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Effect of Sewage Pollution on the Health Status of Sewage Farm Workers

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Growing population and industrialization coupled with the introduction of modern intensive agricultural techniques involving irrigation are causing increasingly heavy demands on water resources. The reuse of municipal and industrial waste water has become an attractive option for increasing water reserves in such areas (shuval 1977). Reuse of waste for agricultural purposes may be particularly attractive because it supplies rich organic content, part or even all of the nitrogen required and essential nutrients (Shuman 1988). Moreover now a days the land disposal of sewage waste water is being considered as a cost effective disposal with minimal environmental impact (Visesman and Hammer 1985) and also as an efficient measure of abatment of pollution of streams and rivers.

However, the reuse of manicipal and industrial waste waters in farming has disadvantages. The sewage water carries a potentially dangerous load of heavy metals, chemical contaminants, parasites and microbial pathogens (Petruzzelli 1989). So the major problem associated with waste water reuse in agriculture is the risk of communicable diseases and infection (Mahajan 1987) and hence the workers and community in such polluted areas may have some occupational risks (Viswanathan 1985). The sewage contaminants may have an adverse impact on hematological and immunological parameters of the sewage workers. This had made many investigators to focus their attention on the immunotoxic effect of these environmental pollutants on humans and on experimental animals (Sheehan 1984). Therefore in the present study an attempt has been made to evaluate the effect of sewage pollution on occupational health of sewage farm workers.

MATERIALS AND METHODS

Madurai city is the second, largest and most densely populated city of Tamil Nadu (9'55' N 7'07 '02' E). This city is only partially sewered, and more than 70% of its area lack sewage facilities. The domestic sewage and Industrial effluents are collected from Madurai-South at eight points of the city. From these subpumping stations, sewage effluent is sent to Sandaipettai main pumping station. Finally from this point, the waste water is pumped to Avaniapuram sewage farm (ASF) through pipe lines.

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The Avaniapuram sewage farm (ASF) is located 10 km away from the city, situated on the way to Madurai Airport. The available records at the Madurai Corporation mention that this farm was started in the year 1910 by Britishers initially with 173 acres and was further extended to 385 acres at a later stage. At present, the farm is being managed by Madurai Corporation. 185 acres is used for cultivation of fodder grasses and 32 acres for raising greens and vegetables, both irrigated with sewage water.

The ASF receives approximately 2 million gallons of sewage water everyday from Madurai City. The sewage effluent collected at this farm is regularly subjected to physical separation of liquid sewage and sewage sludge. There is no chemical or disinfectant treatment given at any point of collection, pumping and irrigation of sewage effluent. At present, there are approximately 42 male workers are engaged in the farming work, of these, 32 workers are directly exposed to the sewage effluent.

The following were the 'Inclusion Criteria' adapted in selecting the sewage farm workers for investigation.a) those who were directly come in contact with the sewage effluent and sewage sludges. b) those who were in employment for five consecutive years and above and c) male workers in the age group of 20 to 55 years. Similarly, the 'Exclusion Criteria' exercised was on the following lines: i) those who were recently employed were not included and ii) those who were chronically suffering from any major illness such as, severe anemia and tuberculosis were excluded. These sewage farm workers were compared with the control group. Age - Matched and sex - matched healthy subjects who were living in similar socio-economic background belonging to the different parts of the city served as 'Normal Controls'.

To study the health status of farm workers, the following parameters were investigated in both experimental and control groups. i) Total and Differential leucocyte counts (TLC & DLC), ii) Blood hemoglobin levels (Hb), iii) Serum total protein, Albumin, Globulin, Albumin/Globulin ratio and iv) Serum Immunoglobulin levels.

Venous blood (10ml) was drawn from the antecubital vein by means of sterile disposable syringe after surface sterilization of the area with ethanol. To avoid cross contamination, separate syringes and needles were used for every prick. To carry out total and differential leucocyte count and to estimate hemoglobin content, 3ml of blood was collected in sterile tube containing EDTA (Ethylene Diamine Tetra Acetic Acid), a powerful anti-coagulant. similarly, 7ml of blood was delivered into another tube containing no coagulant, kept for serum separation (Dacie and Lewis 1975).

Blood samples thus collected without coagulant were immediately transported to the laboratory within an hour or two. When the blood has firmly clotted, the samples were then stored in refrigerator overnight at 4° C. Serum was then separated on the following day as

per the method described by Dacie and Lewis (1975) and stored in storage vials at -20° C till further analysis.

The freshly drawn EDTA added blood samples from both control and experimental subjects were brought to the laboratory within an hour after bleeding. Using a Thoma-type WBC pipette and an Improved Neubauer Hemocytometer, the total leucocyte count (TLC) was made as outlined by Samuvel (1986). The differential leucocyte count was made following the standard protocol adopted in most of the clinical laboratories (Dacie and Lewis 1975). Estimation of the blood hemoglobin (Hb) of both control and experimental subjects was done using Sahli's hemoglobinometer as outlined by Dacie and Lewis (1975). Total proteins and albumins in the serum were estimated **in vitro** by modified Biuret and Dumas method by using a diagnostic reagent kit supplied by M/s Span diagnosis Ltd., Surat, India. Single Radial Immunodiffusion (SRID) technique was employed to estimate the serum immunoglobulins IgG, IgA and IgM levels in the serum samples according to Hudson and Kay (1989). For this, ready to use solugen plates supplied by M/s Immunodiagnostics Ltd., New Delhi were used with appropriate reference standards.

RESULTS AND DISCUSSION

The results presented in Table 1. compare the total leucocyte count between control and workers group. The values obtained for controls fall within the reported Indian normal range (Braunwald et al. 1987). Contrary to the expectation of leucocytosis among workers group, there is only a marginal increase of TLC (10%) over control subjects. However, this difference was found to be satistically significant at $P < 0.05$.

Table 1. Total leucocyte count (TLC) among healthy subjects and sewage farm workers (MEAN ± SE)

Group	Number of Subjects	Leucocytes/mm^3	Significance
Controls	20	8537.50±183.52	NS
Experimental	20	9402.50±106.09	$P < 0.001$
% Change		10.1%	

NS = Not statistically significant.

There could be many reasons for this closer to normal response. One reasonable argument could be physiological adaptation of these workers to the external stimuli. The other reason could be that there was less number of pathogens crossed the intestinal barrier which did not result in perturbances in the WBC count. Chronic

Table 2. Differential Leucocyte Count (DLC) and Hemoglobin among Normal healthy control and Sewage farm workers (MEAN ± SE)

Leucocyte	Control n=20	Experimental n=20	Significance
Neutrophils %	56.55±0.90	58.30±1.93	NS
Eosinophils %	2.40±0.29	4.20±0.89	P <0.05
Lymphocytes %	29.40±1.12	32.50±1.44	P <0.1
Monocytes %	4.00±0.39	5.00±0.58	P <0.1
Basophils %	ND	ND	
Hemogloblin gm%	15.04±0.15	13.04±0.73	P <0.01

NS - Not statistically significant
ND - Not detected

infectious state such as pulmonary tuberculosis would result in leucocytosis in the affected individual (Dale 1980).

Similarly, results obtained for differential leucocyte count did not show any statistically significant deviation in the experimental group (Table 2). However, if the available data is analysed at the individual level, one can note an interesting observation with eosinophil count. As compared to the average of 2.4% in control group and 4.2% in worker group, two farm workers exhibited unusally high eosinophil count (15%). This might be in part, due to the chronic respiratory infection or hookworm infestation which is a common occurence in Madurai due to poor environmental hygiene and sanitary conditions (Anthoniammal 1983).

Table 3. Total Serum Proteins, Albumins, Globulins and A/G Ratio among control and workers (MEAN ± SE)

Group n=20	Total Proteins g%	Alubmin g%	Globulin g%	A/G ratio g%
Control	7.725± 0.294	4.456± 0.271	3.269± 0.321	1.684± 0.265
Experimental	9.100± 0.456	5.274± 0.266	3.825± 0.411	1.838± 0.277
% Change	17.8%	18.3%	17.0%	9.1%
Significance	P <0.01	P <0.002	NS	NS

NS - Not statistically significant.

There is now abundant evidence to indicate that hookworm and other parasitic infestation could cause hookworm anemia in few individuals (Park and Park 1989). Blood hemoglobin levels were estimated in the present study to check the prevalence of hookworm anemia and iron deficiency in both control and experimental groups. Excepting two workers who exhibited a very low Hb content (4gm%), all others presented 'Closer to normal' picture (Table 2). However, an earlier study conducted by Anthoniammal (1983) demonstrated a very high anemic condition (73%) in and around Avaniapuram sewage farm coupled with 39% of hookworm infestation. Disparity in these two observations could be attributed to several variables including subject selection, age, sex, nutritional status of the subject and the methodology followed in collection and examination. According to Holness (1989), the exposure to selenium reduced hemoglobin level and increased anemia among copper refinery workers. But our study did not show any direct metal exposure of farm workers.

Table 4. Serum Immunoglobulin levels among Normal healthy controls and Sewage farm workers (MEAN ± SE)

Group	Number of subjects	IgG mg%	IgA mg%	IgM mg%
Control	30	1063.04± 82.75	109.20± 4.33	102.00± 4.39
Experi-mental	20	1678.50± 75.33	174.20± 11.94	172.35± 22.04
%Change		57.9%	59.5%	68.9%
Significance		$P<0.001$	$P<0.001$	$P<0.005$

Total serum proteins albumin, globulin, and A/G ratio were estimated among control and experimental group and the results are presented in Table 3. As compared to control values, there was 17.8% and 18.3% increase in total protein and albumin levels respectively in the experimental group. However the differences obtained for globulin levels and A/G ratio were not satistically significant. It is reported in the literature that reduction in total serum protein is associated with malnutrition, severe infection and diseased state (Delvin 1986). In the present study, there is an elevation of serum protein and albumin levels which could be attributed atleast in part to the adaptive response to external stress.

In an attempt to evaluate the immunological status of the farm workers, serum Immunoglobulin levels - IgG, IgA and IgM were estimated and the results are presented in Table 4. As compared to control group, workers group exhibited 57% increase in IgG which is statistically significant (Table 4). Serum IgG level was also found elevated in disease conditions such as, Monoclonal gammopathies, Rheumatoid arthritis, Infectious hepatitis, Infectious mononucleosis, Tuberculosis, Leprosy and in parasitic infections (Druty and Graybill

1984). Further, a variety of bacterial products, some viruses or virus components, parasites and other substances may act as polyclonal B-Lymphocyte activators resulting in elevated IgG levels.

Increased IgG levels in farm workers observed in the present study could be attributed to the adaptive humoral immune reaction against a complex set of antigens (Durty and Mills 1984). Also this observation is in agreement with the parasitic infection demonstrated in fecal specimens of the workers.

Similar to IgG, serum IgA levels were also found to be elevated in almost all the workers (Table 4). When the data was subjected to student 't' test it was found to be statistically significant. The reason for the marked increase in IgA could be mainly due to the chronic exposure to an array of complex set of bacterial products, viruses, parasites and their secretary components through oral route. Secretary IgA and serum IgA are produced in gut associated lymphoiditis and in the invasion of pathogens.

Serum IgM levels were also found to be significantly elevated as that of IgA and IgM (Table 4). This class of immunoglobulin is produced in response to primary antibody response to all the antigens. Elevated levels of IgM in workers group appears to be an important observation, which may be suggestive of the activation of IgM clones of B cells by bacterial lipopolysaachrides and clonal activation of CD5+B cells produced in the gut associated lymphoid tissue. This might mean an immunological defect in the regulatory control of B cell activation resulting in excess IgM class antibodies. Further, this might also imply that these workers group belonging to 'High risk groups' who could develop autoimmune disorders on chronic exposure to pathogenic micro organisms (Theofilopoulos, 1984).

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