HEALTH STATUS AMONG FARM WORKERS IN THE WESTERN CAPE — COLLATERAL EVIDENCE FROM A STUDY OF OCCUPATIONAL HAZARDS

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Motivation. Farm workers are a marginalised occupational group whose poor living and working conditions may place them at increased risk for occupational and non-occupational morbidity and mortality. Research into the health status of farm workers has been neglected in the past.

Aims and objectives. As part of an investigation into the neurological and neurobehavioural effects of exposure to organophosphate insecticides, this study describes the demographics, life histories, risk factors for chronic illness and selected indicators of general health status among a group of farm workers in the Western Cape.

Study design. Cross-sectional study conducted in the deciduous fruit farming industry in 1993.

Subjects. 164 pesticide applicators and 83 non-spraying controls (all men) from 73 farms, frequency matched for age and education.

Measurements. A structured questionnaire, venous blood sample for serum and erythrocyte cholinesterase, albumin, gamma glutamyl transferase and haemoglobin assessment, height and weight measurement.

Results. Most farm workers were children of farm workers and had lived and worked on farms for most of their lives. The study found substantial levels of illiteracy (21 - 44%, depending on the definition) and innumeracy (4%) and evidence of a significant morbidity burden: high levels of alcohol intake and ongoing reported application of the 'dop' system, high levels of head injury (70% of subjects) and evidence of substantial adult undernutrition. Protective equipment was relatively well distributed and used, although certain work activities (such as acting as a human marker) continue to pose substantial exposure hazards. There were no differences in respect of cholinesterase levels between spray applicators and controls, although past poisoning was reported by 9% of subjects.

Conclusion. Farm workers appear to be a closed community with a high disease burden. Their health needs pose substantial challenges to the public health authorities.

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Agricultural work has long been recognised as one of the occupations most hazardous to human health.[1-3] Occupational risk factors include increased morbidity and mortality from accidents, zoonoses, climatic exposure, respiratory disease caused by dust and organic matter, chemical toxicity and ergonomic hazards. In South Africa, however, farm work has also been characterised historically by extremely poor living conditions,[4,5] including low wages, inadequate housing, poor sanitation, inadequate water supplies and paternalistic and coercive labour relations.[6-9] While some of these conditions are improving as agriculture becomes increasingly capitalised,[9,10] the historical legacy of inequality is substantial. These factors will have a direct impact on the health of farm workers and their families and lower their resistance to occupational risk factors present in their working environment.

For example, high rates of alcohol consumption have been reported among farm workers.[5,6] Excessive alcohol consumption may be expected to render subjects susceptible to a wide range of potential occupational and non-occupational health stressors. High levels of interpersonal violence have been reported as the major cause of high rates of admission to rural hospitals in the Western Cape for trauma, much of this coupled with alcohol abuse.[11] Given the low educational levels among farm workers,[12,13] the lack of amenities and social services[7] and the particularly closed nature of farming communities,[9,14] many have argued that farm workers are locked into a cycle of poverty and dependence[4,5,7,9] that will have profound adverse effects on their health and the health of their families.

Data examining this contention are presented in this paper, which reports on the health status of 247 fruit farm workers in the Western Cape. These workers were studied as part of an investigation into the potential adverse effects of organophosphates on neurological and neuropsychological function. The results of the analysis of the effects of pesticide exposure have been described in detail elsewhere.[15-17] This paper concentrates on the descriptive findings relating to the demographics, life histories, risk factors for chronic illness and disability and health status indicators recorded as potential confounders in the above study.

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METHODS

The study was performed as a cross-sectional analytic survey over the period January to March 1993 on farms in the rural Western Cape during peak agrichemical spraying season. This paper, however, reports only the descriptive data arising from the study. The deciduous fruit industry was selected for the study because of its high agrichemical use[18] and its central importance as an employer in the region.[19] All farms belonging to either of three local co-operatives farming deciduous fruit in the Ceres/Kouebokkeveld region were included in the farm sample (a total of 113 farms). All spraymen on the selected farm, as well as 1 non-spraying control (group matched in respect of age and educational status; 1 control for every 2 spraymen) were included.

Because of concerns about the untested cross-cultural validity of most neuropsychological tests, study subjects were restricted to Afrikaans-speaking, non-migrant permanent male farm workers, previously classified as coloured in terms of apartheid race categorisation*. Workers with any clinical evidence of vitamin deficiency or encephalopathy of known origin, a history of long-term administration of psychotropic medication or previous injury resulting in deformity and/or other abnormality of the lower limbs interfering with peripheral sensation were excluded from the study.

Data on a wide range of risk factors for chronic illness and disability were collected, including past medical history, history of head injury, use of tobacco and dagga, history of pesticide poisoning and practices related to potential pesticide exposures. Particular attention was paid to documenting the working and life histories of each subject so as to estimate cumulative lifetime exposures and to evaluate factors in the history potentially related to neuropsychological competency (such as visual acuity, numeracy and experience with video games).

Alcohol consumption was assessed in detail using a variety of methods. Subjects were asked to report usual drinking patterns, recent drinking patterns, what they regarded as normal and abnormal drinking as well as lifetime consumption. Serum gamma glutamyl transferase (GGT) was measured as a nonspecific marker of liver damage that may be attributable to alcoholic liver insult. In addition, two questionnaire screening tests were used. The CAGE questionnaire[20] is an acronym for 4 questions (Cutting down, Angered by others' criticism, Guilty, Eye-opener (*'regmaker'*)); based on pilot study findings, the Michigan Alcoholism Screening Test (MAST) was abbreviated to a set of 12 questions scored to a maximum of 27. The original MAST questionnaire[21] has a maximum score of 50 points. Criteria for identifying a subject as potentially alcoholic were a score of 2 or more on the CAGE or 5 or more on the MAST. Subjects were also asked whether they were given alcohol on the farms where they worked as part of a 'dop' system. There was no independent verification of self-reported data, although analyses were performed to compare responses to this question by different workers from the same farms.

Scores were derived for knowledge of, attitude toward and practices with regard to pesticides and safety, and the levels of and reasons for usage in current jobs were recorded. Knowledge scores were based on post-coding of open-ended questions on the dangers of pesticides, and on methods of prevention of poisoning (maximum 3) and attitude scores on the sum of attitude items which the subjects identified as very important on an ordinal scale (maximum 4; good or excellent scores at least 3 out of 4). Potential domestic exposure to agrichemicals among study subjects was identified from the presence of another household member involved in spray activities, the re-use of pesticide containers or the use of farm chemicals at home. Serum and erythrocyte cholinesterase levels were estimated by the chemical pathology laboratory at Groote Schuur Hospital using standard methods. The former was measured with butyrylthiocholine as substrate[22] and the latter with acetylthiocholine as substrate.[23] Excellent precision in the laboratory estimates for both enzymes based on blinded duplicate samples has been reported elsewhere.[24]

Univariate descriptive statistics are presented in this paper. Limited bivariate analyses comparing demographics and cholinesterase levels of sprayers with those of non-sprayers, and knowledge, attitude and practices (KAPs) by education and age stratified by spraying status, were carried out using appropriate parametric comparisons of means (*t*-tests) or non-parametric comparisons of medians (Wilcoxon).

The study was conducted in accordance with the Declaration of Helsinki of the 25th World Medical Assembly[25] and the guidelines established by the South African Medical Research Council.[26] Consent procedures took place in Afrikaans, the first language of the subjects. Full confidentiality was observed for the subjects, and only when appropriate (for example, if blood chemical values were found to be low) were the usual medical attendants of the workers informed of the need for retesting, or for withdrawal from any further pesticide exposure. Follow-up of affected workers was provided through tertiary hospital facilities.

RESULTS

Two hundred and forty-seven subjects, including 164 spray operators and 83 controls from 73 farms, participated in the study. This represented 68% of eligible subjects and 65% of eligible farms. Seventy-seven per cent of the participant farms were greater than 25 hectares in size. In contrast, of the 39 farms that did not participate, most (64%) were smaller than 25 hectares in size ($\chi^2 = 18.07$; $P < 0.0001$).

*The term 'coloured' is used here to reflect the Afrikaans-speaking working-class population of the Western Cape who were classified as a separate 'racial' group under apartheid legislation and for whom cultural and ethnic identities continue to be constructed, reconstructed and debated in South Africa today. The use of the term in no way constitutes legitimation of the apartheid terminology but rather a reflection of the social construction of identity in a race-cleaved society.

The mean age of the subjects was 36.9 years (SD 10.0) and mean educational level achieved was 5.1 years (SD 2.9), translating to an average of a Standard 3 education in the group. Twenty-one per cent of subjects were unable to sign their names when giving consent for the study, suggesting substantial illiteracy. Using a modification of UNESCO criteria (fewer than 6 years of completed schooling[27]), approximately 44% of subjects would be considered illiterate. Non-numeracy was another indicator of low education, and 9 subjects (3.7%) were found to be innumerate.

The subjects' parents' occupations are listed in Table I. The most common parental employment was as farm worker and very few subjects' parents had ever held skilled or supervisory jobs.

Table I. Parental occupation of deciduous fruit farm workers (N = 241)

	Father	Mother
Farm worker	191 (79.5%)	94 (39.0%)
Supervisory/semi-skilled work on a farm	10 (4.1%)	1 (0.4%)
Labourer in another industry	36 (14.9%)	11 (4.6%)
Domestic service	-	35 (14.5%)
Housewife	-	93 (38.6%)
Other	4 (1.7%)	7 (2.9%)
Total	241	241

The majority of subjects reported having spent most of their lives resident on a farm. On average, workers spent 32.3 years (SD 11.1; range 1 - 63) living on a farm and most of this time (mean 27.4 years) had been spent on deciduous fruit farms. Over three-quarters of subjects spent more than half their childhood years growing up on a deciduous fruit farm. Workers reported an average of 2.3 previous jobs per subject, almost exclusively in agriculture (88.2%).

High prevalences of smoking and alcohol use are reflected in Table II. Eighty-one per cent of subjects reported being current smokers and the average cumulative lifetime consumption (including all forms of tobacco) was 12.0 (SD 12.9) pack-year equivalents. Fewer than 5% reported never having used alcohol. These figures are likely to be underestimates, particularly with regard to volunteering alcohol and dagga usage, and alcohol data are complemented by other measures in tables that follow.

Table II. Percentage prevalence of alcohol, tobacco and dagga use among deciduous fruit farm workers

	Alcohol use (N = 247)	Smoking of tobacco (N = 247)	Dagga use (N = 245)
Current	67.6	81.0	3.7
Past	27.9	10.9	24.1
Never	4.5	8.1	72.2

Almost one-fifth (19.4%) of workers interviewed reported current use of the 'dop' system, and 47.8% of workers had lived on at least one farm in the past where the 'dop' system had been in use. When excluding farms where workers on the same farm gave contradictory reports on the use of the 'dop' system, the prevalence of current use was 6.1% of workers on 11.0% of farms.

Various quantitative measures of alcohol use are summarised in Table III. Using the clinical range quoted by the Groote Schuur Hospital chemical pathology laboratory (0 - 40 U/l), 10.5% of the sample exhibited elevated levels of GGT. On the basis of the CAGE questionnaire, 87% of the sample would be defined as potentially alcoholic, while the equivalent proportion for the MAST questionnaire was 65%.

Table III. Alcohol usage among fruit farm workers

Alcohol measure	No.	Mean	SD	Range
Cumulative lifetime kilograms of alcohol	247	216.8	204.0	0 - 1 000.5
Grams alcohol consumed on a usual weekend	236	260.0	190.2	1 - 940
Grams alcohol consumed in preceding week	236	241.5	192.4	0 - 952
Grams alcohol consumed at a sitting	236	135.6	146.6	2 - 810
Grams alcohol regarded as excessive by subject	216	165.6	119.3	10 - 564
CAGE score (max. 4)	247	2.8	1.3	0 - 4
MAST score (max. 27)	247	7.5	5.9	0 - 27
Serum GGT (U/l)	247	22.8	19.0	5 - 124

A past history of relevant medical disorders was found in a minority of subjects. However, previous brain injuries were common in the sample, and there was a history of 303 brain injuries causing loss of consciousness among 169 subjects (69.8%). Eighty-two subjects (33.9%) experienced two or more episodes of loss of consciousness as a result of a brain injury, and in 79 subjects (32.6%) the loss of consciousness was reported as lasting an hour or longer (Table IV).

The commonest types of brain injury were either from a blunt object (39% of all subjects) or from a penetrating wound (16% of all subjects). These were about twice to three times as common as motor vehicle accidents or sport injuries, and this probably reflects high levels of interpersonal violence experienced by farm workers. Other types of brain injury included near-drownings, asphyxiation by fire smoke and sports injuries.

Past occupational poisoning with pesticides was reported by 22 subjects (8.9%) of whom 15 (6.1%) reported time off work or having consulted a doctor. In none of these cases was the chemical responsible identified. The risk of sprayers reporting a previous poisoning episode was more than twice as high among workers who had previously worked on farms

Table IV. Medical, psychiatric and neurological findings on interview and examination

	Percentage	Total No.
Past history* of:		
Epilepsy	2.1	240
Diabetes	0.8	240
Psychiatric disorder	0.4	240
Past history of brain injury (BI):		
Any BI	70.1	242
BI causing loss of consciousness	69.8	242
BI causing loss of consciousness for longer than 1 hour	32.6	242
Currently on medication	11.2	242
Unable to recognise numbers	3.7	242
Visual acuity difficulty	4.9	242
Past experience of:		
Watching video games	75.6	221
Playing video games	18.6	221

* Self-reported morbidity.

practising the 'dop' system than among sprayers who had never lived on such farms (OR = 2.80; 95% CI 1.01 - 7.82). Controlling for age and current exposure status in a multiple logistic regression model did not change the point estimate or the confidence interval for this odds ratio.

Forty-eight subjects (19%) reported having been used as human markers for aerial spraying in their lifetimes, with 24 subjects (9.7%) reporting exposures as a human marker in their current job. Other job activities reported among the group with potential exposure to pesticides included operating a mist blower to apply pesticides (N = 172), spraying pesticides with a handgun (N = 112) or backpack (N = 68), animal dipping (N = 97), and gardening activities on the farm property (N = 60).

Among applicators, 18 (21.7%) reported that they currently used no personal protective equipment (PPE) while an identical percentage reported using all five possible forms of PPE. The reason for reported usage of gloves was usually for spraying (90%) or mixing (9%) of pesticides, and that for reported usage of masks was similar. Overalls and plastic coats were widely used for both spraying and general farm work. The type of mask most frequently used was a helmeted mask (52%), sometimes with oxygen supplied (10%). Surgical-type masks (14%) or facial shields (17%), which give inadequate protection, were less widely used. Among the currently exposed group, education appeared to be related to reported usage of protective equipment. Applicators with 5 or more years of education were more likely to report use of all five forms of PPE (OR = 1.67; 95% CI 0.92 - 3.04).

Knowledge of the dangers of pesticides and methods of prevention were scored as poor in only 3 and 8 subjects, respectively, and 66% of all subjects rated either good (3 out of 4) or excellent (4 out of 4) on attitudinal scores.

Forty-four subjects reported taking agrichemicals home for gardening; organophosphates (10) and dithiocarbamates (8) were the chemicals most usually reported. Among workers involved in spray activities, the majority (76%) reported that after work they removed their protective overalls at home. Overalls were usually (70%) washed only once a week, and no plans were made for washing the overall separately from other clothing. The majority of farm workers (90%) reported access to running water, the source of which was a covered borehole, i.e. groundwater.

The results of blood chemical measurement among subjects are summarised in Table V. Levels below the clinical 'normal range' for haemoglobin (13.5 - 17.0 g/dl) and albumin (35 - 50 g/dl) were found in 16.6% and 2.4% of subjects, respectively. The mean height of the subjects was 165 cm (SD 5.8).

Table V. Blood chemical measurements among deciduous fruit farm workers

Measurement	No.	Mean	SD	Range
Plasma cholinesterase	247	6 357	1 232	3 002 - 9 398
Erythrocyte cholinesterase	247	5 271	705	2 730 - 7 090
Haemoglobin	247	14.76	1.33	11.0 - 17.9
Haematocrit	247	47.1	3.5	35.0 - 58.0
Serum albumin	247	44.9	3.1	32.0 - 54.0
Serum GGT	247	22.8	19.0	5.0 - 124.0
Standardised erythrocyte cholinesterase*	247	35.8	4.5	17.0 - 49.3

* Standardised erythrocyte cholinesterase = erythrocyte cholinesterase/haemoglobin.

Mean plasma cholinesterase levels for sprayers (6 416 U/l; SD 1 251 U/l) and non-sprayers (6 240 U/l; SD 1 194 U/l) were not significantly different, neither were standardised erythrocyte cholinesterase levels (mean 35.5 U/g haemoglobin, SD 4.0; and mean 36.2 U/g haemoglobin, SD 5.3, respectively). Five subjects (2.0%) had plasma cholinesterase levels below the laboratory reference levels (4 000 - 8 000 U/l); 2 of these were not actively involved in current agrichemical application. Similarly, 4 subjects had erythrocyte cholinesterase levels below the equivalent laboratory reference range (4 000 - 8 500 U/l); 2 of these were not currently applying agrichemicals. None of those with low plasma levels had concurrent low erythrocyte cholinesterase levels. One subject with a particularly low erythrocyte cholinesterase level (more than 3 SD below the mean) had a plasma cholinesterase level well within the normal range, and exhibited no evidence of clinical cholinergic intoxication or history of previous poisoning.

DISCUSSION

Data from this study appear to suggest a considerable burden of morbidity and a high prevalence of risk factors for chronic illness and disability among farm workers in the region. Alcohol abuse, head injury and chronic undernutrition stand

out as the most striking of the findings, although a wide range of adverse health states were identified. Median schooling of 6 years (Standard 4) reflects the low educational levels among farm workers in South Africa[28] and is a finding consistent with previous studies in the Western Cape.[12] It is remarkable that 7 years from the millennium, 1 in 5 farm workers remains unable to write; this level of illiteracy poses a major challenge to both the public health services and the educational system in the province. However, it does appear that the heaviest burden lies with older workers, suggesting a gradual improvement in educational services over time.

Given that participant farms tended to be the larger establishments, there may be some bias in generalising the results to all farms in the region. However, there is good evidence that conditions on larger farms are better than on smaller farms[7,10] and our results would therefore underestimate true morbidity and risk factors among farm workers in the Western Cape. This tendency would be further strengthened by the sampling strategy that deliberately excluded workers with clinical evidence of vitamin deficiency or a history of encephalopathy.

A striking feature to emerge from the life history data was the seemingly closed nature of farm life — most subjects had spent the majority of their lives resident on a farm, usually a deciduous fruit farm, and most subjects' parents had been employed as farm workers, with very few ever having held skilled or supervisory jobs. This insularity has major implications for risk reduction and preventive strategies applicable for farm workers, particularly for health promotion strategies that seek to change behaviours and for the implementation of community participation in a primary health care framework. Other studies[7,9,10,14,29] have shown how this cycle of confinement to the farm environment is integral to the maintenance of the social control typically exerted over farm workers in the agricultural workplace.

Data in this study confirm the patterns of high alcohol intake reported among farm workers,[6] both in quantitative measures and in questionnaire inventories, where in excess of 68% of workers would be identified as alcoholic. While the application of screening tests developed in a hospital setting in a developed country for the detection of alcoholism may be subject to cross-cultural biases in other settings, the other markers of alcohol consumption appear to confirm consistent and excessive consumption. For example, over 10% of workers had biochemical evidence of liver injury and farm workers' consumption was far higher than reported in other South African[30-32] and southern African[33] studies. The amount of alcohol reported to have been consumed in the past week was more than double that of rural white residents[30] and urban blacks of a similar age range[32] in the Western Cape. Expressed in distributional terms, over 80% of farm workers in this study reported consuming more alcohol than the highest average intake (110 g/week) reported for any of the age strata in either of the two studies above.

The contribution of the 'dop' system (whereby workers receive part of their remuneration in alcohol) to the legacy of alcohol abuse among farm workers requires further study. It is of concern that almost 20% of workers in this study reported currently receiving alcohol in their present employment, all of which took place on farms not producing wine or grapes. Even when adjusting most conservatively for possible over-reporting, over 6% of workers on 10% of farms reported ongoing use, which reinforces public calls for stronger action to abolish the practice on farms in the Western Cape.[33]

High rates of alcohol consumption will place additional burdens on already under-resouced rural health services. Alcohol-related trauma is already a major problem at rural hospitals[11] and domestic violence linked to alcohol abuse is an important issue for rural development projects.[34] The interaction between alcohol exposure and pesticide safety is also relevant. Workers who reported ever having been supplied with alcohol on farms were at higher risk of pesticide poisoning, even when age and current spraying activity at work were controlled for. Another illustration of the vulnerability to pesticides associated with the 'dop' system is a recent notification that 24 workers were involved in a mass poisoning when their 'dop' was contaminated by a highly toxic insecticide.[35] In a setting of high and often poorly controlled agrichemical usage, regular and systematic ingestion of alcohol may make farm workers vulnerable to homicidal or accidental injury on a large scale.

Smoking rates, unsurprisingly, are relatively high and consistent with findings in urban areas. The high rates predict a considerable burden of tobacco-related disease in future years. In addition, a number of parameters pointed to a significant problem of adult undernutrition. Rates of anaemia (16.8%) and hypo-albuminaemia (2.4%) were high and the mean height of the subjects (165 cm) was substantially lower than norms for men in the USA, and significantly lower than the mean height of a random sample of adult coloured men in the Cape Peninsula in 1990 (mean difference = 2.5 cm; $P < 0.0001$).[36] These biochemical and anthropometric findings may reflect the prevalence of chronic undernutrition in this population as well as the presence of other chronic diseases. Similar findings regarding chronic undernutrition have been made among other farm worker populations in the subcontinent.[37]

Of note was that the markers of exposure to organophosphate insecticides were not significantly reduced in workers currently employed in spraying activity. This is partly due to the design of the study, which was aimed primarily at evaluating the health effects associated with long-term exposure, and the sampling constraints imposed by this particular study question. Nonetheless, given the relatively high current use of protective equipment (at least 75% of applicators reported using some PPE and 22% used all five forms of PPE) and the seemingly good knowledge of and

attitude toward pesticides compared with other studies,[7,38,39] this may reflect a high level of hygiene practices in one of the more modern agricultural sectors in the country. However, studies able to follow workers over a season would be the optimal design to address such a question, and careful attention to avoidance of reporting bias may be required.

Rates of previous poisoning with pesticides (about 9%) indicate that pesticides have been an important health risk for workers. Moreover, certain work practices are clearly in need of reform. For example, almost 10% of workers reported being asked to act as a human marker for aerial spraying and 19% had performed this task at some point. Such exposures are entirely avoidable and are illegal in many developed countries.

CONCLUSION

Farm workers have inherited a considerable burden of morbidity as a result of the historical legacy of poor living and working conditions in the agricultural sector. Alcohol abuse, the inheritance of the 'dop' system, high levels of interpersonal violence and injury and evidence of chronic adult malnutrition are among some of the key public health issues identified. Research into the health status and health needs of farm workers has been neglected in the past, reinforcing their ongoing marginalisation in the organisation of social services. The health services face complex challenges if they are to address the needs of farm workers, particularly if district health services are to operationalise the primary health care approach in rural farming areas of South Africa.

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