddleston 2003) [11].

#### Reproductive Abnormalities and Miscarriages

As per various reports from Kheti Virasat Mission, Faridkot (Punjab), the number of childless couples and young males with infertility was alarmingly high in more than 100 villages of the Malwa region (Dutt 2007). In the Jajjal village of Bathinda, 12.7% of boys (age 13–23 years) failed to show puberty (*i.e.*, voice change and moustaches); 3.4% of boys failed for enlargement of external genitalia, and 5.8% of girls (age 13–20 years) had not started menstruation before age 15 years and there were 0.012% cases of infertility (Halder 2007) [11]. Khan *et al.* (2010) [13] reported that the increased HCH levels cause a significant decrease in semen quality as well as sperm count. The cause of infertility among males is Y chromosome micro-deletion and alteration in sperm quality after organochlorine exposure, which affects the seminal and prostatic functions (Pant *et al.* 2004) [18]. Pesticides have the potential to interfere with androgen action and affect the development and maturation of the reproductive tract in males and cause declination in semen quality (Jurewicz *et al.* 2009) [12]. Miscarriages in the spouses of farmers have shown direct connection to pesticide exposure. The miscarriage rate varies with the pesticide used (Garry 2004; Kumar and Kumar 2007) [9]. Pathak *et al.* (2010) [19] investigated the possible association of organo chlorine pesticides in the pathogenesis of recurrent miscarriages. The increase in insecticide levels in the blood of vertebrates has been reported to cause reproductive dysfunction (Singh *et al.* 2008) [22]. It clearly suggests that exposure to pesticides can be a significant contribution towards various reproductive disorders.

#### Neurological and Behavioral Disorders

Thakur *et al.* (2008) [23] reported the chronic effects of pesticides as inability to perform developmental tasks among rural children in cotton-growing areas of Bathinda. Pesticides have been reported to have adverse effects on mental and psychomotor development (Bouchard *et al.* 2011) [5] and act as potent neurotoxins (McConnell *et al.* 1999; Abou-Donia 2003) [15, 1].

#### Pesticides in Rural Communities in the Malwa Region of Punjab, India

People exposed to pesticides may feel dizzy, confused, and may have reduced coordination, intelligence quotient (IQ) and learning disability, permanent brain damage (Bjørning-Poulsen *et al.* 2008) [3], risk of Parkinson’s disease (Rugbjerg *et al.* 2011) [21], risk of dementia (Baldi *et al.* 2011) [2], decrease in AChE (acetylcholinesterase) activity, and may also suffer from nephron toxicity (Singh *et al.* 2010) [22]. Organophosphorus (OP) insecticides are potent inhibitors of serine esterases such as AChE (Buckley *et al.* 2005) [4] and serum cholinesterase, which results in accumulation of acetylcholine and over-stimulation of acetylcholine receptors in synapses of the autonomic nervous system, central nervous system (CNS), and neuromuscular junctions (Lotti 2001). The exposure to cholinesterase inhibitors was associated with symptoms of depressive psychosis like depressed mood, lethargy, insomnia, and lack of concentration (Rowntree *et al.* 1950) [20]. It has been observed that certain pesticides competitively bind with the thyroid hormone binding protein,

transthyretin (Meerts *et al.* 2000) [16], and some bind more avidly than thyroxine T<sub>4</sub>, displacing T<sub>4</sub> and potentially interfering with its transport to the developing brain (Schettler 2001).

Bajinder Pal Singh in the year 2008 [22] investigated the incidence of cancer mortality in the villages of Malwa Region in Indian Punjab for a five year period from 2002-2006. In his study he reported that cancer mortality tends to increase with increase in pesticide residues both in water and soil. The correlation with pesticide residues in water is slightly stronger than that with soil. Pesticide residues in water arise from two sources i.e. leaching into ground water as well as canals. The source of drinking water in the study villages varies between tube wells and canal water. In case of tube wells water is rarely treated before use and is often consumed directly after drawing it from well. Canal water is treated in a plant in the village but in most cases an old antiquated elementary sand filtration based plant is the only installation in the village. Hence water is rarely treated from pesticide residues in the entire study area. J.S. Thakur and others conducted an epidemiological study of high cancer among rural agricultural community of Punjab in the year 2008 and reported that water used for various purposes including drinking was highly polluted. The main source of drinking water was hand pump water, tap water and canal water. Pesticides were the main source of pollutants. Levels of As,

Se, Hg in ground water at Talwandi Sabo more than the permissible level. As seen above permissible levels in tap water in Talwandi Sabo. Pesticides were even present in vegetable samples (cauliflower, carrot) and fruits. Hence, various studies reviewed above, show high pollution level in the waters of Punjab leading to various dangerous diseases like cancer. In spite of these studies, nothing concrete has been undertaken to curb this menace neither by the general public nor by the Government. The recent report of 2011-12 of the Comptroller and

Auditor General of India also highlights the apathetic attitude of the Central as well as State governments in checking the rising menace of water pollution which is having its toll not only on animal species but also on human beings.

### Premature Hair Greying

Premature greying of hair has been reported in both males and females in this region.

Premature greying of hair has been observed in 4.7% of children of age nearly 10 years from the Jajjal village of the Bathinda district (Halder 2007) [11]. Pesticides are known to produce reactive oxygen species (ROS) in the human body. Evidence from studies on epidermal melanocyte aging suggests that ROS damages both nuclear and mitochondrial DNA, which may lead to mutations in bulbar melanocytes (Van Neste and Tobin 2004) [26]. Nishimura *et al.* (2005) [17] reported that defective self-maintenance of melanocyte stem cells due to exposure to environmental toxicants as one of the possible cause of change in hair color.

### Conclusions

The long-time over-use of pesticides appears to be a major cause for prevalence of various diseases in cotton cultivated districts of the Malwa region of Punjab. Commercialization and privatization of health services have excluded a sizeable proportion of the population, particularly those belonging to socially disadvantaged groups like landless laborers, marginal and small farmers, and poor from the coverage of health

services provided by organized sector in rural areas. To safeguard human life from the toxic effects of pesticides, adequate steps need to be taken. Providing safe drinking water and uncontaminated foods are the foremost requirements. Screening of farmers for health risk should be done periodically. There is an urgent need to reduce morbidity and mortality related to pesticide poisoning through review and improved pesticide policies. Strengthening of community programs about the safe use of pesticides can minimize the risks of intentional and unintentional pesticide poisoning.

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