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Prevalence of respiratory morbidity among children working in filature units of the sericulture industry and the effects on general health of the children.

Dr. R. R. Patil*, M.Sc (Epid), Research Assistant
Dr. S. Lewin, MD DNB, Associate Professor
Dr. S.D. Subba Rao, DCh DNB, Professor and Head
Dr. Om Prakash, MD, Consultant Physician
Dr. Peter Prashanth DCh, Consultant Paediatrician
Dr. Chitra Dinakar, DCh DNB, Lecturer
Dr. C.M. Francis*, MD, Advisor
Dr. Thelma Narayan*, MD, Advisor

Concept, Design (Drs. RP, SL, SDSR), Acquisition of data (Drs. RP, PP), Analysis, Interpretation (Drs. RP, SL, SDSR, CD), Drafting (Drs. RP, SL, CD), Final Approval (Drs. RP, SL, SDSR)

* Community Health Cell
367, Srinivasa Nilaya, Ist Main, Ist Block, Jakkasandra, Bangalore 560 034
Karnataka, India
And

Department of Pediatrics
St. Johns Medical College and Hospital, Sarjapur Road, Bangalore 560034
Karnataka, India

Corresponding Author:
Dr. Rajan R Patil
Research Assistant, Community Health Cell, 367, Srinivasa Nilaya, Ist Main, Ist Block, Jakkasandra, Bangalore 560 034. Ph.: 5525372 / 5531518
Email: sochara@vsnl.com

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Sexual & Child Health file

Introduction:

Karnataka contributes to nearly 70% of the country's total mulberry silk production and the town of Ramanagaram is among the largest cocoon-marketing centre in Asia. The cocoon market averages a daily transaction upto 30 tonnes per day. The town has a population of 79,382 with 6,478 child laborers, 2138 reelers and 915 charkhas, 1500 filature units and 102 grainage units. Children are employed in all stages of the silk processing, making sericulture a child-based industry. About 80 % of the individuals involved in reeling silk are between the ages of 10-15 years [*Human rights report, 1999]. Children usually are involved in the filature unit tasks of cooking/boiling. During this process of 'cooking', the silkworms emit a protein called sericin in the form of foul-smelling vapors that pervade not only the silk units but also the entire region surrounding the units. It is this protein vapor that has been attributed to cause chronic bronchitis and asthma.

There are few studies on occupational health among children in this industry. An earlier study among adults reported that 16.9% of the total subjects from sericulture industry could be clinically categorized as having occupational asthma free from symptoms while away from work, with exacerbations upon resumption of occupation. At least 21.8% of the persons employed in silk filatures responded positively to both cocoon and pupal allergens [2]. Studies have shown that children develop sensitization to indoor allergens as they grow older in that atmosphere. Sensitivity of 1.5% at 1 yr age increases to 90% at 8-11 yrs of age [3]. In the sericulture sector, the child grows up working at the cost of the health, education, and social opportunities of children. Recent epidemiological studies of naturally occurring and occupational asthma have shown the importance of allergic factors in the pathogenesis. The research question this study set out to answer was "Is the prevalence of health problems (especially respiratory morbidity) more in children working in the filature units of sericulture industries at Ramanagaram town as compared to the children who are not working in filature units?" Findings of such a study is hoped to strengthen the policy action vis a vis child labour in sericulture.

Objectives:

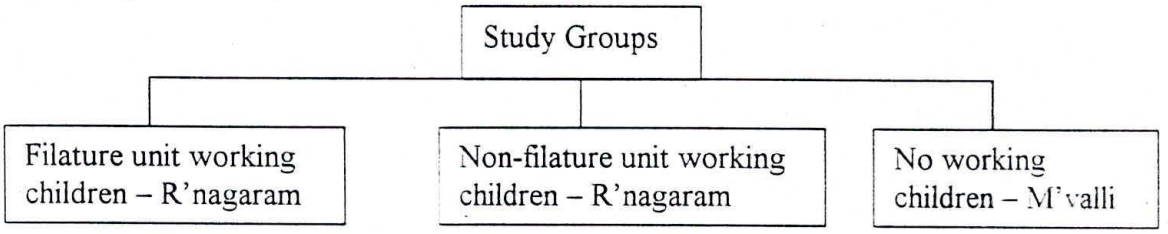
The primary objective was to study the comparative prevalence of Respiratory morbidity especially Hyperactive Airways among children working in filature units. The secondary objective was to study the comparative general health status among children working in the filature units.

Methodology:

Design

The study was designed as a cross-sectional (prevalence) study of environmental conditions at work/home and the presence of clinical evidence of health problems with special reference to hyper reactive airways as determined by symptoms, signs and peak expiratory flow rates. The definition of 'exposure' in our study was children working in filature units for at least 3 months and definition of 'control' (non-exposed) was school children not working in filature units. The significant difference in the number of

functioning units in the two town appeared to permit a comparison between groups - exposed, internal non-exposed (internal control group) in Ramanagaram and external non-exposed (external control group) in Malvalli. The study population was divided into three groups: Group I included were children working in the filature unit of the local sericulture industry at Ramanagaram for at least 3 months; Group II included controls from among neighbours at home not working in a similar allergen industry (internal controls); and, Group III included Malavalli children not exposed to a similar environment (external control). A sample size of 276 children based on known incidence of 4-5% and an expectation of 20-25% incidence of hyperactive airways was obtained by consecutive sampling of children of consenting parents (power 80). As controls from the home locality and the identified external control (Malavalli, 50 kms away, 2 filature units, 13 Charkhas and 3 grainage units, no child labour), a minimum of 100 children was examined on a similar basis in each of the control groups. During the pilot study, randomization and stratified selection of study subjects led to operational problems due to community members questioning the rationale behind the selection process, which then had to be changed to a simple first come first serve basis.



Questionnaire

The questionnaire used was a modification of the subjective ISAAC and a Bangladesh questionnaires (ISAAC Lancet 1985, Hassan et al Int J Epidemio 2002) and factors associated with asthma as described by Parmesh (Ind J Ped 2002) along with objective physician clinical examination similar to those utilized in clinics to suspect and diagnose children with respiratory disease especially hyper reactive airways.

Inclusion/Exclusion Criteria

The inclusion criteria was all children aged >5 to 18 years, who have worked for more than 3 months in the filature units of the sericulture industry at Ramanagaram town as the exposed group. Exclusion criteria were those who were acutely ill; asymptomatic but unable to perform peak flows satisfactorily; and, those who refused to consent.

Methods

Initially, standardization and training for data collection (demographic, symptoms, environmental factors) and measurements (clinical, peak flow rates before and after inhaled broncho-dilator, silk skin test) was carried out in the field for the social workers and field investigator. A local Rotary Hospital was utilized for baseline blood investigations, skin testing, education and medication. Social workers made contact with parents of potential study children and obtained a written informed consent for examination and testing utilizing information printed in appropriate local languages including a separate consent form. Utilizing a questionnaire, the field investigators and

social workers documented a clinical history, including symptoms and environmental factors, with specific reference to hyperactive airways. A detailed examination including anthropometry, PEFR before and 20 mins after two beta agonist (Salbutamol) inhalations using a standard spacer device and a silk skin test. Blood samples (Hb, TC, DC and ESR) were collected in open vials for manual counts by technicians in the local Rotary Hospital. The study began in Ramanagaram with a pilot study on 12th December 2002 and concluded on 9th Jan 2003 in Malvalli.

Outcome variables

The clinical endpoints in this study were predominantly respiratory symptoms in view of the nature of the occupation under scrutiny. Hyper reactive airways would be clinically suspected if a child has presenting symptoms of recurrent episodes of night cough, wheeze, fast breathing or chest retractions in isolation or in combination with the examination finding of rhonchi. A child who keeps presenting with the production of sputum (phlegm) and cough could have episodes of bronchitis, while those with recurrent coryza, running nose, nose blocks, sneezing could indicate allergic rhinitis. The presence of non-painful itching eyes with redness and watering would point to allergic conjunctivitis. All these conditions would be health problems probably attributed due to occupational effects of working in filature units. In view of the portability, ease of use and the field study conditions, we chose to use PEFR [5] as an objective assessment for airway hyper-reactivity. A onetime PEFR variability of > 15% was to be taken as significant objective evidence of bronchial hyperreactivity [4 Evaluation of asthma and allergy. awww.wnmeds.ac.nz/academic/med/warg/adv.html] before and after inhaled beta- agonist. In addition, to attribute any allergic manifestation to the silk utilized in the industry, a silk skin test was compared in all with a saline and histamine skin test. Outcome variables were hence defined as follows: Hyperactive airway disease was suggested by episodes of wheeze, cough, fast breathing, chest retractions, night cough and/or rhonchi. Allergic symptoms of frequent colds and sneezing; red eyes with itching and watering and no pain; itching skin rash were defined for the questionnaire.

Skin Test

For the silk skin test, the allergen extract is obtained from Silkworm pupae. Silkworm pupae are separated from cocoons, immersed in liquid nitrogen and crushed into a fine powder. Water is added to the powder till it forms a slurry and squeezed through a two-layered muslin cloth. Four volumes of chilled acetone are added to one volume of the extract and after stirring, the mixture is filtered though Whatman No. 3 filter paper under suction. The residue is washed several times with chilled acetone and finally with chilled peroxide-free diethyl ether. The resultant powder is dried and kept at –20 degrees Celsius for further use. For use, the acetone-dried powder of pupae is stirred for two hours at room temperature with 20 ml of 100 mg sodium phosphate buffered saline, pH 7.4. The slurry is centrifuged at 20,000xg for 15 minutes. The crude extract thus obtained (1:20 wt/vol) is filter sterilized and used for prick skin tests after diluting with an equal volume of sterile glycerin to give a 1:40 wt/vol. [2] Allergy for silk was tested by placing 0.1 ml silk antigen, Histamine and Normal saline on the volar surface of the forearm. A skin prick test was carried out on all three drops on the arm. The skin reaction of silk antigen

was read after 15 minutes by comparing with Histamine and Normal saline, which served as positive and negative controls. The interpretation of positive reaction to silk antigen was based on comparative size of wheal formation at the site of skin prick test. If wheal formed by silk antigen was equal to or more than wheal produced by the histamine it was taken to be positive. The test was performed by a single observer (Dr. PP) to avoid inter-observer variability.

Statistical Analysis

Data collected was independently analyzed using EPI Info -6 and probability calculated. Differences between the groups were considered statistically significant if the p value was < 0.05.

Ethics

The study included a Subject Information Form and Informed Consent in the local language and confidentiality of all data was maintained. Our study was cleared by the Institution Ethical Review Board.

Results:

A total of 401 children were selected from Ramanagaram (279:122 workers: non-workers; 192:209 male: female)and 142 from Malavalli (all non workers; 71:71 male: female).

Table I: Baseline external factors that may affect the study clinical outcomes

	R'nagaram workers	R'nagaram non-workers	Malavalli non-workers
Use of Agarbathi	87.8% 245/279	89.3% 109/22	46.5% 66/142
Gas, cooking fuel	0.0% 0/275	3.4% 4/118	8.6% 11/128
Kerosene, cooking fuel	23.3% 64/275	24.6% 29/118	35.2%45/128
Wood, cooking fuel	76.7% 211/275	72.0% 85/118	56.3%72/128
Exposure to heavy traffic	66.3% 185/279	55.7% 68/122	54.9% 78/142

Exposure to Pets	38.0% 106/279	39.3% 48/122	28.9% 41/142
Exposure to smoker at home	76.3% 213/279	79.5% 97/122	42.3% 60/142
Exposure to smoker at work/school,	93.5% 261/279	41.0% 50/122	unavailable
Use of Mosquito Repellants	69.9% 195/279	68.0%83/122	41.5% 59/142
Diet, non-veg	100.0% 276/276	99.2% 119/120	99.2%127/128
Diet, Eggs	88.9% 248/279	80.3% 98/122	84.5% 120/142
Diet, Milk buffalo	5.7% 9/159	5.5% 4/73	10.1% 11/109
Diet, Milk cow	94.3% 150/159	94.5% 69/73	89.9%88/109

These factors (Table I) may interfere with the outcome frequencies. Many of these factors are related to potential hyperreactive airway disease such as exposure to the utilization of wood for cooking, exposure to pets, exposure to smokers at home/work/school and use of mosquito repellants that were more common in Ramanagaram compared with Malavalli. These factors may by themselves or at least predispose as factors triggering hyperreactive airway disease. Many of these factors may also reflect the effects of industry on traditional households being associated with an increased earning capacity and urbanization of the township associated with similar occupations within the town limits.

Table II: Clinical Features (Symptoms. Signs, basic tests) results:

Sl. No	SYMPTOMS	RAMNAGARAM		MALVALLI	STATISTICAL SIGNIFICANCE
		Working (W)	Control (C)	Control (C)	R'Nagar indicates between W and C; Malavalli indicates W and Malavalli C.
1.	Recurrent Wheeze	13.3% (37/279)	7.4% (9/122)	2.2% (3/136)	R'Nagar p=.09 Malvalli **p=<0.01**
2.	Recurrent Fast Breath	14.0% (39/279)	8.3% (10/121)	2.9% (4/136)	R'nagar p=0.11 Malvalli **p=<0.01**

3.	Recurrent chest retraction	14.7% (41/279)	11.5% (14/122)	5.1% (7/136)	R'Nagar p= 0.38 Malvalli p= **<0.01**
4.	Recurrent Cough	31.5% (88/279)	20.5% (25/122)	4.4% (6/136)	R'nagar p=**0.02** Malavalli p**<0.01**
5.	Recurrent Phlegm	19.4% (54/279)	9% (11/122)	2.2% (3/136)	R'Nagar p=**<0.01** Malvalli p=**<0.01**
6.	Recurrent Night Cough	21.6% (60/278)	15.7% (19/121)	2.3% (3/136)	R'Nagar p=0.17 Malvalli p=**<0.01**
7.	Frequent colds, sneeze,	35% (97/277)	27.3% (33/121)	16.9% (23/136)	R'Nagar p=0.13 Malvalli p=**<0.01**
8.	Recurrent Eye red/itch/water	15.8% (44/278)	9% (11/122)	5.9% (8/136)	R'Nagar p=<0.06 Malvalli p=**<0.01**
9.	Recurrent Itching skin rash	13% (36/278)	9% (11/122)	3.7% (5/136)	R'Nagar p=<0.27 Malvalli p=**<0.01**
10.	Recurrent Oozing Skin	8.9% (25/279)	2.5% (3/122)	0.7% (1/136)	R'Nagar p=**0.02** Malvalli p=**<0.01**
11.	Hospital admission for any of above problems	7.2% (20/279)	6.6% (8/122)	2.9% (4/136)	R'Nagar p=0.8 Malvalli p=0.08
12.	PEFR cut off 15%	20.0% (54/270)	24% (27/114)	20% (21/105)	R'Nagar p=0.32 Malvalli p=0.84
13.	Silk antigen +ve	33.1% (92/278)	29.17% (35/120)	27.9% (26/93)	R'Nagar p=0.91 Malvalli p=0.57
14.	Clinically defined hyperactive airways (presence of Wheeze, fast breathing, chest retraction, cough, night cough, rhonchi, chest retraction.	53.4% (149/279)	41.8% (51/122)	19% (27/142)	R'nagar p=0.042 Malvalli p=**<0.01**
15.	Family history of asthma/allergy	25.9% (72/278)	23.7% (29/122)	11.8% (16/136)	R'nagar p=0.65 Malvalli p=**<0.01**
16.	**Pallor**	73% (219/279)	73% (90/122)	69% (98/142)	No significant difference
17.	Eosinophils	3.96% (n=250)	4.5% (n=114)	3.5% (n=127)	Normal range 1-6%

18. Hb	Hb=<8 gm% Hb=8-10 gm% Hb=10-12 gm%	13.6% (n=37/272) 65.8% (n=179/272) 20.8% (n=56/272)	16.1% (19/118) 66.9% (79/118) 16.9% (20/118)	16.7% (22/132) 76.5% (101/132) 6.8% (9/132)	
19 a. NCHS	6-10 yrs Mean Ht (SD) cms Mean Wt (SD) Kgs	132.3(10.3) (n=37) 23.9(3.2) (n=38)	122.9 (7.2) (n=57) 20.3 (3) (n=58)	122.4(9.9) (n=51) 20.4(4) (n=51)	5th – 95th Percentile 107-148cm 5th – 95th Percentile 17-45 kg
19 b. NCHS	10-12 yrs Mean Ht (SD) in cms (n= Mean wt (SD) in Kgs	141(7.9) (n=114) 28.4 (4.7) (n=114)	138.7 (9.8) (n=52) 27.6 (5.9) (n=58)	135.6(5.5) (n=67) 26.9(3.7) (n=68)	5th – 95th Percentile 127-162 **cm** 5th – 95th Percentile 24-58 kg
19 c. NCHS	12-14yrs Mean Ht (SD) in cms Mean wt (SD) in Kgs	149.4 (8) (n=105) 34.4 (5.6) (n=106)	143(8.4) (n=10) 29.05 (6.3) (n=10)	142.6(6.4) (n=18) 30 (3.8) (n=18)	5th – 95th Percentile 137-177 cm 5th – 95th Percentile 30-72 kg
20.	Vitamin B Deficiency	9.6% (27 279)	7.3% (9/122)	2.3% (3/142)	R'Nagar, p=0.45 Malvalli **p=0.04**

All the above mentioned parameters (Table II) suggestive of hyperreactive airway disease, bronchitis and allergic rhinitis obtained were most prevalent among children working in the filature units at Ramanagaram compared to both internal and external controls. Except for recurrent cough among working children at Ramanagaram no other parameter was statistically significantly different when compared to the internal non-workers in Ramanagaram. When the workers at Ramanagaram were compared with the controls at Malavalli there was statistical significant difference among the groups and their prevalence of 'allergic' manifestations. However, the objective Eosinophil counts, PEFR variability and Silk antigen testing did not differ between the groups. Moderately

severe anaemia (Hb < 10 gm/dl) was the commonest health problem with > 78% of all children needing treatment and advice. Children > 10 years showed a reduction in expected heights and weights progressively worsening with age. Vitamin B complex deficiency was significantly more common in the Ramanagaram population compared to Malavalli (9% versus 2%).

Discussion:

There have been few attempts to study occupational health status among sericulture workers (Harindranath et al [2]). Clinical survey of sericulture workers at Kollegal and Chikkaballapur led by PV Subbarao et al [6], and an Interns' project study in Kamagere village of Kollegal taluk by Ananthraman et al [7] are some documented work. However all these studies were done on the adult workers. The uniqueness of present study stems from the fact that it is a community based occupational health study carried out on children working in filature units of sericulture industry.

Symptoms

In all those children with symptoms, those working in the filature units of Ramanagaram (WR) are more frequently affected than those non working (NWR) but residing in Ramanagaram, though apart from recurrent oozing skin lesions the difference was not statistically significant between these groups. The results did reveal that there was a significant difference between working children from Ramanagaram and the external control group from Malvalli (MAL). Respiratory morbidity was more frequent among the population of children living in Ramanagaram when compared to Malavalli.

Respiratory morbidity

These symptoms suggest that working children show higher proportion respiratory problems when compared to non-working children both in Ramanagaram and Malvalli. Bronchial hyperreactivity was significantly increased in the study population of working children at Ramanagaram in comparison to those from the external control at Malavalli. In comparison, reported prevalence of respiratory morbidity in an intern's study conducted in Kamagere village in Kollegal District of Karnataka among reelers and non reelers, prevalence of wheezing was 26%-8%, nocturnal cough 8%-4% and phlegm 22%-8% respectively. Except for wheezing none of the difference was statistically significant [7]. Harindranath et al findings revealed that 36% of the workers in reeling units were suffering from asthma of varying severity[2].

In comparison, most of the reported prevalence studies on asthma in children are generally studied among school children by administering questionnaires. The ISAAC study revealed an overall range for Indian cities a prevalence of 2%-18%. This study was restricted to age group of 13-14 years. Associated conditions in childhood asthma are allergic rhinitis 75%, serious otitis media 22.5% sinusitis 9% and eczema 8% [8]. Parmesh et al reported a study in the age group 6-15 years children a prevalence of asthma 16.6% in urban and 5.7% in rural children in Karnataka[3].

Allergy

Allergic symptoms pertaining to upper respiratory tract, allergic bronchitis, skin rash were prominent in our study. These symptoms suggest that there was a significant difference of increased "allergic" symptoms (Allergic Rhinitis, Conjunctivitis, Bronchitis, Atopic skins lesions) among working children living in Ramanagaram versus those in Malvalli control. In all those children with symptoms, those working in the filature units of Ramanagaram were more frequently affected than non-filature workers of Ramanagaram, though apart from recurrent oozing skin lesions the results were not statistically significant between these groups. It must be remembered that even on using validated questionnaires, the findings may not be applicable to countries that have a prevalence of infectious diseases with similar symptoms (ISAAC Lancet 1998). Other health conditions like anemia, poor growth were seen in all groups described above. Working children of Ramanagaram show significantly higher proportion of Vitamin B deficiency than control children in Ramanagaram as well as Malvalli ($P<0.05$)

Asthma/Hyperreactive airway disease

The hallmark of asthma has always been the concept of reversible airway obstruction. PEFR appeared similar in all groups working/non-working in RAM and those in MAL (20%, 24%, 20%). It is possible that a single PEFR variability exercise has its limitations in the detection of hyper-reactive airways and that a comparison with a personal best, not possible with a cross sectional study in our set-up would be needed to objectively clarify the presence of hyper-reactive airways. An intermittent asthma or hyper-reactivity rather than a persistent state could also be reason for the lack of differences between PEFR variability of groups.

Asthma presentation in children is varied; thus determining asthma by a single parameter may not be correct. When symptoms suggestive of asthma taken in combination (wheeze, chest retraction, fast breathing, night cough and clinical findings of rhonchi and chest retraction) for clinical definition of hyperactive airways, Ramanagaram working children had statistically significant higher proportion 53% when compared to control children both in Ramanagaram 41% OR 1.6 P=0.042 and Malvalli 19% OR=4.86, P=<0.01 respectively. In comparison, Harindranath et al (Ann Allergy 1985) revealed that 36% of adult workers were suffering from asthma of varying severity. It is also obvious that the longer the duration of exposure the more likely is the manifestations of asthma. Does this mean that children may not objectively manifest the effects of the exposure to the allergen early and only after years of exposure would permit documentation of the disorder during adulthood. It is known that many workers of sericulture start working in childhood and could be afflicted with asthma by their early twenties causing disability and degrading the quality of life (Inbanathan A et al Benficiary Assessment Report Inst of Social and Eco Change, Bangalore, 1995; 1 Sec/BA/74:1). There is also postulated that children already exposed and sick due to allergy may no longer be permitted to work in the industry and not be recorded as a part of the actively working study population.

Skin Tests

Skin test is an independent predictor of asthma and the association becomes stronger with the addition of raised eosinophil counts and history of a parasitic disease (Celedon et al Ped 2001). Skin prick antigen testing noted that 1/3rd of working children in Ramanagaram (33%) showed sensitization, similarly high proportion of sensitization was seen among the controls (29% in Ramanagaram and 28% in Malvalli). In the study reported by Harindranath et al silk antigen positivity was 21.8% of the persons employed in silk filatures responded skin prick test. 28% of the total subjects screened responded positively to either or both of the antigens. High sensitization in Malvalli control group could not be explained only by very small number of silk units in Malvalli. Possibility of cross reactivity to other allergens such as due to the fluttering of insects raising scales (moths) will have to be looked into (ISEC report, BA 074: 23). All these possible explanation can only be proved by extensive immunological studies. The detection of allergen specific blood (serum) Immunoglobulins could provide good supplement data in future studies with regards the specific nature of the allergen causing the problems.

Ramanagaram versus Malavalli

It now appears that the entire study population in Ramanagaram had similar features, irrespective of work or no work in filature units and they significantly differed by being more frequent than the group from Malvalli. One possible explanation would be, the allergens causing the allergic respiratory manifestations seen in Ramanagaram appear to be widespread in the environment. If silk as a known antigen is one such allergen, it is too extensive in the environment at Ramanagaram to show a significant difference among children actually working and not working in filature units. It could be postulated that the silk industry being the major allergen industry in the area of Ramanagaram could just be the reason for this environment. Malvalli on the other hand with far less numbers of silk units had lower respiratory morbidity as compared to study groups of Ramanagaram. In addition, factors like the utilization of wood for fuel, exposure to pets, exposure to smokers at home/work/school and the use of mosquito repellants were commoner in Ramanagaram may add to the differences between groups. Parmesh (Pulm Pharmac Ther 2002) clearly states that urbanization, air pollution and environmental tobacco smoke contribute to the increased prevalence of asthma among children. The preexisting exposure to atopy may constitute an increased risk factor for asthma caused by occupational hazards.

General Health Indicators

General health indicators documented indicate that the entire study population, irrespective of residence or work, were anemic and in need of iron/anti-helminthics which were provided as an interventional component of the study. Physical growth as measured by height and weight remained on an average between the 5th and 95th percentile of NCHS standards and results even showed a physically healthier child among workers at Ramanagaram. This may simply be because of the industry's selection of children to work being the ones who appear physically fit to maintain productivity.

Child Labour

More importantly, the issue of child labor in silk industry needs to be addressed. Children are employed in all stages of the silk processing, making sericulture a child-based industry. Child labour in the country is prohibited and regulated in various processes sectors by the Child Labour (Prohibition and Regulation) Act. The Act classifies various sectors and processes as 'hazardous' or 'non-hazardous' only based on the physical-working environment. However, such a perspective fails to recognize that any process involving child labour is detrimental to the child, since it hinders the overall development and health of the child; health in this context refers to the physical, emotional and social well being of the child (as defined by the WHO) [12].

Conclusions:

In conclusion, children in Ramanagaram had a significantly higher frequency of respiratory morbidity compared with those in Malavalli. Ramanagaram's children with "allergic" symptoms (Airway - upper/lower; skin, eye) were significantly higher as compared to those residing in Malavalli. These frequencies were highest among those working in filature units as a group. It is obvious that there must be a common environmental factor in Ramanagaram that differentiates it from Malavalli. One major factor could be the number of silk units in the region. This study suggests that health hazards due to an allergen industry such as sericulture has a far wider impact than on the individual, but on the environment affecting the entire community. Certainly more extensive studies utilizing a longitudinal design, detailed pulmonary function tests, serial monitoring and serum silk specific antigens may be called for to study the problem. Until then it would be prudent to initiate measures in protecting the working child population in filature units of the Silk industry from continuing their exposure to allergens that in the years to come will be the cause of further respiratory morbidity/disability in adulthood.

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CH-17

PREVALENCE OF HYPER-REACTIVE AIRWAY DISEASE IN CHILDREN WORKING IN THE FILATURE UNITS IN THE SERICULTURE INDUSTRY AND THE EFFECTS ON THE GENERAL HEALTH OF THE CHILDREN

Report of a study

Conducted by :

Community Health Cell
 # 367, Srinivasa Nilaya,
Jakkasandra 1st Main
Kormangala 1st Block
Bangalore-360034.

And

Department of Pediatrics
St. Johns Medical College and Hospital
Sarjapur Road
Bangalore -560034

Initiated and Supported
Sponsored by :

Movement for Alternatives and Youth Awareness (MAYA)
#111, 5th Block, 5th Main
Jayanagar 560041.

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Sericulture + child Health
file

Prevalence of respiratory morbidity among children working in filature units of the sericulture industry and the effects on general health of the children.

Dr. R. R. Patil*, M.Sc (Epid), Research Assistant
Dr. S. Lewin, MD DNB, Associate Professor
Dr. S.D. Subba Rao, DCh DNB, Professor and Head
Dr. Om Prakash, MD, Consultant Physician
Dr. Peter Prashanth DCh, Consultant Paediatrician
Dr. Chitra Dinakar, DCh DNB, Lecturer
Dr. C.M. Francis*, MD, Advisor
Dr. Thelma Narayan*, MD, Advisor

Concept, Design (Drs. RP, SL, SDSR), Acquisition of data (Drs. RP, PP), Analysis, Interpretation (Drs. RP, SL, SDSR, CD), Drafting (Drs. RP, SL, CD), Final Approval (Drs. RP, SL, SDSR)

* Community Health Cell
367, Srinivasa Nilaya, Ist Main, Ist Block, Jakkasandra, Bangalore 560 034
Karnataka, India

And

Department of Pediatrics
St. Johns Medical College and Hospital, Sarjapur Road, Bangalore 560034
Karnataka, India

Corresponding Author:
Dr..Rajan R Patil
Research Assistant, Community Health Cell, 367, Srinivasa Nilaya, Ist Main, Ist Block, Jakkasandra, Bangalore 560 034. Ph.: 5525372 / 5531518
Email: sochara@vsnl.com

Sponsored by Movement for Alternatives and Youth Awareness (MAYA), #111, 5th Block, 5th Main, Jayanagar, Bangalore, Karnataka 560041.
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Introduction:

Karnataka contributes to nearly 70% of the country's total mulberry silk production and the town of Ramanagaram is among the largest cocoon-marketing centre in Asia. The cocoon market averages a daily transaction upto 30 tonnes per day. The town has a population of 79,382 with 6,478 child laborers, 2138 reelers and 915 charkhas, 1500 filature units and 102 grainage units. Children are employed in all stages of the silk processing, making sericulture a child-based industry. About 80 % of the individuals involved in reeling silk are between the ages of 10-15 years [*Human rights report, 1999]. Children usually are involved in the filature unit tasks of cooking/boiling. During this process of 'cooking', the silkworms emit a protein called sericin in the form of foul-smelling vapors that pervade not only the silk units but also the entire region surrounding the units. It is this protein vapor that has been attributed to cause chronic bronchitis and asthma.

There are few studies on occupational health among children in this industry. An earlier study among adults reported that 16.9% of the total subjects from sericulture industry could be clinically categorized as having occupational asthma free from symptoms while away from work, with exacerbations upon resumption of occupation. At least 21.8% of the persons employed in silk filatures responded positively to both cocoon and pupal allergens [2]. Studies have shown that children develop sensitization to indoor allergens as they grow older in that atmosphere. Sensitivity of 1.5% at 1 yr age increases to 90% at 8-11 yrs of age [3]. In the sericulture sector, the child grows up working at the cost of the health, education, and social opportunities of children. Recent epidemiological studies of naturally occurring and occupational asthma have shown the importance of allergic factors in the pathogenesis. The research question this study set out to answer was "Is the prevalence of health problems (especially respiratory morbidity) more in children working in the filature units of sericulture industries at Ramanagaram town as compared to the children who are not working in filature units?" Findings of such a study is hoped to strengthen the policy action vis a vis child labour in **sericulture.**

Objectives:

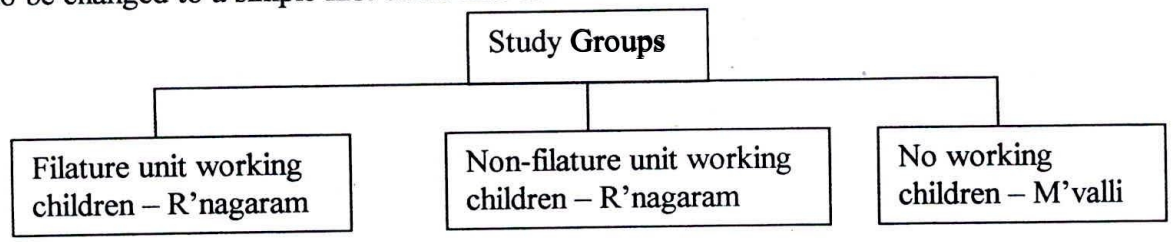
The primary objective was to study the comparative prevalence of Respiratory morbidity especially Hyperactive Airways among children working in filature units. The secondary objective was to study the comparative general health status among children working in the filature units.

Methodology:

Design

The study was designed as a cross-sectional (prevalence) study of environmental conditions at work/home and the presence of clinical evidence of health problems with special reference to hyper reactive airways as determined by symptoms, signs and peak expiratory flow rates. The definition of 'exposure' in our study was children working in filature units for at least 3 months and definition of 'control' (non-exposed) was school children not working in filature units. The significant difference in the number of

functioning units in the two town appeared to permit a comparison between groups - exposed, internal non-exposed (internal control group) in Ramanagaram and external non-exposed (external control group) in Malvalli. The study population was divided into three groups: Group I included were children working in the filature unit of the local sericulture industry at Ramanagaram for at least 3 months; Group II included controls from among neighbours at home not working in a similar allergen industry (internal controls); and, Group III included Malavalli children not exposed to a similar environment (external control). A sample size of 276 children based on known incidence of 4-5% and an expectation of 20-25% incidence of hyperactive airways was obtained by consecutive sampling of children of consenting parents (power 80). As controls from the home locality and the identified external control (Malavalli, 50 kms away, 2 filature units, 13 Charkhas and 3 grainage units, no child labour), a minimum of 100 children was examined on a similar basis in each of the control groups. During the pilot study, randomization and stratified selection of study subjects led to operational problems due to community members questioning the rationale behind the selection process, which then had to be changed to a simple first come first serve basis.



Questionnaire

The questionnaire used was a modification of the subjective ISAAC and a Bangladesh questionnaires (ISAAC Lancet 1985, Hassan et al Int J Epidemio 2002) and factors associated with asthma as described by Parmesh (Ind J Ped 2002) along with objective physician clinical examination similar to those utilized in clinics to suspect and diagnose children with respiratory disease especially hyper reactive airways.

Inclusion/Exclusion Criteria

The inclusion criteria was all children aged >5 to 18 years, who have worked for more than 3 months in the filature units of the sericulture industry at Ramanagaram town as the exposed group. Exclusion criteria were those who were acutely ill; asymptomatic but unable to perform peak flows satisfactorily; and, those who refused to consent.

Methods

Initially, standardization and training for data collection (demographic, symptoms, environmental factors) and measurements (clinical, peak flow rates before and after inhaled broncho-dilator, silk skin test) was carried out in the field for the social workers and field investigator. A local Rotary Hospital was utilized for baseline blood investigations, skin testing, education and medication. Social workers made contact with parents of potential study children and obtained a written informed consent for examination and testing utilizing information printed in appropriate local languages including a separate consent form. Utilizing a questionnaire, the field investigators and

social workers documented a clinical history, including symptoms and environmental factors, with specific reference to hyperactive airways. A detailed examination including anthropometry, PEFR before and 20 mins after two beta agonist (Salbutamol) inhalations using a standard spacer device and a silk skin test. Blood samples (Hb, TC, DC and ESR) were collected in open vials for manual counts by technicians in the local Rotary Hospital. The study began in Ramanagaram with a pilot study on 12th December 2002 and concluded on 9th Jan 2003 in **Malvalli.**

Outcome variables

The clinical endpoints in this study were predominantly respiratory symptoms in view of the nature of the occupation under scrutiny. Hyper reactive airways would be clinically suspected if a child has presenting symptoms of recurrent episodes of night cough, wheeze, fast breathing or chest retractions in isolation or in combination with the examination finding of rhonchi. A child who keeps presenting with the production of sputum (phlegm) and cough could have episodes of bronchitis, while those with recurrent coryza, running nose, nose blocks, sneezing could indicate allergic rhinitis. The presence of non-painful itching eyes with redness and watering would point to allergic conjunctivitis. All these conditions would be health problems probably attributed due to occupational effects of working in filature units. In view of the portability, ease of use and the field study conditions, we chose to use PEFR [5] as an objective assessment for airway hyper-reactivity. A onetime PEFR variability of > 15% was to be taken as significant objective evidence of bronchial hyperreactivity [4 Evaluation of asthma and allergy. awww.wnmeds.ac.nz/academic/med/warg/adv.html] before and after inhaled beta- agonist. In addition, to attribute any allergic manifestation to the silk utilized in the industry, a silk skin test was compared in all with a saline and histamine skin test. Outcome variables were hence defined as follows: Hyperactive airway disease was suggested by episodes of wheeze, cough, fast breathing, chest retractions, night cough and/or rhonchi. Allergic symptoms of frequent colds and sneezing; red eyes with itching and watering and no pain; itching skin rash were defined for the questionnaire.

Skin Test

For the silk skin test, the allergen extract is obtained from Silkworm pupae. Silkworm pupae are separated from cocoons, immersed in liquid nitrogen and crushed into a fine powder. Water is added to the powder till it forms a slurry and squeezed through a two-layered muslin cloth. Four volumes of chilled acetone are added to one volume of the extract and after stirring, the mixture is filtered though Whatman No. 3 filter paper under suction. The residue is washed several times with chilled acetone and finally with chilled peroxide-free diethyl ether. The resultant powder is dried and kept at –20 degrees Celsius for further use. For use, the acetone-dried powder of pupae is stirred for two hours at room temperature with 20 ml of 100 mg sodium phosphate buffered saline, pH 7.4. The slurry is centrifuged at 20,000xg for 15 minutes. The crude extract thus obtained (1:20 wt/vol) is filter sterilized and used for prick skin tests after diluting with an equal volume of sterile glycerin to give a 1:40 wt/vol. [2] Allergy for silk was tested by placing 0.1 ml silk antigen, Histamine and Normal saline on the volar surface of the forearm. A skin prick test was carried out on all three drops on the arm. The skin reaction of silk antigen

was read after 15 minutes by comparing with Histamine and Normal saline, which served as positive and negative controls. The interpretation of positive reaction to silk antigen was based on comparative size of wheal formation at the site of skin prick test. If wheal formed by silk antigen was equal to or more than wheal produced by the histamine it was taken to be positive. The test was performed by a single observer (Dr. PP) to avoid inter-observer variability.

Statistical Analysis

Data collected was independently analyzed using EPI Info -6 and probability calculated. Differences between the groups were considered statistically significant if the p value was < 0.05.

Ethics

The study included a Subject Information Form and Informed Consent in the local language and confidentiality of all data was maintained. Our study was cleared by the Institution Ethical Review **Board.**

Results:

A total of 401 children were selected from Ramanagaram (279:122 workers: non-workers; 192:209 male: female)and 142 from Malavalli (all non workers; 71:71 male: female).

Table I: Baseline external factors that may affect the study clinical outcomes

	R'nagaram workers	R'nagaram non-workers	Malavalli non-workers
Use of Agarbathi	87.8% 245/279	89.3% 109/22	46.5% 66/142
Gas, cooking fuel	0.0% 0/275	3.4% 4/118	8.6% 11/128
Kerosene, cooking fuel	23.3% 64/275	24.6% 29/118	35.2%45/128
Wood, cooking fuel	76.7% 211/275	72.0% 85/118	56.3%72/128
Exposure to heavy traffic	66.3% 185/279	55.7% 68/122	54.9% 78/142

Exposure to Pets	38.0% 106/279	39.3% 48/122	28.9% 41/142
Exposure to smoker at home	76.3% 213/279	79.5% 97/122	42.3% 60/142
Exposure to smoker at work/school,	93.5% 261/279	41.0% 50/122	unavailable
Use of Mosquito Repellants	69.9% 195/279	68.0%83/122	41.5% 59/142
Diet, non-veg	100.0% 276/276	99.2% 119/120	99.2%127/128
Diet, Eggs	88.9% 248/279	80.3% 98/122	84.5% 120/142
Diet, Milk buffalo	5.7% 9/159	5.5% 4/73	10.1% 11/109
Diet, Milk cow	94.3% 150/159	94.5% 69/73	89.9%88/109

These factors (Table I) may interfere with the outcome frequencies. Many of these factors are related to potential hyperreactive airway disease such as exposure to the utilization of wood for cooking, exposure to pets, exposure to smokers at home/work/school and use of mosquito repellants that were more common in Ramanagaram compared with Malavalli. These factors may by themselves or at least predispose as factors triggering hyperreactive airway disease. Many of these factors may also reflect the effects of industry on traditional households being associated with an increased earning capacity and urbanization of the township associated with similar occupations within the town limits.

Table II: Clinical Features (Symptoms, Signs, basic tests) results:

Sl. No	SYMPTOMS	RAMNAGARAM		MALVALLI	STATISTICAL SIGNIFICANCE
		Working (W)	Control (C)	Control (C)	R'Nagar indicates between W and C; Malavalli indicates W and Malavalli C.
1.	Recurrent Wheeze	13.3% (37/279)	7.4% (9/122)	2.2% (3/136)	R'Nagar p=.09 Malvalli **p=<0.01**
2.	Recurrent Fast Breath	14.0% (39/279)	8.3% (10/121)	2.9% (4/136)	R'nagar p=0.11 Malvalli **p=<0.01**

3.	Recurrent chest retraction	14.7% (41/279)	11.5% (14/122)	5.1% (7/136)	R'Nagar p= 0.38 Malvalli p= **<0.01**
4.	Recurrent Cough	31.5% (88/279)	20.5% (25/122)	4.4% (6/136)	R'nagar p=**0.02** Malavalli p**<0.01**
5.	Recurrent Phlegm	19.4% (54/279)	9% (11/122)	2.2% (3/136)	R'Nagar p=**<0.01** Malvalli p=**<0.01**
6.	Recurrent Night Cough	21.6% (60/278)	15.7% (19/121)	2.3% (3/136)	R'Nagar p=0.17 Malvalli p=**<0.01**
7.	Frequent colds, sneeze,	35% (97/277)	27.3% (33/121)	16.9% (23/136)	R'Nagar p=0.13 Malvalli p=**<0.01**
8.	Recurrent Eye red/itch/water	15.8% (44/278)	9% (11/122)	5.9% (8/136)	R'Nagar p=<0.06 Malvalli p=**<0.01**
9.	Recurrent Itching skin rash	13% (36/278)	9% (11/122)	3.7% (5/136)	R'Nagar p=<0.27 Malvalli p=**<0.01**
10.	Recurrent Oozing Skin	8.9% (25/279)	2.5% (3/122)	0.7% (1/136)	R'Nagar p=**0.02** Malvalli p=**<0.01**
11.	Hospital admission for any of above problems	7.2% (20/279)	6.6% (8/122)	2.9% (4/136)	R'Nagar p=0.8 Malvalli p=0.08
12.	PEFR cut off 15%	20.0% (54/270)	24% (27/114)	20% (21/105)	R'Nagar p=0.32 Malvalli p=0.84
13.	Silk antigen +ve	33.1% (92/278)	29.17% (35/120)	27.9% (26/93)	R'Nagar p=0.91 Malvalli p=0.57
14.	Clinically defined hyperactive airways (presence of Wheeze, fast breathing, chest retraction, cough, night cough, rhonchi, chest retraction.	53.4% (149/279)	41.8% (51/122)	19% (27/142)	R'nagar p=0.042 Malvalli p=**<0.01**
15.	Family history of asthma/allergy	25.9% (72/278)	23.7% (29/122)	11.8% (16/136)	R'nagar p=0.65 Malvalli p=**<0.01**
16.	Pallor	73% (219/279)	73% (90/122)	69% (98/142)	No significant difference
17.	Eosinophils	3.96% (n=250)	4.5% (n=114)	3.5% (n=127)	Normal range 1-6%

18. Hb	Hb=<8 gm% Hb=8-10 gm% Hb=10-12 gm%	13.6% (n=37/272) 65.8% (n=179/272) 20.8% (n=56/272)	16.1% (19/118) 66.9% (79/118) 16.9% (20/118)	16.7% (22/132) 76.5% (101/132) 6.8% (9/132)	
19 a. NCHS	6-10 yrs Mean Ht (SD) cms Mean Wt (SD) Kgs	132.3(10.3) (n=37) 23.9(3.2) (n=38)	122.9 (7.2) (n=57) 20.3 (3) (n=58)	122.4(9.9) (n=51) 20.4(4) (n=51)	5th – 95th Percentile 107-148cm 5th – 95th Percentile 17-45 kg
19 b. NCHS	10-12 yrs Mean Ht (SD) in cms (n= Mean wt (SD) in Kgs	141(7.9) (n=114) 28.4 (4.7) (n=114)	138.7 (9.8) (n=52) 27.6 (5.9) (n=58)	135.6(5.5) (n=67) 26.9(3.7) (n=68)	5th – 95th Percentile 127-162 cm 5th – 95th Percentile 24-58 kg
19 c. NCHS	12-14yrs Mean Ht (SD) in cms Mean wt (SD) in Kgs	149.4 (8) (n=105) 34.4 (5.6) (n=106)	143(8.4) (n=10) 29.05 (6.3) (n=10)	142.6(6.4) (n=18) 30 (3.8) (n=18)	5th – 95th Percentile 137-177 cm 5th – 95th Percentile 30-72 kg
20.	Vitamin B Deficiency	9.6% (27/279)	7.3% (9/122)	2.3% (3/142)	R'Nagar, p=0.45 Malvalli **p=0.04**

All the above mentioned parameters (Table II) suggestive of hyperreactive airway disease, bronchitis and allergic rhinitis obtained were most prevalent among children working in the filature units at Ramanagaram compared to both internal and external controls. Except for recurrent cough among working children at Ramanagaram no other parameter was statistically significantly different when compared to the internal non-workers in Ramanagaram. When the workers at Ramanagaram were compared with the controls at Malavalli there was statistical significant difference among the groups and their prevalence of 'allergic' manifestations. However, the objective Eosinophil counts, PEFR variability and Silk antigen testing did not differ between the groups. Moderately

severe anaemia (Hb < 10 gm/dl) was the commonest health problem with > 78% of all children needing treatment and advice. Children > 10 years showed a reduction in expected heights and weights progressively worsening with age. Vitamin B complex deficiency was significantly more common in the Ramanagaram population compared to Malavalli (9% versus 2%).

Discussion:

There have been few attempts to study occupational health status among sericulture workers (Harindranath et al [2]). Clinical survey of sericulture workers at Kollegal and Chikkaballapur led by PV Subbarao et al [6], and an Interns' project study in Kamagere village of Kollegal taluk by Ananthraman et al [7] are some documented work. However all these studies were done on the adult workers. The uniqueness of present study stems from the fact that it is a community based occupational health study carried out on children working in filature units of sericulture industry.

Symptoms

In all those children with symptoms, those working in the filature units of Ramanagaram (WR) are more frequently affected than those non working (NWR) but residing in Ramanagaram, though apart from recurrent oozing skin lesions the difference was not statistically significant between these groups. The results did reveal that there was a significant difference between working children from Ramanagaram and the external control group from Malvalli (MAL). Respiratory morbidity was more frequent among the population of children living in Ramanagaram when compared to Malavalli.

Respiratory morbidity

These symptoms suggest that working children show higher proportion respiratory problems when compared to non-working children both in Ramanagaram and Malvalli. Bronchial hyperreactivity was significantly increased in the study population of working children at Ramanagaram in comparison to those from the external control at Malavalli. In comparison, reported prevalence of respiratory morbidity in an intern's study conducted in Kamagere village in Kollegal District of Karnataka among reelers and non reelers, prevalence of wheezing was 26%-8%, nocturnal cough 8%-4% and phlegm 22%-8% respectively. Except for wheezing none of the difference was statistically significant [7]. Harindranath et al findings revealed that 36% of the workers in reeling units were suffering from asthma of varying severity[2].

In comparison, most of the reported prevalence studies on asthma in children are generally studied among school children by administering questionnaires. The ISAAC study revealed an overall range for Indian cities a prevalence of 2%-18%. This study was restricted to age group of 13-14 years. Associated conditions in childhood asthma are allergic rhinitis 75%, serious otitis media 22.5% sinusitis 9% and eczema 8% [8]. Parmesh et al reported a study in the age group 6-15 years children a prevalence of asthma 16.6% in urban and 5.7% in rural children in Karnataka[3].

Allergy

Allergic symptoms pertaining to upper respiratory tract, allergic bronchitis, skin rash were prominent in our study. These symptoms suggest that there was a significant difference of increased "allergic" symptoms (Allergic Rhinitis, Conjunctivitis, Bronchitis, Atopic skins lesions) among working children living in Ramanagaram versus those in Malvalli control. In all those children with symptoms, those working in the filature units of Ramanagaram were more frequently affected than non-filature workers of Ramanagaram, though apart from recurrent oozing skin lesions the results were not statistically significant between these groups. It must be remembered that even on using validated questionnaires, the findings may not be applicable to countries that have a prevalence of infectious diseases with similar symptoms (ISAAC Lancet 1998). Other health conditions like anemia, poor growth were seen in all groups described above. Working children of Ramanagaram show significantly higher proportion of Vitamin B deficiency than control children in Ramanagaram as well as Malvalli (P≤0.05)

Asthma/Hyperreactive airway disease

The hallmark of asthma has always been the concept of reversible airway obstruction. PEFR appeared similar in all groups working/non-working in RAM and those in MAL (20%, 24%, 20%). It is possible that a single PEFR variability exercise has its limitations in the detection of hyper-reactive airways and that a comparison with a personal best, not possible with a cross sectional study in our set-up would be needed to objectively clarify the presence of hyper-reactive airways. An intermittent asthma or hyper-reactivity rather than a persistent state could also be reason for the lack of differences between PEFR variability of groups.

Asthma presentation in children is varied; thus determining asthma by a single parameter may not be correct. When symptoms suggestive of asthma taken in combination (wheeze, chest retraction, fast breathing, night cough and clinical findings of rhonchi and chest retraction) for clinical definition of hyperactive airways, Ramanagaram working children had statistically significant higher proportion 53% when compared to control children both in Ramanagaram 41% OR 1.6 P=0.042 and Malvalli 19% OR=4.86, P=<0.01 respectively. In comparison, Harindranath et al (Ann Allergy 1985) revealed that 36% of adult workers were suffering from asthma of varying severity. It is also obvious that the longer the duration of exposure the more likely is the manifestations of asthma. Does this mean that children may not objectively manifest the effects of the exposure to the allergen early and only after years of exposure would permit documentation of the disorder during adulthood. It is known that many workers of sericulture start working in childhood and could be afflicted with asthma by their early twenties causing disability and degrading the quality of life (Inbanathan A et al Benficiary Assessment Report Inst of Social and Eco Change, Bangalore, 1995; 1 Sec/BA/74:1). There is also postulated that children already exposed and sick due to allergy may no longer be permitted to work in the industry and not be recorded as a part of the actively working study population..

Skin Tests

Skin test is an independent predictor of asthma and the association becomes stronger with the addition of raised eosinophil counts and history of a parasitic disease (Celedon et al Ped 2001). Skin prick antigen testing noted that 1/3rd of working children in Ramanagaram (33%) showed sensitization, similarly high proportion of sensitization was seen among the controls (29% in Ramanagaram and 28% in Malvalli). In the study reported by Harindranath et al silk antigen positivity was 21.8% of the persons employed in silk filatures responded skin prick test. 28% of the total subjects screened responded positively to either or both of the antigens. High sensitization in Malvalli control group could not be explained only by very small number of silk units in Malvalli. Possibility of cross reactivity to other allergens such as due to the fluttering of insects raising scales (moths) will have to be looked into (ISEC report, BA 074: 23). All these possible explanation can only be proved by extensive immunological studies. The detection of allergen specific blood (serum) Immunoglobulins could provide good supplement data in future studies with regards the specific nature of the allergen causing the problems.

Ramanagaram versus Malavalli

It now appears that the entire study population in Ramanagaram had similar features, irrespective of work or no work in filature units and they significantly differed by being more frequent than the group from Malvalli. One possible explanation would be, the allergens causing the allergic respiratory manifestations seen in Ramanagaram appear to be widespread in the environment. If silk as a known antigen is one such allergen, it is too extensive in the environment at Ramanagaram to show a significant difference among children actually working and not working in filature units. It could be postulated that the silk industry being the major allergen industry in the area of Ramanagaram could just be the reason for this environment. Malvalli on the other hand with far less numbers of silk units had lower respiratory morbidity as compared to study groups of Ramanagaram. In addition, factors like the utilization of wood for fuel, exposure to pets, exposure to smokers at home/work/school and the use of mosquito repellants were commoner in Ramanagaram may add to the differences between groups. Parmesh (Pulm Pharmac Ther 2002) clearly states that urbanization, air pollution and environmental tobacco smoke contribute to the increased prevalence of asthma among children. The preexisting exposure to atopy may constitute an increased risk factor for asthma caused by occupational hazards.

General Health Indicators

General health indicators documented indicate that the entire study population, irrespective of residence or work, were anemic and in need of iron/anti-helminthics which were provided as an interventional component of the study. Physical growth as measured by height and weight remained on an average between the 5th and 95th percentile of NCHS standards and results even showed a physically healthier child among workers at Ramanagaram. This may simply be because of the industry's selection of children to work being the ones who appear physically fit to maintain productivity.

Child Labour

More importantly, the issue of child labor in silk industry needs to be addressed. Children are employed in all stages of the silk processing, making sericulture a child-based industry. Child labour in the country is prohibited and regulated in various processes sectors by the Child Labour (Prohibition and Regulation) Act. The Act classifies various sectors and processes as 'hazardous' or 'non-hazardous' only based on the physical-working environment. However, such a perspective fails to recognize that any process involving child labour is detrimental to the child, since it hinders the overall development and health of the child; health in this context refers to the physical, emotional and social well being of the child (as defined by the WHO) [12].

Conclusions:

1. Children working in filature units in the sericulture industry have a higher prevalence of respiratory morbidity than the non-working (School children) children both in Ramanagaram and Malvalli towns. The difference was statistically significant among the Ramnagaram working and Malvalli non-working children, whereas the difference between working and non working children in Ramanagaram was not statistically significant.

2. Children in Ramanagaram whether working or non working in the filature units had significantly higher frequency of respiratory and other allergic symptoms (airway, skin and eye) as compared with the children in Malvalli.

3. The over all risk appears to be related to the number of filature units in the area.

4. Anaemia is prevalent in almost all the children, whether working or non-working.. The height and weight for age of working children were better than those of non-working children. This is probably due to the preferential employment of robust children by the employers and drop out of children who become unhealthy.

5. Skin antigen tests, baseline and post-bronchodilator PEFR were inadequate to further confirm and support the proposed association recognized in the study. This will need more elaborate longitudinal, hospital-based investigations, including serial monitoring, spirometry and allergen specific IgE serum immunoglobulin levels.

6. The health impact of sericulture industry on the children of the area (in addition to occupation group) must be kept in mind in any move to reduce health hazards.

In conclusion, children in Ramanagaram had a significantly higher frequency of respiratory morbidity compared with those in Malavalli. Ramanagaram's children with "allergic" symptoms (Airway - upper/lower; skin, eye) were significantly higher as compared to those residing in Malavalli. These frequencies were highest among those working in filature units as a group. It is obvious that there must be a common environmental factor in Ramanagaram that differentiates it from Malavalli. One major factor could be the number of silk units in the region. This study suggests that health hazards due to an allergen industry such as sericulture has a far wider impact than on the individual, but on the environment affecting the entire community. Certainly more extensive studies utilizing a longitudinal design, detailed pulmonary function tests, serial monitoring and serum silk specific antigens may be called for to study the problem. Until then it would be prudent to initiate measures in protecting the working child population in filature units of the Silk industry from continuing their exposure to allergens that in the years to come will be the cause of further respiratory morbidity/disability in adulthood.

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