

# A clinical and radiographic study of coir workers

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**Uragoda, C. G. (1975).** *British Journal of Industrial Medicine* 32, 66-71. **A clinical and radiographic study of coir workers.** Processing of coir, which is the fibre obtained from the husk of the coconut, is a dusty procedure; 779 workers in two coir processing factories in Sri Lanka were examined clinically and radiographically for evidence of respiratory disease. Respiratory symptoms were present in 20 (2.6%) of them, which is no higher than in the general population. Respiratory disease such as asthma, chronic bronchitis, byssinosis, and pulmonary tuberculosis which may occur from occupational exposures were considered, but there was no evidence to suggest a definite association between these conditions and coir dust. Twenty-two workers had abnormal chest radiographs, but when compared with a control group of 591 workers from an engineering firm where lesions were found in 20 cases, there was no significant difference. In the opinion of the medical officer, management and workers of the large factory investigated, coir dust does not produce any respiratory disability. The chemical composition of coir dust is similar to that of sisal which is also relatively inert.

Coir is the fibre obtained from the husk of the coconut. It has a wide variety of uses depending on the colour, length, and thickness of the fibres. The thick long variety or bristle is used for the manufacture of brushes. The short thin fibres are in demand for use in mattresses. Sometimes they are impregnated with rubber to improve the quality of the mattresses or for use as upholstery material. Coir fibre is more lasting than most of the other types of fibre. Rope made of coir has the advantage that it will stretch considerably without breaking. Since the fibre is resistant to sea water, cables and riggings made from it were used by early voyagers. White fibre is sometimes used in the manufacture of oil filters. Other uses of coir are in the production of nets, twine, sacks, matings, and brooms.

Although the effects of many vegetable dusts on the respiratory system have been investigated, there is hardly any information on the effects, if any, of coir dust. The mechanics of industrial pulmonary disease due to the inhalation of organic dusts are not well understood (Pepys, 1966). They may affect the lungs in many ways (Stott, 1958). First, they may

produce asthmatic and bronchitic conditions: dusts of certain woods and gums, for example, cause asthma, while cotton workers may develop byssinosis. Secondly, pulmonary disease may be caused by bacteria and fungi contained in the dust, as in farmer's lung and bagassosis. Thirdly, silica which may be a contaminant can produce pulmonary fibrosis.

Besides coir, vegetable fibres of commercial importance are cotton, flax, hemp, sisal, jute, and manila. Byssinosis occurs in subjects working with cotton, flax (Elwood *et al.*, 1965), and soft hemp (Valič *et al.*, 1968), but ropeworkers using hard hemp and manila do not get byssinosis (Munt, Gauvain, Walford, and Schilling, 1965). Stott (1958) did not find byssinosis among sisal workers in Kenya but he detected four cases with apical fibrosis which he concluded were probably related to the occupation. Mair, Smith, Wilson, and Lockhart (1960), in an investigation of jute workers in Dundee, failed to find any evidence of respiratory disease which could be attributed to their occupation. Gilson *et al.* (1962) confirmed the absence of byssinosis in sisal and jute

workers. As regards coir, the statement of Quinn (1971) that 'the hacking and spinning processes in the large manufacturing factories which give off large quantities of fibre dust may be injurious to the health of the workers' is rather equivocal and is not supported by evidence. Therefore the present investigation was undertaken to determine whether coir dust produced clinical or radiographic evidence of pulmonary disease.

### The industry

The coir industry in Sri Lanka is very old, probably dating back to the 13th or 14th century. Machine manufacture of bristle fibre was probably introduced in the period 1880-90. Prior to this date fibre was manufactured in England from the husks of imported nuts (some 12 million a year) by a firm in Millwall (Child, 1964).

It is estimated that the total world output of coir is 270 000 tons (270 000 000 kg) annually, but after local use in their respective countries only about 100 000 tons (100 000 000 kg) enter the world market as coir each year. Sri Lanka is the biggest exporter of coir, for it supplies 90-95% of this amount. The export of fibre in 1972 amounted to 94 150 tons (94 150 000 kg). Though Sri Lanka exports coir to 54 countries, the main buyers are the United Kingdom, West Germany, and Japan (Subasinghe, 1973).

The nut of the coconut palm (*Cocos nucifera*) consists of the husk and the central hard globular seed within which is the white kernel and the milk, a watery liquid.

The husk is the mesocarp of the fruit and consists of a collection of fibres bound together by a light pith. The external surface of the husk is leathery. The fruit is usually green in colour, but the fully ripened or dried fruit is brown. The latter yields brown fibre while that produced from the green fruits which are used for culinary purposes is white. The white fibre has a higher commercial value, but since its manufacture is a cottage industry only a small amount is produced, the average volume of exports being 67 tons (68 000 kg) a year. Since the manufacture of copra and desiccated coconut are large industries that extensively use the dried nuts, production of brown fibre is proportionately large.

### Extraction of coir

When the husks are green it is difficult to separate the fibre from the pith. Therefore the husks have to be soaked in water or retted for six to nine months in order to facilitate this operation. Retted husks give out a very unpleasant odour. Retting is done either in barricades in the brackish backwaters of streams near the sea or in pits in the ground. The

dried husks as opposed to the green ones need only a month of retting. However, if the husks are crushed mechanically rather than manually, a retting period of seven to 10 days is sufficient. If extraction of fibre is done in machines called decorticators retting is not required at all, the brown husks being soaked in water for only a few minutes, but the fibre has the disadvantage of having a high dust content.

Most of the fibre extraction is done in mills of which there were 576 in 1971 with an estimated labour force of 40 000 to 50 000. The majority of these mills are semimechanized ones where a worker has to hold one end of the retted husk against a rapidly rotating drum fitted with numerous vertical nails. This manoeuvre removes most of the pith from one end. The other end of the husk is similarly treated. The process is repeated twice or thrice on a second drum with more closely fitted nails when more pith and the short fibres fall to the ground leaving a hank of long fibre in the hand. In fully mechanized mills the husks which have been soaked for only a few minutes are fed into a decorticator where the husks are mechanically crushed and beaten by metal rods and the pith removed. The extracted fibre is sifted to remove any loose pith, washed, and then dried, usually in the sun.

### Processing of coir

The milled fibre is transported to factories in Colombo for processing before export. The primary considerations in processing are to improve the colour of the coir by bleaching, remove the remaining pith, and make it as dust-free as possible, separate it into different grades such as mattress and bristle fibre in order to conform to the requirements of the indenting firms abroad, and compress the fibre into the smallest possible volume by baling or twisting so as to conserve shipping space.

Bleaching is done by exposing the fibre to sulphur fumes. Fibre is stacked on wooden platforms constructed on the floor of small cubicles. A bucket of burning sulphur is placed in a tunnel under the cubicle. The fumes disperse under the woodwork and rise upwards, percolating through the fibre which is allowed to bleach for 12 to 13 hours.

The fibre meant for mattress and upholstery work is teased by feeding bundles of coir into a large machine which disperses fibre by a rotating spiked drum. The teased fibre is carried by a conveyor belt to a twisting machine where it is tightly spun into thick rope-like cords which are wound into coils weighing about a hundredweight (50 kg) each. On reaching the country of its destination the cords are converted back into fibre by passing through a detwisting machine.

Bristle fibre is thicker and longer than other types of fibre, and is separated by hackling through a steel comb. This work is done by teams of women who

work at hackles fixed to long benches. The worker holds one end of the bundle of fibres to be hackled and spreads out the other end fan-wise. She sprinkles a little water on the fibre, lubricates the steel comb with a little coconut oil, and then briskly passes the spread end through the teeth. The process is repeated with the other end. Shorter fibres which are suitable for making mattresses fall to the ground while the long bristle remains in the hand. The bristle is tied into small bundles and is cut into required lengths in a machine which clips off the ends.

Mattress fibre and sometimes bristle fibre are exported in the form of tightly packed bales. Three hundredweight (150 kg) of fibre, which is the average output from 1 000 coconuts is mechanically compressed under high pressure to a volume of about 10 cubic feet (0.28 m<sup>3</sup>). The bales are wrapped in hoop iron.

The fibre that is brought to the processing factories in Colombo is in the dry state and contains small particles of pith which the earlier treatment has failed to remove. Under the mechanized processes to which fibre is submitted in the factory most of the dry residual pith is given off.

Two of the biggest processing factories in Colombo which were established over 70 years ago together handle 56% of the country's export trade and are therefore responsible for nearly half the fibre available in the world market. These two factories were selected for the present survey. They employ 1 246 out of the 3 696 workers who were engaged in the fibre processing in Sri Lanka at the beginning of 1973. The rest of the workers are employed in smaller factories which are less mechanized and therefore more labour intensive.

In the two selected factories processing is carried out in several large halls. More than one process is housed in the same hall which has no partitions to separate the sections. The halls are covered on all four sides but they are fitted with large open doorways. Much dust is generated in the teasing and twisting machines but ducts fitted to them lead the dust to a central point where it is collected in sacks. As would be expected more dust is collected from teasing machines since teasing precedes twisting. In spite of this protective measure some dust escapes. Hackling and baling are also dusty processes. The atmosphere of the factory is heavily laden and the floor covered with dust. The dust consists of fine particles of pith which is a brown spongy substance similar to cork. The large particles are 3 to 4 mm in diameter. All the workers are exposed to the dust to a greater or lesser degree, but they do not wear masks.

#### Subjects and methods

The two factories had a labour force of 735 and 511 respectively. Only those workers who were directly en-

gaged in coir processing and exposed to dust were included in the study, categories such as office staff, watchers, and lorry drivers being excluded. The total number of workers admitted to the study was 779, the respective numbers from the two factories being 498 and 281. There were 95 women. An occupational history was obtained from each worker and checked with information supplied by the management regarding the type of work and length of service. A 70 mm radiograph of the chest was taken of every worker. Eighty-three workers who complained of respiratory symptoms or who had a definite or doubtful abnormality in the miniature radiograph were recalled and submitted to a clinical examination and a repeat postero-anterior radiograph of the chest on standard-sized film. Sputum examination by direct smear and culture for tubercle bacilli, white cell and differential count, and erythrocyte sedimentation rate were also done where indicated.

A control group of 591 workers from a nearby engineering firm were radiographed on 70 mm film. The social background of this group was similar to that of the coir workers.

Thirty-nine selected coir workers who had complained of respiratory symptoms or had some radiographic abnormality on standard-sized film were recalled five to 10 months later and re-examined in order to assess whether there was progression of their clinical condition.

The large factory has its own full-time medical officer who runs a well-equipped surgery where records are well maintained. The medical officer as well as the management of this factory were questioned regarding the incidence of respiratory disease among the workers, premature retirements, and deaths from respiratory causes.

## Results

The average age of the 779 workers examined was 30.1 years (Table 1).

TABLE 1  
AGE AND SEX DISTRIBUTION

Age group	Males	Females	Total
10-19	2	0	2
20-29	312	0	312
30-39	209	17	226
40-49	131	42	173
50-59	30	36	66
Total	684	95	779

The average period of service of the 779 workers was 11.2 years (Table 2); 235 (30.3%) workers had served for more than 14 years.

Respiratory symptoms occurred in 20 (2.6%) of the 779 workers. These symptoms were cough (17 workers), expectoration (10), dyspnoea (10), wheeze (6), chest pain (1), and haemoptysis (1). There were 22 workers with radiographic lesions; these con-

TABLE 2  
PERIOD OF SERVICE OF COIR WORKERS

Years	No.	%
0- 5	253	32.4
6-10	173	22.2
11-15	118	15.1
16-20	133	17.1
21-25	65	8.4
26-30	31	4.0
31-35	6	0.8
<i>Total</i>	779	100.0

sisted of small rounded opacities (6 cases), small irregular opacities (2), opacities suggestive of active tuberculosis (1) and inactive tuberculosis (10), large opacities (2), emphysema (2), and cavity (1). Only half the workers with radiographic lesions had symptoms. There was no radiographic deterioration in any worker when re-examined five to 10 months later.

Being unaware of the clinical and radiographic features which may result from exposure to coir dust, it was felt that several likely respiratory diseases should be considered.

#### Asthma

Asthma is well known to occur as a result of exposure to certain vegetable dusts of occupational origin. Therefore a close inquiry was made from the workers as to any history suggestive of this condition. There were six men with asthma, two of whom had it prior to their employment in the industry and therefore it could not be related to exposure to coir dust. Further, their attacks eased off in spite of regular exposure to the dust. Another two cases gave a family history of asthma. Their attacks occurred at fairly wide intervals though they worked regularly at the factory. Therefore it is unlikely that their attacks were precipitated by coir dust. In the remaining two cases there was no definite indication whether the asthma was related to coir dust or not. Asthma is a fairly common condition in Sri Lanka, and an incidence of six cases (0.8%) among 779 coir workers is consistent with the incidence in the general population.

#### Chronic bronchitis

Chronic bronchitis is seldom diagnosed in Sri Lanka, mainly because of low consumption of smoking tobacco and relative freedom from atmospheric pollution. There were only three cases of chronic bronchitis in the coir workers examined.

#### Byssinosis

As byssinosis is caused by dusts from vegetable fibres

such as cotton, flax, and soft hemp, workers were closely questioned regarding symptoms suggestive of this condition.

The factories operated three eight-hour shifts, and they were closed on Saturday afternoons and Sundays but none of the workers gave a history of Monday fever. The medical officer had not come across a single case of byssinosis, and the manager and supervisors were unaware of any such symptoms in the workers. Thus there is no clinical evidence to suggest the presence of byssinosis among coir workers. In this respect coir appears to belong to the same group as sisal, jute, and hard hemp.

#### Pulmonary tuberculosis

There were nine cases with definite evidence of past or present tuberculosis among the 779 coir workers. All of them had contracted the disease during their period of employment as coir workers. This prevalence is similar to that in the general population in Sri Lanka. Eight of the nine affected workers belonged to the small factory where 281 workers were examined, while there was only one case among the 498 workers in the large factory. If exposure to coir dust carried an increased risk of tuberculosis, then one would have expected a more even distribution of cases in the two factories where the average period of service of each set of workers was similar, namely 10.1 and 11.8 years respectively.

#### Discussion

The two factories selected for the study are the largest in Sri Lanka. They were mechanized and therefore the workers were much exposed to dust which was liberated in large quantities. A considerable labour force was employed in them. The workers had spent long periods in the factories, the average being 11.2 years; 37 workers had served for over 25 years. In these circumstances, if coir dust were capable of producing any disease in the lungs, this fact should emerge in this study.

The number of workers with respiratory symptoms was 20 (2.6%). In a recent random survey of the general population in Sri Lanka, when 29 054 persons were questioned, 4.7% of the population complained of respiratory symptoms (National Tuberculosis Survey Team and WHO Regional Tuberculosis Training and Evaluation Team, 1971). This provides epidemiological evidence that coir workers do not complain of respiratory symptoms any more than the general public.

The present study did not suggest an increased susceptibility of the workers to respiratory diseases such as asthma, chronic bronchitis, byssinosis or pulmonary tuberculosis.

There were 22 workers with abnormal radiographs. The majority of the lesions were due to active

or inactive tuberculosis. In nine men a past history of tuberculosis was obtained, while another two appeared to have inactive lesions. One worker with large opacities due to bronchiectasis had symptoms prior to working in the coir industry. Thus in 12 out of the 22 men, it may be inferred that the lesions were unrelated to occupation.

In the control group of 591 workers from an engineering firm, matched for age, there were 23 with abnormal radiographs. This difference between coir workers and controls is not statistically significant ( $\chi^2 = 1.21$ ). These findings suggest that coir workers probably do not develop any radiographic lesions due to their occupation.

The medical officer at the large factory was struck by the paucity of respiratory ailments among the coir workers in spite of the visibly dusty atmosphere they have worked in for years. This was corroborated by the manager and supervisors. Further, none of the workers themselves, even those with symptoms, attributed any respiratory illness to coir dust. Occasionally a heavy concentration of dust raised by a breeze may provoke sneezing, but the men denied that the dust caused irritation of the conjunctiva or the nasal mucosa. When they cleared the nose or the throat the secretions contained coir dust.

The large factory was established in 1901. According to the management only one worker has retired prematurely before the age of 55 years; one other died in harness from respiratory illness during the past 25 years. The former had pulmonary tuberculosis while the condition of the latter was not known. If coir dust were harmful to the respiratory system, one would have expected more premature retirements and deaths from respiratory illness.

It is of interest that the chemical composition of coir dust is closely similar to that of sisal dust (Table 3), and both these dusts are relatively innocuous to the respiratory system. Bagasse too contains lignin and cellulose but in rather different proportions. Its pathogenicity is probably mediated through a fungus.

TABLE 3  
COMPARISON OF CHEMICAL COMPOSITION OF  
COIR, SISAL, AND BAGASSE DUST

	Coir (Menon and Pandalai, 1958) %	Sisal (Stott, 1958) %	Bagasse (Lemone <i>et al.</i> , 1947) %
Lignin	25.2	38	15
Cellulose	35.0	30	55
Pentosans	7.45	15	24
Acetic acid	—	1	6
Moisture	11.9	9	—
Ash	8.7	12	—

The larger particles of coconut pith are spongy in texture and resemble cork in this respect. The exact chemical composition of cork has not been determined, but it too contains cellulose and cellulose-like material (20-32%) and lignin (20-32%). Other constituents include tannin (2.5-6.5%) and cerin (2-3%) (Cooke, 1949). Unlike coir dust, cork may produce a relatively benign pulmonary fibrosis known as suberosis (Cancellata de Abreu, 1971).

The benign nature of coir dust has important economic implications in an expanding industry which already employs about 75 000 persons in Sri Lanka. At the same time this fact should be of some importance to the importing countries, though workers who handle it in such countries are unlikely to be much exposed to the dust since hardly any pith should remain in the fibre once it is processed in the producing country.

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