4(I).1.1 General demographic profile among pesticide sprayers and controls

Demographic profile, body composition and occupational exposure profile of pesticide sprayers (tractor mounted, knapsack) and control subjects are shown in Table 4(I).1.1. Mean values of age, height, weight, BMI, body fat %, and VFA among subjects of all groups are statistically similar ($P>0.05$) although the mean values of height, weight, BMI, body fat%, and VFA are higher in control subjects as compared to exposed subjects. Pesticide exposure duration in tractor-mounted sprayers and knapsack sprayers was almost similar. All the subjects participated in study were male. The personal habits such as smoking, tobacco chewing, alcohol drinking as well as dietary habits were also statistically similar between controls and sprayers ($P>0.05$) although smoking, tobacco chewing and alcohol consumption habit more prevalent among control subjects than exposed subjects.

As per the BMI classification of WHO, about 50% study subjects, both control and exposed group had normal BMI. The knapsack sprayers showed higher prevalence (53%) of underweight while higher prevalence percentage of overweight was observed in controls (23%). Majority of knapsack sprayers had normal body fat% and VFA while control subjects had higher body fat% and VFA count as compared to other groups.

Higher percentage of illiteracy (26%) was found among knapsack sprayers as compared to tractor-mounted sprayers (13%) and controls (4%). Among tractor-mounted sprayers, 65% subjects were married as compared to knapsack sprayers (81%) and controls (78%).

4(I).1.2 Pesticide usage

Pesticides used by sprayers in the agricultural fields are listed in Table 4(I).1.2. Most of the pesticides used by the sprayers belong to insecticide group of pesticides that are OP. Beside these CB, SP, OC and others were also used to protect fruits and crops from insects and to increase production and quality. Pesticides used by sprayers of both category comes under extremely hazardous (Ia), highly hazardous (Ib) and moderate hazardous (II) class of pesticides as
per WHO classification (2004) and these pesticides are easily available in the Indian market [Table 4(I).1.2].

4(I).1.3 Farm work practices

The agricultural workers engaged in pesticide application for agricultural purpose were interviewed face-to-face to gain information regarding the storage practice adopted by the user, method use for spraying of pesticides, type of personal protective equipment (PPE) used during handling, mixing and spraying of pesticide, accidents during farm work practices and extent to which safety norms being followed by the sprayers and finally their knowledge concerning the risks of pesticide exposure are presented in Table 4(I).1.3. The sprayers reported the place for pesticide storage among sprayers [inside the house (44%), inside plantation areas (11%), no storage (17%), tools storage room (28%)], place for pesticide preparation [in home (17%), in fields (44%), near pond (39%)], handling of pesticide container by bare hands (100%), mixing of pesticide [by bare hands (33%), by rod (11%) and by motor (56%)], wear PPE during mixing/loading/spraying [no sprayer use gloves, goggles, apron, cloth as face mask (22%), head protector/cap (39%), wear full-sleeved shirt (56%), boots (39%)], wet cloths during spraying (67%), personal habits during spraying such as smoking (25%), lunch between spraying operations (42%), take care of wind direction during spray (72%), bath at the end of work (78%), change clothes after spraying at end of work day (75%), pesticide contaminated clothes washed with family clothes (64%), knowledge of pesticides as toxic (78%), none of them has acquired training in integrated pest management programme and fate of empty packages [none buried or burned, discarded into the river/canal/field (63%), home use (19%), sold to scrap dealer (9%) and used for some other work (8%). Hazardous work practices observed during pesticide handling, diluting the pesticides, and spraying of pesticide are depicting in figure [4(I).1.1 to 4(I).1.5].
4(I).1.4 Self reported symptoms on health among pesticide sprayers and controls

Self reported morbidity profile of each system among controls and pesticide sprayers are shown in Table 4(I).1.4. Pesticide sprayers showed higher percentage of morbidity profile as compared to controls. Pesticide sprayers reported higher percentage of symptoms on health as compared to controls in systems viz., nervous (52), ocular (51), respiratory (47), cardiovascular (35), gastrointestinal (54), musculoskeletal (58), dermal (32), genito-urinary (5) and reproductive (4). The risk assessment of morbidity shows significantly higher odd ratio (OR) in sprayers for neurological (OR-9.62; 95% CI:4-21; P<0.001), ocular (OR-5.79; 95%CI:3-11; P<0.001), respiratory (OR-8.05; 95%CI:4-18, P<0.001), cardiovascular (OR-2.83; 95%CI:1-5; P<0.001), gastrointestinal (OR-4.14; 95%CI:2-7; P<0.001), musculoskeletal (OR-7.18; 95%CI:4-14; P<0.001), dermal (OR-5.47; 95%CI:2-13; P<0.001) symptoms [Table 4(I).1.4].

4(I).1.5 Self reported symptoms on health among knapsack and tractor-mounted sprayers

Self reported morbidity profile of each system among controls, tractor-mounted and knapsack sprayers are shown in Table 4(I).1.5. Sprayers showed higher percentage of morbidity profile as compared to controls. Tractor-mounted sprayers reported higher percentage of health symptoms as compared to knapsack sprayers and controls including neurological (69), ocular (63), respiratory (47), cardiovascular (39), gastrointestinal (62), musculoskeletal (62), dermal (36), genito-urinary (7) and reproductive (4). The risk assessment of morbidity shows significantly higher odd ratio (OR) in tractor-mounted sprayers as compared to controls in system viz., for neurological (OR-20.03; 95% CI:9-47; P<0.001), ocular (OR-9.65; 95%CI:5-20; P<0.001), respiratory (OR-7.98; 95%CI:4-18, P<0.001), cardiovascular (OR-5.17; 95%CI:2-12; P<0.001), gastrointestinal (OR-5.78; 95%CI:3-11; P<0.001), musculoskeletal (OR-8.57; 95%CI:4-18; P<0.001), dermal (OR-6.47; 95%CI:3-16; P<0.001) genito-urinary (OR-7.45; 95%CI:0.92-339; P<0.05) [Table 4(I).1.5].
Knapsack sprayers also showed higher percentage of symptoms on health as compared to controls including neurological (30), ocular (35), respiratory (48), cardiovascular (30), gastrointestinal (44), musculoskeletal (53), dermal (28), genito-urinary (3) and reproductive (4) symptoms. The risk assessment of morbidity showed significantly higher odd ratio (OR) in knapsack sprayers as compared to controls for neurological (OR-3.86; 95%CI:2-9; \(P<0.01\)), ocular (OR-3.05; 95%CI:1-7; \(P<0.01\)), respiratory (OR-5.52; 95%CI:3-13, \(P<0.001\)), cardiovascular (OR-3.47; 95%CI:1-8; \(P<0.01\)), gastrointestinal (OR-3.92; 95%CI:2-8; \(P<0.001\)), musculoskeletal (OR-5.80; 95%CI:3-12; \(P<0.001\)), dermal (OR-4.36; 95%CI:2-11; \(P<0.01\)) symptoms [Table 4(I).1.5].

4(I).1.6 Prevalence of self reported symptoms pertaining to nervous system among study subjects

Prevalence of self reported symptoms pertaining to nervous system among study subjects are shown in Table 4(I).1.6. Excessive salivation (\(P<0.001\)), excessive sweating (\(P<0.001\)), frequent severe headache (\(P<0.05\)), dizziness (\(P<0.01\)), tremor (\(P<0.05\)), headache (\(P<0.001\)), fatigue (\(P<0.01\)), severe irritability (\(P<0.05\)), convulsions (\(P<0.01\)), numbness (\(P<0.05\)), forgetfulness (\(P<0.05\)), change in taste (\(P<0.05\)) symptoms were found to be more among sprayers as compare to controls. Among sprayers, tractor-mounted sprayers have reported higher prevalence of headache (49%), excessive sweating (37%), excessive salivation (34%), fatigue (21%), dizziness (18%), numbness (17%), convulsion (15%), frequent severe headache (14%), forgetfulness (13%), severe irritability (13%), change in taste (10%), tremor (10%), fainting (7%), disorientation (2%). The knapsack sprayers reported headache (15%), excessive sweating (22%), excessive salivation (16%), fatigue (10%), dizziness (2%), convulsion (6%), frequent severe headache (1%), forgetfulness (6%), severe irritability (3%), change in taste (8%) and tremor (6%) [Table 4(I).1.6].

4(I).1.7 Pesticide related symptoms on health other than neurological among study sprayers and controls

Self reported health symptoms other than neurological among controls, tractor-mounted sprayers and knapsack sprayers are shown in Table 4(I).1.7. Blurred
vision \( (P<0.001) \), itching in eyes \( (P<0.001) \), dry cough \( (P<0.001) \), stiffness in joints and muscle-pain \( (P<0.001) \), bodyache \( (P<0.001) \), dermal itching \( (P<0.001) \), hyperacidity \( (P<0.001) \), abdominal pain \( (P<0.001) \), pain in eyes \( (P<0.01) \), nausea/vomiting \( (P<0.01) \), red swollen eyes \( (P<0.01) \), difficult in breathing \( (P<0.01) \), productive cough \( (P<0.01) \), dyspnoea \( (P<0.01) \), nose secretion \( (P<0.01) \), pain in chest \( (P<0.01) \), watering of eyes \( (P<0.05) \), refractive error-near vision \( (P<0.05) \), throat irritation \( (P<0.05) \) and burning sensation of skin \( (P<0.05) \) symptoms were found to be significant among sprayers as compare to controls. Among sprayers, tractor-mounted sprayers have reported higher prevalence of blurred vision (22%), itching in eyes (20%), dry cough (16%), bodyache (54%), dermal itching (28%), hyperacidity (28%), abdominal pain (28%), pain in eyes (18%), red swollen eyes (21%), difficult in breathing (15%), productive cough (17%), watering of eyes (16%), refractive error-near vision (21%) and burning sensation of skin (14%). The knapsack sprayers reported blurred vision (13%), itching in eyes (19%), dry cough (14%), Stiffness in joints and muscle-pain (19%), bodyache (48%), dermal itching (21%), hyperacidity (21%), abdominal pain (21%), pain in eyes (7%), nausea/vomiting (19%), red swollen eyes (8%), difficult in breathing (10%), productive cough (15%), dyspnoea (16%), nose secretion (14%), pain in chest (22%), lacrimation (10%), refractive error-near vision (5%), throat irritation (9%) and burning sensation of skin (8%) [Table 4(I).1.7].

4(I).2.1 Cholinesterase levels and its inhibition among pesticide sprayers

Pesticide sprayers showed a significant decline in cholinesterase (AChE and BChE) enzyme activity \( (P<0.001) \) as compared to controls [Table 4(I).2.1]. AChE level decline was 42% \( (P<0.001) \) and BChE activity decline was 49% for sprayers compared to controls \( (P<0.001; \text{Table } 4(I).2.1) \). AChE and BChE levels had significant depleted among tractor-mounted and knapsack sprayers compared to control \( (P<0.001, \text{Table } 4(I).2.2) \). The inhibition in AChE level was more pronounced in tractor-mounted sprayers than knapsack sprayers. Tractor-mounted sprayers had a AChE depletion of 51% whereas knapsack
sprayers had a decline of 26% compared to mean of controls [Table 4(I).2.2]. The inhibition in the BChE activity was more pronounced in knapsack sprayers than tractor-mounted sprayers. Knapsack sprayers had a decline of 53% whereas tractor-mounted showed a decline of 46% [Table 4(I).2.2].

Multiple regression model showed no significant association between cholinesterase levels and age, BMI, duration of exposure among study subjects [Table 4(I).2.3]. Personal habits like smoking, tobacco chewing, alcohol intake and dietary habits did not significantly affect the cholinesterase levels among study subjects [Table 4(I).2.4- 4(I).2.7].

4(I).3.1 Lung function and its inhibition among pesticide sprayers

Spirometric lung function studies in sprayers displayed decrement in lung function as compared to controls [Table 4(I).3.1]. The decline in FEV₁ level was 4% and 28% in PEFR level in sprayers compared to controls \(P<0.001;\) [Table 4(I).3.1]. Lower FEV₁ and PEFR levels was observed was among tractor-mounted and knapsack sprayers as compared to control [Table 4(I).3.2]. The decrement in the FEV₁ level was more pronounced in knapsack sprayers than tractor-mounted sprayers but statistically not significant. Knapsack sprayers had a FEV₁ decrement of 7% whereas tractor-mounted sprayers had a decrement of 1% compared to mean of control [Table 4(I).3.2]. Significant decrement in PEFR level was found in tractor-mounted sprayers and knapsack sprayers as compared to control \(P<0.001;\) [Table 4(I).3.2]. The decrement in the PEFR level was more pronounced in knapsack sprayers than tractor-mounted sprayers. Knapsack sprayers had a decline of 30% whereas tractor-mounted show a decline of 27% [Table 4(I).3.2].

Multi regression model showed significant negative association of lung function (FEV₁ and PEFR) levels with age \(P<0.001).\) PEFR also show significant positive association with BMI [Table 4(I).3.3]. Control subjects with smoking habit had significantly lower mean value of PEFR as compared to non smokers \(P<0.05;\) [Table 4(I).3.4]. Personal habits like smoking, tobacco chewing, alcohol intake and dietary habits did not significantly affect the lung functions among exposed subjects [Table 4(I).3.4 - 4(I).3.7].
4(I).4.1 Nerve conduction studies and its inhibition among pesticide sprayers

Pesticide sprayers showed significant decline in MNCV and SNCV as compared to controls [\(P<0.001\); Table 4(I).4.1]. Decline in MNCV was 36% and decline of SNCV was 31% among sprayers compared to controls [\(P<0.001\); Table 4(I).4.1]. Odd ratios (ORs) were significantly raised for slowing of MNCV (OR- 20.77; 95%CI:6-86) and SNCV [OR-7.47; 95% CI:2-32; Table 4(I).4.2].

Significant decrement in MNCV was found in tractor-mounted sprayers and knapsack sprayers as compared to control [\(P<0.001\); Table 4(I).4.3]. Tractor-mounted sprayers show a reduction in MNCV of 34 % whereas knapsack sprayers show 39% [\(P<0.001\), Table 4(I).4.3]. Significant decrement in SNCV was found in tractor-mounted sprayers and knapsack sprayers as compare to control [\(P<0.001\); Table 4(I).4.3], but the slowing in the SNCV was more pronounced in tractor-mounted sprayers than knapsack sprayers. Knapsack sprayers showed a decline of 29% in SNCV compared to 32% decrement in tractor-mounted sprayers [Table 4(I).4.3]. Knapsack sprayers showed higher odd ratios (OR) for slowing of MNCV (OR- 36.50; 95% CI:8-193) as compared to tractor-mounted sprayers [OR- 16.66; 95% CI:5-72; Table 4(I).4.4]. Tractor-mounted sprayers showed higher odd ratios (OR) for slowing of SNCV (OR- 7.65; 95%CI:2-34) as compared to knapsack sprayers [OR-7.02; 95% CI:1-39; Table 4(I).4.4].

Multiple regression model showed significant association of MNCV with age [\(P<0.05\); Table 4(I).4.5]. BMI and duration of exposure did not show any significant association with MNCV or SNCV [Table 4(I).4.5]. Personal habits like smoking, tobacco chewing, alcohol intake and dietary habits did not significantly affect the NCV among study subjects [Table 4(I).4.6-4(I).4.9].

4(I).5.1 Residual analysis

Mean values of OC pesticide residues (ppb) in blood of sprayers and control shown in Table 4(I).5.1. Alpha – HCH and total HCH were found significantly
higher in sprayers as compared to controls \([P<0.05; \text{Table 4(I).5.1}]\). Only one blood sample of sprayers showed op-DDT (1.69 ppb).

Pesticide residue monitoring data in air at Malihabad and Bakshi Ka Talab is shown in Table 4(I).5.2. Organochlorine isomers were detected in ambient air at study locations. No air concentration standards for pesticides have been set by regulatory bodies in India, Environmental protection Agency, USA and other agencies to compare the values.

SPM and RSPM at Malihabad and Bakshi Ka Talab mango plantations exceeds National Ambient Air Quality Standards (NAAQS) limit [Table 4(I).5.3]. Pesticide residue concentration detected in fruit (mango) samples was within maximum residual limit (MRL) prescribed by Food and Agriculture Organization (FAO). Hand pump water samples collected from the Malihabad and Bakshi Ka Talab were monitored for OC and OP pesticides. All collected water samples showed no detection for pesticides. OP urinary metabolites (urinary dialkylphosphates) were not detected in urine samples collected from sprayers and pesticide retail shopkeepers. Soil samples collected from mango plantations showed \(\alpha\)-endosulfan and gamma-HCH.