BYSSINOSIS

RESPIRATORY CONDITIONS AMONG TEXTILE MILL WORKERS IN BAHIR DAR - ETHIOPIA

BY

mentesinot w. yohannes, m.d.

MASTER'S THESIS

Addis Ababa, Ethiopia, 1988

DECLARATION

I, the undersigned, declare that this thesis is my work and that all sources of material used for this thesis have been duly acknowledged.

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Place ADDIS ABABA

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ADDIS ABABA UNIVERSITY, FACULTY OF MEDICINE

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CERTIFICATE OF APPROVAL

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I hereby, recommend that the thesis prepared under my supervision by Dr. Mentesiont W. Yohannes entitled BYSSINOSIS: Respiratory Conditions among Textile Mill Workers in Bahir Dar - Ethiopia be accepted in partial fulfilment of the requirements for the degree of MASTERS OF SCIENCE IN COMMUNITY MEDICINE - M.Sc. (Comm. Med.)

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BYSSINOSIS

RESPIRATORY CONDITIONS AMONG TEXTILE MILL WORKERS IN BAHIR DAR - ETHIOPIA

BY

MENTESINOT W. YOHANNES, M.D.

Thesis submitted as Partial Fulfilment of the Requirements for the Degree of Master of Science in Community Medicine

(MSc. in Comm. Med.)

Addis Ababa, Ethiopia, 1988

Dedicated to

MY MOTHER, MRS. ATSEDE TEFERRA

For Leading Her Children into Intellectual Pursuits and in Memory

of My FATHER WOLDEYOHANNES WOLDEMESKEL.

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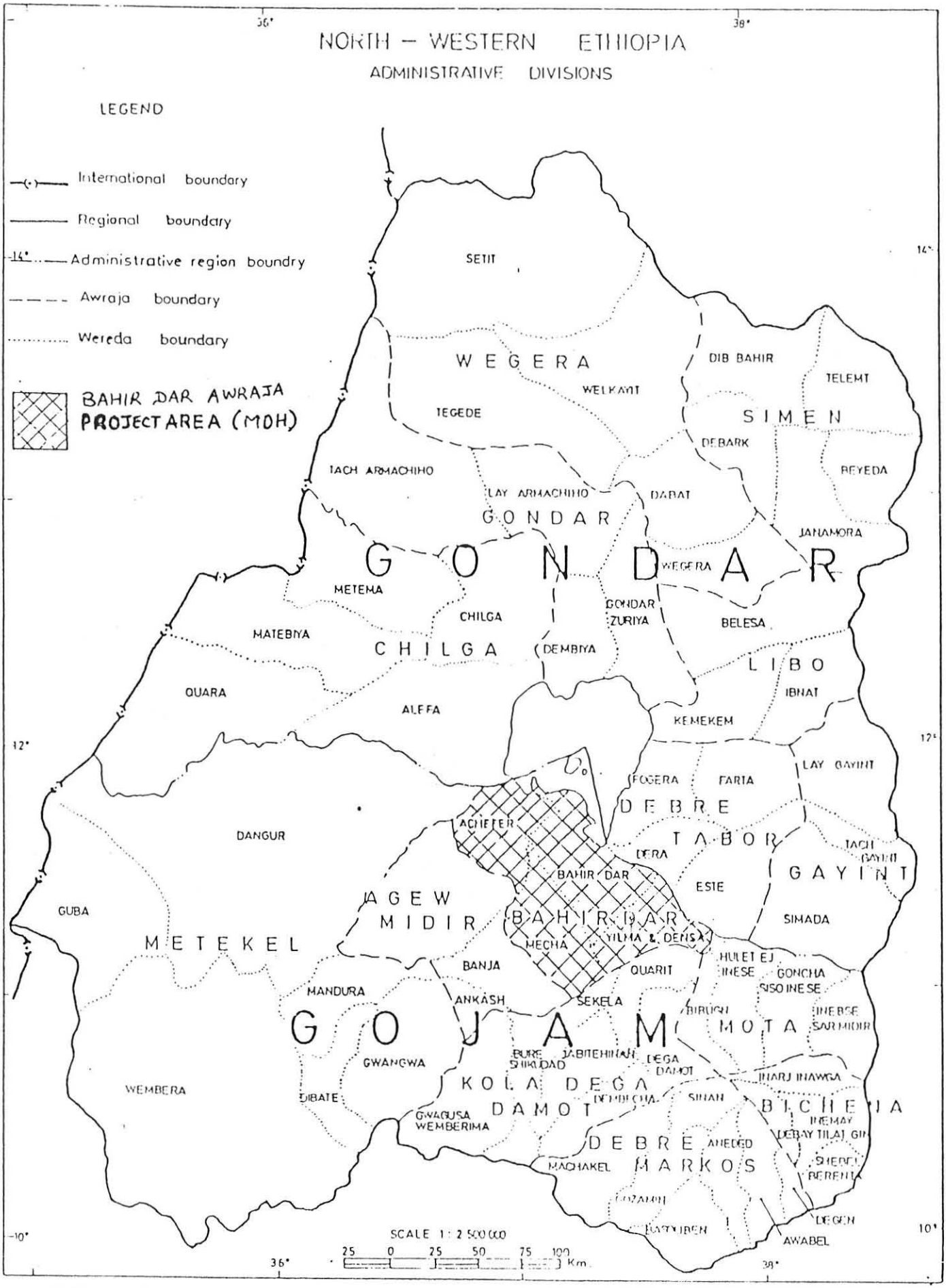
ABBREVIATIONS

ACGIH	-	American Conference of Governmental Industrial Hygienists.
ATS	-	American Thoracic Society
BTPS	-	Body Temperature and Pressure Saturated with water vapour.
CNRD	-	Chronic Non-specific Respiratory Disease
COPD	-	Chronic Obstructive Pulmonary Disease
CTMM	-	Cotton Textile Mill Management
EHPU	-	Ethiopian Health Professionals Union
FEV_1	-	Forced Expiratory Volume in one second
FVC	-	Forced Vital Capacity
IDRC	-	International Development and Research Centre
ILCA	-	International Livestock Centre for Africa
MLSA	-	Ministry of Labour and Social Affairs
MLSA-WSHS	-	Ministry of Labour & Social Affairs - Workers' Safety and Health Section
MOH	-	Ministry of Health
NTC	-	National Textile Corporation
OLD	-	Occupational Lung Desease
PDRE	-	Peoples Democratic Republic of Ethiopia
RIBS	-	Rural Integrated Basic Services
RTD	-	Respiratory Tract Disease
SD	-	Standard Deviation
TLV	-	Threshold Limit Value

SUMMARY

This study was conducted to investigate the prevalence of byssinosis and other respiratory conditions among 595 workers (322 male and 273 female) involved in dusty operations of a typical Ethiopian textile mill located in Bahir Dar, Ethiopia. A respiratory questionnaire was administered and pre-and post-shift forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) were determined for each worker. Multiple area air samples were analysed for elutriated dust concentration (range 0.86-3.52 mg/m^3) and personal sampling dust concentration (range: 1.03 - 3.83mg/m^3) . The case study groups and control groups were stratified by time weighted dust concentration and then cross-tabulated with respect to high and low cumulative dust exposure. The prevalence of byssinosis was assessed to be 43.2% among blowers and 37.5% in carders in comparison to 4 to 24% among workers in other sections. Chronic bronchitis and bronchial asthma also occurred in the range of 17.6 to 47.7% and 8.5 to 20.5% respectively,

in all sections. Significant accross-shift decrements in FEV_1 and FVC were observed in the case study groups when compared with control group. The estimated relative risk of developing byssinosis, bronchial asthma and chronic bronchitis accountable to high cumulative dust exposure were significant with an odds ratio of 21.76 , 5.72 and 3.64 than to low cumulative dust exposure. Significant dose-response relationship for pulmonary function and respiratory illnesses models was also observed by regression analysis. The result of this study revealed that the prevalence of byssinosis and other respiratory illnesses was very high in one of the mills processing raw cotton. Applications of proposed preventive measures and early detection of exposure effects are expected to reduce the prevalence of byssinosis and other respiratory illnesses. Further research including a nationwide survery is suggested in order to determine the magnitude of the problem nationwide. This study represents the first epidemiological study of the textile industry in Ethiopia using diagnostic criterion similar to those which are applied in developed countries, such as the United States and Great Britain. The study has also enhanced our knowledge and experience in integrating occupational health and intersectoral co-operation into practical implementation of primary health care.



SOURCE: Central statistical office (1976 E.C.)

CHAPTER I

INTRODUCTION

I. INTRODUCTION

Lung diseases are one among the most common causes of sickness, disability and death in both the developed and developing countries. Acute bronchitis, asthma, and lower respiratory tract infections are some of the most common causes of absence from work and school. Chronic lung diseases, as well as lung cancer, cause significant morbidity and economic strain to practically every nation of the world.

This Thesis which investigated the prevalence of Byssinosis and other respiratory conditions among Ethiopian workers involved in Dusty operations in one of the Cotton Textile Mills in Ethiopia is divided into six chapters.

Chapter 1 deals with the introduction giving background information on occupational lung diseases in general and the study area, i.e., Bahir Dar Cotton Textile Mill in particular. Chapter II sets out to review literatures on the state, extent and trend of the problem in developed and developing countries. Chapter III deals with the study methodology in detail. Chapter IV deals with the results obtained in depth and followed by the discussion of the findings in Chapter V. Chapter VI sets out with conclusions based on the main problems and findings dealt within the preceeding five chapters giving due consideration to specific working conditions and ways in which work is organised at present in this particular textile mill. This chapter ends with recommendations suggesting lists of relevant salient points whether the exact causes and

effects of byssinosis are known or unknown that might bring about an improvement on worker's health and on their family and social life, since the problem of cotton dust exposure is one of the most important and perhaps one of the most difficult issues facing those who - whatever their background or country are concerned about the working and living conditions of textile workers now and in the years to come.

Eventhough occupational lungs diseases have been recognised since the 16th century an effort is made to briefly summarize their magntude and major social implications in the following introductory material since as a result of which they occupied a prominent role in the study and practice of chest medicine ever since.

The respiratory tract, being one organ of the body which, like the skin, is constantly exposed to the external environment, it is not surprising that it often acts as a portal of entry for potential hazards. Moreover, environmental hazards which are not lethal, but cause effects in insidious fashion, may be difficult to study and identify. Some chemical agents reported to cause lung disease include such air pollutants as sulfur, nitrogen and other oxides, industriai pollutant chemicals, including asbestos and beryllium, and other chemicals, e.g. tobacco smoke, ingested drugs, and aerosol sprays. Biological factors which are hazardous include allergens, viruses and bacteria as well as fungi and insect debris. Adverse consequences of physical agents such as climate, sunlight, and ionizing radiation have also been reported. How much of a role these individual factors play in a workplace or environment remains to be determined on a case-by-case basis.

Coal workers pneymoconiosis (CWP), Silicosis, and asbestosis are examples of disorders caused by the inhalation of mineral dusts that have been the subject of much investigation. How coal dust specifically causes CWP remains unknown. Silicosis most often occurs after many years of exposure. The pathogenesis appears to involve macrophage toxicity as well as the release of lysosomal enzymes leading to fibrogenesis. Any role of immune factors remains unproven. Asbestosis has been the subject of much press, controversy, and litigation in recent years. It has been estimated that 1.5 million workers in the United States may have potential exposure, and exposure has been related to both cases of pulmonary fibrosis and respiratory tract cancer (116).

Other inorganic dusts which cause lung disease appear to occur less commonly. These include berrylium, aluminium, talc, as well as hard metal such as tungsten and colbalt. In addition, there may be acute toxic exposure from such metals as zinc, which may cause so called 'metal fume fever'.

Organic dusts of interest include cotton dust and grain dust which have been widely studied. We have had to rely upon epidemiologic approaches to provide most of the available.

information concerning these disorders because the pathogenesis remains unclear. Other organic dusts, however, are known which may cause clinical disorders known as hypersensitivity pneumonitis or allergic alveolitis, and although these may occur less commonly they have been intensively studied because they provide a model of low organic agents which may cause lung disease. These include such disorders as farmers lung (from thermophilic actinomycetes growing in moldy hay), bagassosis (from moldy sugar cane), maple workers lung (from moldy maple bark), as well as a wide variety of other disorders of similar pathogenesis.

Chemical vapors which have been reported to cause respiratory disease by immunologic mechanisms include toluene diisocyanate (TDI), which is found in the manufacture of polyurethane, may cause asthma by presumed immune mechanisms. Other substances including Western REd Cedar (plicatic acid), plasticizers, and epoxyresins (pthalic anhydride and trimellitic anhydride) have also been found to cause occupational asthma by immunologic mechanisms.

Irritant gases such as chlorine, nitrogen dioxide, and ammonia cause acute respiratory effects and in sufficient amounts

they may also induce bronchiolitis. In the chemical industry, occassional accidental spills have been reported where significant amounts of gases like chlorine or phosgene have escaped into the environment. Due to sufficient long-term data which has not yet been accumulated, the chronic effects of these exposures are at present unknown.

Occupational carcinogens which have been well studied include asbestosis and bis-chloromethylether. Tobacco smoke is a ubiquitous personal and enviromental pollutant. Although tobacco has been used in western culture for more than 400 years, human inhalation of cigarette smoke is a twentieth century phenomenon with major medical and economic consequences. Eventhough the cause and effect relationship between cigarette smoking and lung cancer is one of the best documented in medicine, the current epidemic still continues. Cigarette smoking is also the most important factor contributing to the development of chronic obstructive pulmonary disease (COPD), that is, chronic bronchitis and emphysema. In addition, passive smoking has been documented to cause adverse effects in children in the home, especially in the allergic ones. Smoking may, therefore, actually constitute an environmental and occupational hazard to nonsmoking individuals, although the effects are not yet completely clarified.

Eventhough the subject of occupational lung diseases has been complex and diverse since the time of its recognition. Margret Turner - Warwick [114] has recently summarized quite concisely some of the problems of occupational lung disease (OLD). These include:

i. diverse manifestations,

ii. overlooked environmental factors,

iii. difficult-to-define causal factors,

I V. difficulty of defining dose-response and threshold levels for a hazard free environment,

V. difficulty of case definition,

Vi. the even more-difficult-to-define preclinical/subclinical cases,

Vii. the emergency of nonscience issues resulting from resolution of science questions, and

Viii. unpopularity and unattractiveness of final choices.

"When all is said and done, the community through its politicians has to consider whether the advantages to the community of a particular product as a whole outweigh the hazard which may be inevitable during the course of its production. In the final analysis this may prove to be the greatest problem of all"(114)

It is not surprising, therefore, that a problem so complex and diverse has been the subject of our present study, i.e. the prevalence of byssinosis and other respiratory conditions among Bahir -Dar textile mill workers exposed to a cotton dust environment. In spite of the controversy that will arise in the application of proposed recommendations based on the findings which really deserve the concern of all those responsible for the protection of workers' health. Just a few years ago, the word environment was still only rarely used: it is now everywhere in every day use. It refers to everything that surrounds us: the air that we breath, the dwellings we live in, the fertile land and the deserts, the oceans, seas and rivers, the animal world, our places of occupation, our social relationships, and even our general living conditions.

If today there is deep concern to protect our environment, it is not only because it is indispensable to life in all its forms but also because it is threatened.

We are living in an age of technological progress that is rapidly advancing and the benefits of which are accompanied by some baneful effects on mankind as well as on the environment.

The rapid development of methods of production, means of transport and trade has given birth to many industries which have been increasingly grouped together in vast complexes. Labour has settled around these industries, in the towns and outskirts with a resulting rapid growth of population. Workmen's garden cities, roads, railway lines, industrial plants, etc., have been built without any overall planning.

It is at his place of work in the environment that the worker spends at least one-third of his time. The working environment exercises a decisive influence on the health and safety of the individual, as well as on his physical and mental well-being. The stress factors existing at the place of work are many and varied. They include the physical aspects of the environment, such as the microclimatè (temperature, humidity, etc), dusts, gases and vapors, ionising radiations, noise and vibrations, as well as pollution from all sorts of effluxes. Most of the work

involves the use of products and materials liable to release emanations or dusts that could be harmful to health. The factors of stress also encompass certain aspects of the organisation and nature of the work, such as the pace of work, repetitive or monotonous work, night shifts, etc. The quality of human relations within the undertaking, including the psychological climate, and the problems of mental health that arise are also regarded as forming part of the working environment.

While it is incumbent on all of us to take part in the protection of the environment, the worker has a role to play with a three-fold capacity - as an individual, as a member of the community and as a trade unionist. He must have at his disposal, therefore, all the information that will enable him to take stock of the conditions of his life at work, in his home and with his family, as well as of the close connections between the world of labour, economic life and the environment in general.

If trade unions are concerned about the conservation of the environment, it is precisely because it is their responsibility to protect the worker at his work and to improve his living conditions. The worker himself, on his part, occupies a unique position since he is the key element in a system of production that can contribute to the deterioration of the environment.

Conservation of the environment is, today, implicit in the very notion of development. How, indeed, could one speak of economic growth and improvement of the quality of life and at the same time, say the impact of that growth had adverse effects on the daily life of the individual and threatened the future?

It may be thought by some that this study which attempted to assess the effect of cotton dust exposure on the respiratory system among textile mill workers is too one-sided and stressed especially the ill effects of economic growth. There is, however, no questioning of the undoubted benefits in the improvements of standards of living resulted from technical progress in this textile mill when the no less obvious ecological damage it has done is also brought to light.

Conditions of work in the textile industry, including problems related to organisation of work have inevitably been affected by the developments, not to say upheavals, that have taken place in the textile industry in the past 30 years or so.

Apart from the general economic situation, characterized in many countries by inflation, fierce competition accompanied by exceptionally rapid technological progress has led to an expansion in textile manufacturing in some countries while operating at the expense of causing serious damage to the industry in others. This has had repercussions, firstly on the standard of living of workers, and secondly on the modus operandi of the undertakings themselves, on their efforts to keep running at a profit. These factors have in their turn affected working hours, renumerations, job content and of course workers' health.

The author of this thesis, however, fully aware of the close links between home and work place, housing location and conditions, welfare facilities, etc., concentrated primarily on the deleterious effects of cotton dust exposure on the respiratory system that occur in textile mill workers. As there are no reported data on the prevalence of byssinosis and other respiratory symptoms among textile mill workers in Ethiopia, the author investigated the prevalence of byssinosis and other respiratory symptoms among Ethiopian workers involved in dusty opertions in

different sections of the spinning and weaving departments of Bahir Dar Textile Mill in an attempt to elucidate the determinants and to test serveral hypotheses associated with the occurrence of byssinosis.

Bahir Dar Textile Mill, in Bahir Dar Awraja (District), Gojjam Region, was established in the early 1960's with a some-what current ventilation system installation in the early 1980's . At present, it has a working population of 3,500. Including its extended family it comprises about 35% of the population of Bahir Dar town. In this textile mill, a daily eight-hourly system is operating continuously for the whole week, while intermittently providing a "day-off" for each worker to rest.

The leading causes of morbidity[115] are intestinal parasitosis, diarrhoeal diseases, upper respiratory tract infections, and all skin disease in Bahir Dar Awraja, intestinal parasitosis, all skin diseases, venereal diseases and upper respiratory tract infections in Bahir Dar Town, and , upper respiratory tract infections and bronchial asthma, nervous strain (anxiety neurosis), gastritis and duodenitis, arthritis and rheumatism unspecified in Bahir Dar Textile Mill.

Last but not least, it is the belief and opinion of the Authors that taking these specific problems as an entry point, the present findings and suggestions will serve as a basis to draw strategies in in-corporating occupational health and safety into urban primary health care activities.

CHAPTER II

LITERATURE REVIEW

II. LITERATURE REVIEW

Although the current concern for occupational health hazards suggests that they are a result of a modern industrialised society, it had been recognised long before that respiratory diseases are frequently encountered among workers exposed to a variety of dusts in agricultural and industrial settings in many countries of the world.

Occupational diseases were first described by the Greeks and Romans. By the 4th century B.C. hazards in the mining industry had been recognised at the time when protection for workers and prevention of diseases were not given due consideration. Five hundred years later, Pliny the Elder described a bladder-derived mask used to protect labourers from inhaling lead dust and fumes. In 1556, Georgius Agricola suggested the introduction of mine ventilation and recommended the use of protective masks. He also described the disease now known as silicosis[1].

The first generally accepted treatise on occupational hazards in the work place was De Morbis Artificum by an Italian Doctor Bernando Ramazzini published in 1713. His book described several occupational lung diseases including those that are manifested in farmers, bakers and millers, grain measurers, and hemp workers[2]. It is worthy to note that many of the illnesses described by Ramazzini resulted from exposure to organic

dusts. Today, dusts from wood, grain (and flour) and textile fibers and/or contamination by microorganisms account for a large number of respiratory disorders of occupational origin[3].

There are a limited number of ways in which the lungs may react to foreign agents depending to a large extent upon their nature and properties. Toxic gases and fumes may cause acute haemorrhagic tracheobronchitis and bronchiolitis, pulmonary oedema, haemorrhagic pneumonitis and destruction of alveolar epithelium. Dusts provoke reactions which range from trivial local aggregation of cells at one end of the scale to striking and often progressive collagenous fibrosis or widespread, but resolvable, cell accumulation or granulomas at the other. Some substances in all these categories may be capable of inducing asthma. The character and severity of reactions are determined by at least three basic factors:

i. the nature and properties of the dust;

ii. the amount of dust retained in the lungs and the duration of exposure, i.e. the dose x time relationship;

iii. individual idiosyncracy and immunological reactivity of the subject.

Each of these poses complex problems, whereas the identity and physicochemical characteristics of inhaled dusts are usually known. The reasons for the differing patterns of events which follow their retention are not completely understood. Generally, it can be said that the extent of disease likely to be produced by a dust fibrogenic potential is proportional to the amount of dust and the period of time over which it is inhaled; a large dose over a short period and a small dose continued over a long period are both liable to cause disease. Obviously, a simple but all-embracing concept of the pathogenesis of the different types of pneumoconiosis and other occupational diseases cannot be expected because, on one hand, the composition of inhaled and potentially noxious substances, and on the other, the reaction of the body to them differ both qualitatively and quantitatively[4]. *Complaints may occur singly or as a part of a 'symptom complex' as seen in workers exposed to cotton, flax, or hemp dusts.*

Ramazzini described the respiratory problems observed in textile workers: ".....For a foul and poisonous dust flies out of these materials, enters the mouth, then the throat and lungs, makes the workmen cough incessantly, and by degrees brings on asthmatic troubles.....one may see these men always covered with dust from the hemp, pasty-faced, coughing, asthmatic, and blear-eyed.....they cannot help taking in foul particles by the mouth; these pollute the spirits and stuff up the organs of respiration....."[2].

Not only was respiratory disease among textile workers recognised by the father figures of occupational medicine[2,5], but was also described by the nineteenth century English novelist Elizabeth Gaskell[6].

> "Fluff?" said Margaret inquiringly.
> "Fluff," repeated Bessy. "Little bits, as fly off fro' the cotton, when they're carding it, and fill the air till it looks all fine white dust. They say it winds round the lungs, and tightens them up. Anyhow, there's many a one as works in a carding room, that falls into a waste, coughing and spitting blood, because they're just poisoned by the fluff".

Although the term byssinosis, the respiratory disease affecting cotton, flax and hemp workers, was not used until 1877[7], its cardinal symptom was first described by Mareska and Heyman, two Belgian physicians in 1845: ".....All workers declared that the dust troubled them much less on the last days of the week than on Monday and Tuesday....."[8].

The term 'byssinosis' (βύσσος = flax and linen made from it), introduced by Proust in 1877[7] and first employed in 1902 in Great Britain by Oliver [9], embraces a gradation of

respiratory symptoms due to exposure to the dust of cotton, flax, soft hemp and, to a limited degree, sisal which range from acute dyspnoea with cough and reversible breathlessness and chest tightness on one or more days of a working week to (it is believed) permanent respiratory disability due to irreversible air flow obstruction.

Although cotton and flax have been used in the manufacture of textiles since times immemorial, byssinosis does not seem to have been recognised or possibly, to have existed until the introduction of mechanised processes in the early nineteenth century [10]. *In 1831 Kay described respiratory disease, which appears to differ from 'bronchitis' in cotton workers in Lancashire where most of the British cotton industry was concentrated, but in 1860 Greenhow seems to have given the first clear description of the symptom pattern now usually associated with byssinosis* [12], *namely, that of late-onset asthma which worsens at the beginning of the working week than at the end, and an increased severity of symptoms on the first day at work after an absence of more than a weekend.*

After a number of studies on textile workers during the last 25 years, it is now generally accepted that hazardous textile dusts fall into two distinct groups. First, there are those of cotton, flax and soft hemp (cannabis sativa) which give rise to

a disease known as byssinosis; and secondly, there are the dusts of jute, manila, sisal etc., which cause persistent cough and expectoration, but not the symptoms of byssinosis[13]. At this point, it is important to note that other symptoms referred to as mill fever, weavers' and mattress makers' fever had been described and may still occur following exposure to cotton, flax or hemp as they are distinct from byssinosis[4].

About 30 years ago, byssinosis was thought to be confined to Lancashire cotton workers (Schilling, 1956)[14] and flax workers in Northern Ireland (Smiley, 1951)[15] where it was commonly known as 'poucey*chest' and affecting only men engaged in the spinning process.

However, it was subsequently reported to occur among workers in various processing units in Scotland (Smith et al..1962)[16], Holland, Germany, Sweden, the USA, Egypt, Greece, India and Taiwan (Bouhuys et al., 1967a)[17], Spain (Bouhuys et al., 1967 b)[18], Belgium (Tuypens, 1961)[19], Australia (Gandevia and Milne, 1965 a)[20] and Israel (Chwat and Mordish, 1963)[21].

The orthodox model of the natural history of byssinosis owes much to the studies of Schilling and his co-workers[23,24], After some years in the mill, a textile worker preparing or spinning cotton, flax or hemp develops 'chest symptoms' on the first day

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*'poucey' is a dialect used to mean dirty or nasty.

of work after a break - generally, a Monday (grade ½) in western countries. As the disease progresses these symptoms become apparent every Monday (grade 1) and later, on subsequent weekdays as well (grade 2). At that stage, it is believed, removal of the worker from that particular exposure would relieve him of symptoms and any long term effects. Should he continue to be exposed, permanent respiratory disablement may supervene (grade 3).

This model of the natural history appears to have been established from a series of cross-sectional studies of workers with different exposures to dust (differing in both duration of exposure and concentration) and at varying progressive stages of the disease. No major longitudinal studies covering the complete time span through to residual respiratory disability have been reported[25].

In byssinosis all the symptoms are important as there are no characteristic changes observed from physical examination, radiography, or pulmonary function tests. Indeed, all the findings are frequently normal.

With the advent of epidemiological studies in the 1950s the description of the symptoms was relayed from the patient to the investigator so that the patients' response to an interview could be restricted to 'yes' or 'no'. The word tightness was

chosen, with the result that most present day descriptions of the disease tell us that 'tightness' is what the patient feels. This total reliance on a single symptom has led some investigators to look for more objective ways, such as measurement of FEV_1 in determining the disease. So we now have a model consisting of presumptions that chest 'tightness' generally accompanied by a fall in FEV, during the day, occurs at the start of the working week and that both the initial and long-term effects are stages of the same disease process. This model forms the basis of proposals for a medical surveillance programme for exposed workers, put forward by a working party of the Health and Safety Executive[26]. It also forms the basis by which claims for disability are judged.

Although clinically characterised for more than a century, neither the etiologic nor the pathogenic mechanism(s) of byssinosis have been determined. Byssinosis occurs throughout the world where cotton, flax and soft hemp fibers are processed; however, cotton dust is most commonly responsible.

A major problem in the evaluation of the causative agent(s) or disease mechanisms is the extreme heterogeneity of cotton dust. Cotton dust is, by definition, a 'dust generated into the atmosphere as a result of the processing

of cotton fibers combined with naturally occurring materials such as stems, leaves, bract, and inorganic matter which may have accumulated on the cotton fibers during the growing and harvesting periods'[27]. In addition, cotton dust is heavily contaminated by gram-positive and gram-negative bacteria and molds.[28-32] Aqueous extracts of cotton dust, plant parts, and microbial agents exhibit a wide variety of biologic responses including, but not limited to activation of the alternative pathway of complement,[33] chemotaxis,[34] pharmacologic mediator release,[35,36] smooth muscle contraction,[37] and ability to induce antibody production.[28,29]

The prevalence of byssinosis in cotton workers varies according to the quality and quantity of 'responsible' dust in their work environment. Plant debris and other foreign matter ('cotton trash') associated with cotton fiber appear to be the source of the agent or agents which cause byssinosis. 'Medium' to 'coarse' dust from lint is generated during the ginning process as well as the opening of the bales, stripping and grinding of carding machines. In general, the prevalence of all grades of byssinosis is proportional to the total concentration of dust of 'medium' and 'coarse' cottonless 'fly' (coarse waste cotton) and to the duration of exposure. (Zuskin and Valic, 1972).[22]

Prevalence among cotton ginnery workers in tropical countries was reported to be 20 per cent in the Sudan (khogali, 1971)[40] and 38 percent in Egypt (El Batawi, 1962).[41] In England, between 1963 and 1966 the total prevalence of byssinosis grades ½ and 2 was 26.9 percent and was higher in 'coarse' than in 'medium' cotton mills (Molymeux and Tombleson, 1970).[42] Among cardroom workers in Holland a prevalence of 17 percent was reported (Lammers, Schilling and Walford, 1964)[43] and in the USA, 25 percent (Zuskin et al, 1969).[44]

Byssinosis is associated with dust concentration and years of exposure. There is also an association between the incidence and dust levels. The highest prevalence occurs among strippers and grinders and the lowest among ring spinners (Berry, Molymeux and Tombleson, 1974).[45] By expressing dust exposure in terms of a time-weighted dust measurement (time-weighted dust concentration = length of exposure in mg years/m^3), it has been reckoned that approximately 10% of workers exposed to 0.5 mg/m^3 of cotton dust for 40 years will contract byssinosis (Fox et al. 1973).[46] Prevalence is reported to be higher in men than in women but whether there is a true sex or occupational difference is not known; certainly more men than women smoke.

Among spinners in Holland and the USA prevalence was reported to be 1.6 and 12 percent respectively (Lammers, Schilling and Walford, 1964; Zuskin et al. 1969).[47] In cotton seed (non-textile) mills where levels of respiratory and total dust were high, prevalence was found to be low although there was a mean decline in ventilatory function during a working shift, but not on Fridays (Jones et al., 1977).[48] Possible explanations for varied prevalences of byssinosis in different countries between operational sections may be due to various factors including the type of cotton processing, dust composition and concentration to which individual workers are exposed as exemplified by strippers and grinders who move continuously over a large working area (Berry, Molyneux, and Tombleson, 1974).[45]

There is some evidence that byssinosis is not more prevalent among topic than non-atopic workers (Bouhuys, 1966)[49] but surveys of a large number of employees using a method of defining atopy do not appear to have been reported. However, asthmatic individuals, who react severely to cotton dust and others who develop symptoms shortly after employment certainly leave the industry at an early stage (Harris et al., 1972).[50]

Smokers experience a greater incidence of byssinosis and loss of ventilatory function at all levels of dust exposure, and also show a greater tendency to develop byssinosis with increasing dust exposure than non-smokers. Cotton workers who smoke contract byssinosis of each grade more significantly than non-smokers at a dust concentration and length of exposure allowed for (Elwood et al., 1965;[51] Bouhuys et al., 1967 b[18]; Fox et al., 1973[46]; Merchant et al., 1973 a[52]; Berry, Molyneux and Tombleson, 1974[45]).

Fox et al., (1973)[46] and Berry, Molyneux and Tombleson (1974)[45] found that the prevalence of 'chronic bronchitis' (MRC definition) is not related to dust concentration but Merchant et al., 1972[53] concluded that byssinosis and 'chronic bronchitis' (mucus hypersecretion) are both influenced by cotton dust exposure and cigarette smoking. Evidence for bronchitis, however, is not always present (Imbus and Suh, 1973).[54] In Australia, the prevalence of productive cough and impairment of respiratory function in cotton mill workers was not found to be specifically attributable to exposure to cotton dust and was less than that observed in current cigarette smokers (Field and Owen, 1979).[55]

As stated earlier, acute and chronic byssinosis are differentiated by the severity of symptoms and more important, by the persistence of symptoms during the work week and away-from-the-work environment. Acute symptoms are particularily evident on the first day of work after the weekend break or after holidays. These acute symptoms are reversible but gradually subside over a period of several days in the work environment or immediately when removed from it. The acute byssinotic reaction can be described clinically by symptoms like chest tightness, breathlessness, coughing and slight elevation in body temperature.[56] Physiological changes include a drop in the 1-second forced expiratory volume (FEV_1) caused by airway constriction;[56] and haematological changes include peripheral leukocytosis and leukocyte recruitment to air passages.[57] These acute symptoms gradually develop into chronic irreversible symptoms which persist in a dust-free environment.[50,58] Elimination of this chronic obstructive disease requires prevention of the acute disease and thus, the identification of the etiological agents and mediators involved in the pathogenesis.

CHAPTER III

RESEARCH METHODOLOGY

III. RESEARCH METHODOLOGY

A. OBJECTIVES

The object of study in this investigation was to determine the deleterious effects of cotton dust exposure on the respiratory system, that occur in textile mill workers involved in dusty operations. As there are no reported data on the prevalence of byssinosis and other respiratory symptoms among textile mill workers exposed to cotton dust in Ethiopia, the purpose of this study was to describe as well as to analyse the findings.

The specific objectives were:

1. to investigate the prevalence of byssinosis, chronic bronchitis, bronchial asthma and other respiratory symptoms among Ethiopian workers involved in dusty operations in the various sections of the spinning and weaving departments, i.e. blowing, carding, drawing, simplex, ringframe, preparatory and weaving sections of the Bahir Dar Textile Mill, Gojjam Region, Ethiopia, and,

2. to explore the determinants for the occurrence of byssinosis.

B. HYPOTHESIS

In addition to the descriptive objectives of this investigation, the following hypothesis focussed on workers involved in dusty operations in the aforementioned sections of the Bahir Dar Textile Mill, were tested.

H1. *The prevalence of byssinosis directly corresponds to the level of cotton dust concentration.*

H2. *The prevalence of byssinosis directly corresponds to the duration of exposure to cotton dust*

H3. *The prevalence of byssinosis is more pronounced in smokers than non-smokers.*

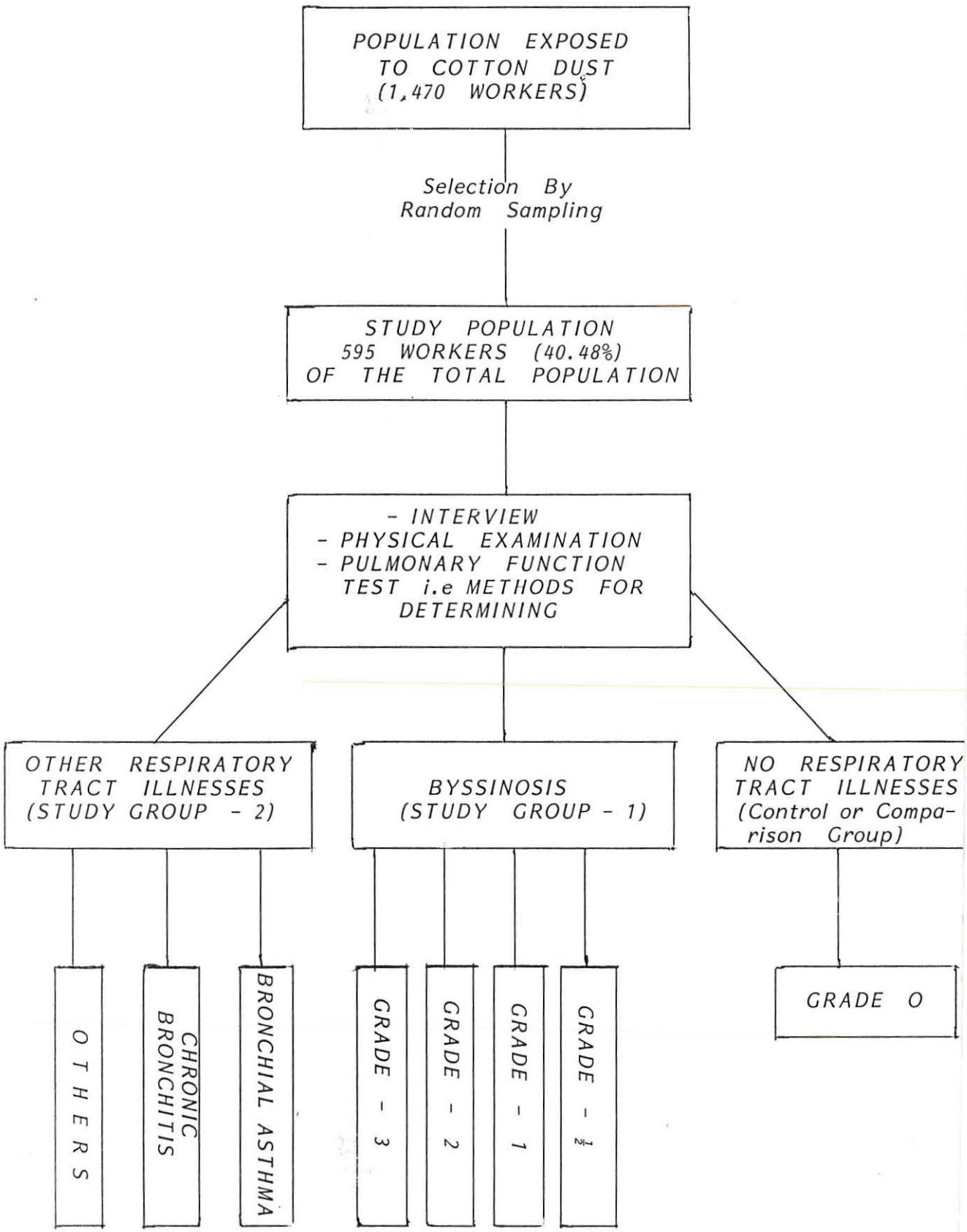
C. DESIGN (Refer to Figure 1)

A case control study was conducted on over 40% of workers exposed to dusty operations in Bahir Dar Textile Mill.

D. POPULATION (REFER TO TABLE 1)

595 workers (322 Male and 273 Female) representing 40.48% of workers involved in dusty operations in the blowing, carding, drawing, simplex, ringframe, preparatory and weaving operations were randomly selected on the guess estimates based on respiratory symptoms and examined for the presence...

Fig. 1. THE STUDY DESIGN OF BAHIR DAR TEXTILE MILL WORKERS



(Bahir Dar 1988)

TABLE I. WORKERS EXPOSED TO COTTON DUST OPERATIONS IN BAHIR DAR TEXTILE MILL BY SEX, DEPARTMENT AND SECTION

DEPARTMENT	SECTION	TOTAL POPULATION				STUDY (SAMPLE) POPULATION			
		M	F	TOTAL		M	F	TOTAL	
				No.	%			No.	%
SPINNING	BLOWING	76	15	91	6.17	44	-	44	7.39
	CARDING	76	-	76	5.15	40	-	40	6.72
	DRAWING	16	37	53	3.59	10	15	25	4.20
	SIMPLEX	65	21	86	5.83	28	14	42	7.06
	RING FRAME	101	476	577	39.12	28	146	174	29.24
WEAVING	PREPARATORY	138	159	297	20.14	37	91	128	21.51
	WEAVING	258	37	295	20.00	135	7	142	23.87
TOTAL		730 (49.49)	745 (50.51)	1,475	100.00	322 (54.12)	273 (45.88)	595	100.00

(Bahir Dar, 1988)

of byssinosis and other forms of respiratory problems. Then, workers found to have byssinosis and other forms of respiratory problems were compared with workers having no respiratory problem i.e. cases vs. controls, in terms of the level and duration of exposure to cotton dust and other independent variables.

For the purposes of data collection and management the principal investigator and manager (co-ordinator) of the research project formed three data collection teams that carried out the following functions.

Data Collection Team 1:	interview and physical examination
Data Collection Team 2:	height and weight measurements, and pulmonary function tests.
Data Collection Team 3:	environmental assessment

E. INTERVIEW AND PHYSICAL EXAMINATION

A modified version of the British Medical Research Council Questionnaire (1980) was filled out on each worker on his/her social, personal, occupational, and past history of illness with emphasis on respiratory and allergic diseases and smoking habits.

Each worker was then examined for the presence of signs of any respiratory disease and chest deformity by one trained physician having no prior knowledge of the worker's section and/or health status.

The stages of byssinosis were defined to allow for subdivision on clinical grounds according to the clinical grades suggested by Schilling et al. (1963).[60]

Grade 0: *No evidence of cough, chest tightness or breathing difficulty on the first day of the working week.*

Grade ½: *Occasional tighntess of the chest on the first day of the working week.*

Grade 1: *Tightness of the chest and/or difficulty in breathing on the first day only of the working week.*

Grade 2: *Tightness of the chest and/or difficulty in breathing on the first and other days of the week.*

Grade 3: *Grade 2 symptoms accompanied by evidence of permanent respiratory disability from reduced ventilatory capacity.*

Subjects who complained of chronic and recurrent cough or phlegm on most days for at least three months per year for two successive years were diagnosed as having chronic bronchitis, (Fletcher, 1959). [16] Subjects with a present history of recurrent attacks of paroxysmal dyspnoea accompanied by wheezing, which was relieved by antispasmodics, were diagnosed as bronchial asthmatics (Hinshaw and Garland, 1963). [62] Chronic coughing and/or phlegm is defined as coughing and/or phlegm production on most days for at least three months per year. Subjects who complained of sneezing, rhinorrhoea, obstruction to the nasal passages, conjuctival and pharyngeal itching and lacrimation were diagnosed as having hay fever [93]

Subjects who gave confirmed past history of pneumonia and pulmonary tuberculosis were also considered in this study, i.e. Those who had documented clinical records.

F. PULMONARY FUNCTION TESTS

Ventilatory function measurements were made on workers who had interrupted their exposure to cotton dust for at least one day due to absence from work before getting on to the first shift after the day (s) off and at the end of the same shift. Two multipurpose spirometers were used for this purpose whose order of use was randomized.

The spirometers were calibrated for volume, time and flow before each testing session. Care was also taken to ensure that the instruments were horizontally placed and none of the airventing slots obscured.

The procedures of measuring forced expiratory volume in one second (FEV) and forced vital capacity (FVC) were clearly explained and demonstrated to each subject and their consent obtained.

Measurements were then taken on the subject sitting upright with the nose clipped. Five expiratory efforts were recorded and the mean of the two highest values was used to estimate the FEV_1 and FVC according to the American Thoracic Society (ATS) criteria for spirometric techniques for epidemiological studies.[63] All volumes were adjusted to body temperature and pressure saturated with water vapour (BTPS), i.e:

$$V_{BTPS} = V \frac{310}{T} \frac{P-PWT}{760 - P_{W37}}$$

where, V = volume measured

T = room temperature

P = actual barometric pressure

P_{WT} = pressure of water vapour at room temperature

P_{W37} = Pressure of water vapour at $37^{O}C$

The preshift FEV_1 values were compared with the expected normal values of Cherniack and Rater.[64]

G. ENVIRONMENTAL ASSESSMENT

The concentration of airborne dust in the breathing zone was determined for each participant during his/her entire shift with the Casella Personal dust sampler which consists of a sampling pump, a pulsation damper and a gravimetric dust sampler, fitted with 10 mm. cyclone for the assessment of 'personal' respirable dust (below 7 microns diameter). The sampling head was attached to a harness (worn by each participant) and fastened to the lapel and the pump attached to the waist belt. The sampling rate was set to 0.2 l/min. and frequent checks were made to maintain it.

The concentration of airborne dust in the general environment of the operation units where the participants worked was concurrently monitored with an Anderson dust sampler fitted with a vertical elutriator.

The instrument was set up at a height of 1.5m at selected positions that evenly covered the work zone. Dust samples were drawn at a rate of 7.4 l/min. to measure the 'inhalable' fractions (below 15 microns diameter).

The dust samplers were calibrated before sampling and the critical orifices used to control flow rates were calibrated against a flow meter.

All samples were collected on whatman glass fibre GF/A with 3.7 cm. diameter to fit the sampling heads. Each filter was weighed before and after sample collection.

Multiple area samples were taken from each operational section and the duration of sampling ranged between 8-10 hours (mean 8.7 hours). After the desired period of exposure time, the sampling filters were removed from the instrument in a dust-free atmosphere, placed into a box and carefully transported (without shaking) to the Polytechnic Institute Analytical Chemistry Laboratory (Bahir Dar, Gojjam) for reweighing.

Weighing was done on a calibrated analytical balance at a sensitivity level of 10^{-5} (0.00001) mg. after equilibrating filters in the laboratory for 24 hours under conditions of similar temperature and relative humidity. The concentration was calculated according to the following equation.

$$\text{Concentration in } mg/m^3 = \frac{(\text{final weight} - \text{initial weight})}{\text{Time in minutes} \times \text{flow rate}} \times 1000$$

H. DATA ANALYSIS

The prevalence of byssinosis, chronic bronchitis, bronchial asthma and other respiratory tract symptoms was determined. The relative magnitude (ratio) of proportions between variables was also established. Then a comparison of means and proportions was carried out for the airborne dust concentration, the prevalence of byssinosis and other respiratory problems and between categories of smoking, by chi-square analysis and t-test. The latter tests were used to perform a comparison of means and proportions for cases vs. controls (case study group 1 = Byssinosis, case study group 2 = other respiratory tract illnesses, case study group 1 & 2 = total respiratory tract illnesses including byssinosis, and control or comparison group = no respiratory tract illnesses) and estimates of risk were derived.

The acute changes in FEV_1 over the workshift were expressed as $\frac{\text{Preshift } FEV_1 - \text{postshift } FEV_1}{\text{Preshift } FEV_1} \times 100 = \Delta FEV_1\ \%$

The acute changes among byssinotics and between byssinotics and control in the different sections were compared using the chi-square analysis. The acute changes in FEV_1 during exposure to Cotton Dust were analysed according to Bouhuys et al[59] as follows:-

A fall in FEV_1 of less than 0.6 litres was considered as a non-acute effect, between 0.06 and 0.2 litres as a slight effect and more than 0.2 litres as a definite effect.

The chronic changes in FEV_1 among exposed workers were also analysed according to Bouhuys et al [59] as follows:- workers with FEV_1 greater than 80% of the predicted values were considered to have no chronic ventilatory impairment, those with FEV_1 60 to 80% slight to moderate, and those with FEV_1 less than 60% to have from moderate to severe impairment.

Finally, the relative contribution of the independent determinant variables to the accurrence of byssinosis and other respiratory problems was examined by straight-line and multiple regression analysis and from the results a regression model and estimates of risk were derived.

For all tests, P less than 0.05 was considered significant.

CHAPTER IV

RESULTS

IV. RESULTS

A. POPULATION

All 595 textile mill workers (323 male and 272 female), sampled from workers involved in the dusty operations, participated in the study signifying a 100% participation rate, i.e. all workers in the study underwent voluntarily interview and pulmonary function testing.

Workers from all the study sections were comparable in age, but differred in sex, height, weight, years of employment and exposure level to cotton dust. There were only 14 smokers and 4 ex-smokers (3.0%), all male.

Over 95% of the cotton workers had not changed jobs or their sections during the course of their employment and only 8 workers (1.34%) had worked in other dusty environments prior to their employment to the textile mill.

B. ENVIRONMENTAL ASSESSMENT

The concentrations of airborne cotton dust in the different sections of Bahir Dar Textile Mill are shown in Table: 2

The highest concentration of cotton dust, inhalable and respirable, was recorded in the blowing and carding sections, whereas the lowest was recorded in the weaving and preparatory sections.

The amount of dust generated in the blowing and carding operations was significantly higher ($P < 0.005$) and more than two fold compared to other operations.

The personal - respirable sampling concentrations were consistently higher than those obtained by the vertical elutriator in all the sections. This might be due to the fact that the personal dust sampler is closer to the machine where dust was emanating.

TABLE: 2 THE CONCENTRATIONS OF AIRBORNE COTTON DUST IN STUDY SECTIONS BY AREA SAMPLING & PERSONAL SAMPLING (MEAN ± SD)

Section	Number of Samples	Area Sampling	Personal Sampling
		"Inhalable" Dust mg/m^3	"Respirable" Dust mg/m^3
Blowing (1)	14	3.52 ± 0.98	3.83 ± 1.06
Carding (2)	18	3.21 ± 1.09	3.58 ± 1.07
Drawing (3)	11	1.62 ± 0.44	1.93 ± 0.23
Simplex (4)	11	1.29 ± 0.32	1.72 ± 0.26
Ringframe (5)	21	1.19 ± 0.49	1.57 ± 0.55
Preparatory (6)	12	0.92 ± 0.23	1.21 ± 0.33
Weaving (7)	25	0.86 ± 0.35	1.03 ± 0.37

Level of Significance

IV_s2	$P>0.05$	IV_s2	$P> 0.05$
IV_s3	$7\ P < 0.0005$	IV_s3	$7\ P< 0.0005$
$2V_s3$	$7\ P < 0.005$	$2V_s3$	$7\ P< 0.0005$

(Bahir Dar, 1988)

C. RESPIRATORY CONDITIONS

The prevalence of byssinosis and other respiratory tract diseases is summarised in Table 3 and Fig. 2.

The prevalence of byssinosis was high among blowers (43.2%) and carders (37.5%) in comparison to 4 to 24% prevalence among workers in other sections. There is a statistically significant difference ($P<0.001$) in the prevalence of byssinosis in the different sections and over an eight-fold increase in developing the problem in the blowing and carding sections as compared to the weaving and preparatory.

The prevalence of byssinosis was relatively higher in females in the drawing, simplex, ring frame and preparatory sections; but otherwise, there is no statistically significant difference in the overall prevalence (Table 4).

The prevalence of chronic bronchitis was also highest among the blowers (47.7%) and carders (45%) in comparison to 17 to 32% prevalence among workers in other sections. There is also a statistically significant difference ($P<0.001$) in the prevalence of chronic bronchitis in the different sections and ...

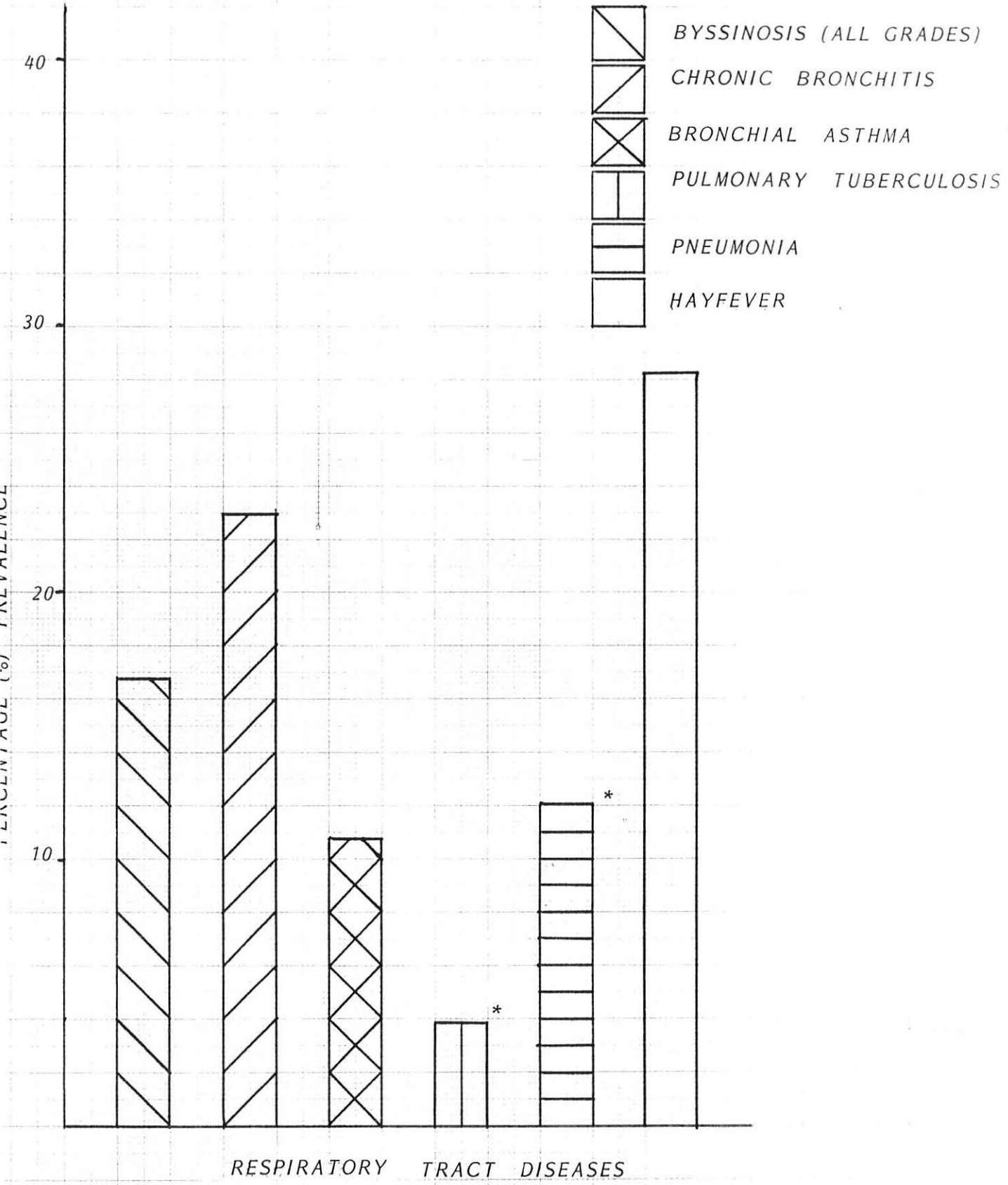
TABLE 3 THE PREVALENCE OF RESPIRATORY DISEASES AMONG EXPOSED WORKERS MEAN AGE AND DURATION OF EXPOSURE

SECTION	Number Examined	Age (Years) Mean ± SD	Duration of Exposure (Months) MEAN ± SD	BYSSINOSIS NO. (%)				Chronic Bronchitis No. (%)	Bronchial Asthma No. (%)
				G½	GI	GII	Total		
Blowing (1)	44	41.3 ± 7.3	201.9 ± 87.2	3 (7)	7(15.9)	9(20.5)	19(43.2)*	21(47.7)*	9(20.5)*
Carding(2)	40	41.5 ± 6.9	200.7 ± 74.8	-	2(5)	13(32.5)	15(37.5)*	18(45)*	5(12.5)
Drawing(3)	25	39.9 ± 6.6	239.6 ± 68.5	3(12)	1(4)	2(8)	6(24)	8(32)	3(12)
Simplex(4)	42	40 ± 6.8	235.3± 69.4	3(7)	3(7.1)	4(9.5)	10(23.8)	10(23.8)	3(7.1)
Ringframe(5)	174	37.5± 6.5	233.1 ± 73.2	12(6.9)	9(5.2)	9(5.2)	30(17.2)	32(20.7)	17(9.8)
Preparatory(6)	128	37.1± 5.8	222.9 ± 71.5	10(8)	-	4(3.1)	14(10.9)	23(18.0)	15(11.7)
Weaving(7)	142	39 ± 4.6	238.7 ± 67	3(2.1)	2(1.4)	1(0.7)	6(4.2)	25(17.6)	12(8.5)
Total	595	38 ± 6.9	218.3 ±79.5	34(5.7)	24(4)	42(7.1)	100(16.8)	137(23)	65(10.8)

* $P < 0.001$

(Bahir Dar, 1988)

FIG. 2 PREVALENCE OF RESPIRATORY TRACT DISEASES AMONG EXPOSED WORKERS



* *Subjects gave a past history of these illnesses; otherwise they received appropriate treatment and got cured.*

(Bahir Dar, 1988)

TABLE: 4 The Prevalence of Byssinosis Among Exposed Workers

Mean Age, Mean Weight, Mean Height and Duration of Exposure

Section	Number Examined	Age (Yrs) (Mean ± SD)	Duration of Exposure (months) Mean ± SD	Height Mean	Weight Mean ± SD	Byssinosis No. (%)				
						G ½	G I	G II	Total	Grand Total
Blowing	M 44	41.3 ± 7.3	201.9±87.2	167.5 ± 6.9	60.6 ± 9.8	3 (7)	7 (15.9)	9 (20.5)	19 (43.2)	19 (43.2)*
Carding	M 40	41.5 ± 6.9	200.7±74.8	166.3 ± 7.1	58.7 ± 9.7	–	2 (5)	13 (32.5)	15 (37.5)	15 (37.5)*
Drawing	M 10	40 ± 8.8	222.2±77.7	165.4 ± 8.4	55.2 ± 8.5	–	–	–	–	6 (24)
	F 15	40.3 ± 4.9	247.3±63.9	158.4 ± 6.2	60.3 ± 8	3 (20)	1 (6.7)	2(13.3)	6 (40)	
Simplex	M 28	41.2 ± 7.6	233.1±76.4	168.8 ± 6.3	61.7 ±10.1	–	1 (3.6)	2(7.1)	3 (10.7)	10 (23.8)
	F 14	37.6 ± 3.9	239.9±55.3	158.5 ± 7	53 ± 8.6	3 (21.4)	2(14.3)	2(14.3)	7 (50)	
Ringframe	M 28	40.6 ± 8.2	228.7±80.9	167.1 ± 6.1	61.8 ± 8	–	1 (3.6)	3(10.7)	4(14.3)	30 (17.2)
	F 146	36.4 ± 5.8	233.1±73.2	157.1 ± 5.7	53.8 ±10.3	12(8.2)	8 (5.5)	6 (4.1)	26(17.8)	
Preparatory	M 37	36.9 ± 6.6	236.1±68.9	168.6 ± 6.7	60.7 ± 8.3	4(10.8)	–	–	4(10.8)	14 (10.9)
	F 91	37 ± 5.5	242.6±64.2	157.4 ± 6.8	52.5 ± 8.9	6 (6.6)	– (4.4)	4	10(11)	
Weaving	M 135	37.1 ± 7.8	238.7±67	167.1 ± 6.2	58.3 ± 9.1	3 (2.2)	2 (1.5)	1 (0.7)	6 (4.4)	6 (4.2)
	F 7	38 ± 3.7	245.1±67.8	162.3 ± 6.9	55 ±13.5	–	–	–	–	

(Bahir Dar, 1988)

*P< 0.001

a four-fold increase in developing the problem in the blowing and carding sections compared to the weaving and preparatory ones.

The prevalence of bronchial asthma was also highest among the blowers (20.5%) in comparison to workers in other sections (P< 0.001) and there was also a three-fold increase in developing the problem in the blowing section as compared to the weaving.

The duration of exposure and the prevalence of respiratory diseases is presented in Table 5. Generally, the prevalence of byssinosis showed a significant increase ($P<0.001$) with the duration of exposure to Cotton dust in the textile mill. The prevalence of chronic bronchitis also showed a steady increase ($P<0.05$) in workers exposed for a long duration of time. Moreover, there was a marked increase ($P<0.001$) in the prevalence of bronchial asthma among exposed workers involved in dusty operations for longer durations.

Table 6 presents the effect of cigarette smoking on the prevalence of byssinosis and other respiratory diseases. No difference of significance ($P>0.05$) was observed in the prevalence of byssinosis between smoking and non-smoking workers. This could be due to a small number of smokers, because of which there is a risk of a type II error. Otherwise, the effect of smoking on the prevalence of chronic bronchitis was found to be highly significant ($P<0.001$).

A total of 32 Cotton Textile Workers out of the 595 study population (5.38%) had unacceptable curves either by the reproducibility criteria or by an inability to perform any forced expiratory manoeuvre and thus were excluded only from the pulmonary

TABLE 5 DURATION OF EXPOSURE AND THE PREVALENCE OF RESPIRATORY DISEASES

Duration of Exposure (Years)	Number Examined	BYSSINOSIS NO (%)				Chronic Bronchitis No. (%)	Bronchial Asthma No. (%)
		G½	GI	GII	TOTAL		
≤ 10 Years	105	2 (1.9)	4(3.8)	-	6(5.7)	17 (16.2)	2 (1.9)
10 - 20 Years	208	11 (5.3)	6(2.9)	8 (3.8)	25(12)	43 (20.7)	12 (5.8)
> 20 Years	282	21 (7.4)	14 (5)	34 (12.1)	69(24.5)	77 (27.3)	50 (17.7)
T o t a l	595	34 (5.7)	24 (4)	42 (7.1)	100(16.8)	137 (23)	64 (10.8)

$P < 0.001$ $P < 0.05$ $P < 0.001$

TABLE 6 THE EFFECT OF SMOKING ON THE PREVALENCE OF BYSSINOSIS

GROUP	NUMBER EXAMINED	DURATION EXPOSURE (YEARS) (MEAN ± SD) +	BYSSINOSIS NO. (%)				CHRONIC BRONCHITIS NO (%)	BRONCHIAL ASTHMA NO. (%)
			G½	GI	GII	TOTAL		
Smokers	14	17.1 ± 3.2	1(7.1)	1(7.1)	1(7.1)	3(21.4)*	9 (64.3)**	-
Non or ex-smokers	581	18.2 ± 5.6	33(5.7)	23(4)	41 (7)	97 (16.7)	128(22)	64(11)

+ N.S. ($P > 0.05$) * N.S. ** $P < 0.001$

(Bahir Dar, 1988)

function test analysis. 11 out of the 100 byssinotics (11%) had spirograms which did not satisfy the reproductibility criteria as did 21 non-byssinotics .

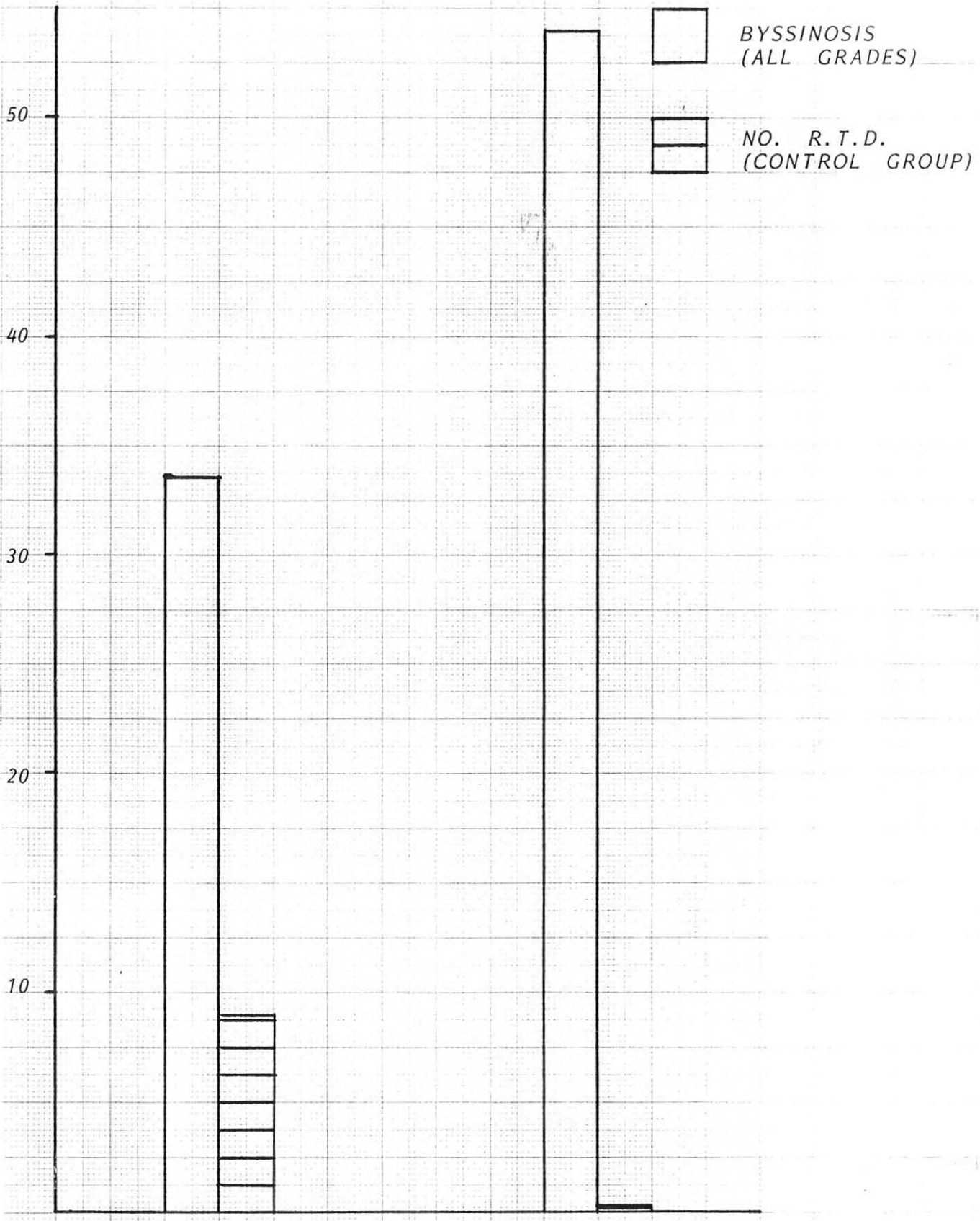
The difference in the pre-and post-shift FEV_1 and FVC values was determined and a drop was noted in all groups but a significant drop occurred only in the FEV_1 value among blowers ($P<0.01$), carders ($P<0.025$) and female ringframers ($P<0.01$).

As shown in Fig. 3 there is a significant reduction in FEV_1 ($P<0.001$) at the end of the shift, more than 10% or 20% among byssinotics when compared with the controls. There was 33.7% reduction in FEV_1 >10% <20% and 53.9%reduction in FEV_1 more than 20%, ($P<0.001$) among byssinotics. Also a significant increase ($P<0.001$) in percentage reduction in FEV_1 was noted with an increase in byssinosis grade.

Otherwise, a 9.1% reduction in FEV_1 >10% < 20% and only a 0.3% reduction in FEV_1, more than 20%, was noted among the control group (No.R.T.D.).

Thus the overall reduction in FEV_1 > 10% was 87.6% among byssinotics where as only a 9.4% reduction in FEV_1 >10% was noted among the control group revealing a significant difference.

FIGURE 3 PERCENT REDUCTION IN FEV_1 IN EXAMINED WORKERS DURING THE FIRST WORKING DAY AFTER ABSENCE FROM WORK*



* Lung function for 11 Byssinotics was not recorded.

(Bahir Dar, 1988)

The acute changes in FEV_1 during exposure to cotton dust were further analysed (Table 7) according to Bouhuys et al (1970) as follows: a fall in FEV_1 of less than 0.6 litres was considered as a non-acute effect, between 0.06 and 0.2 litres as a slight effect and more than 0.2 litres as a slight effect and more than 0.2 litres as a definite effect. Acute effects occurred more in byssinotics as compared to those without respiratory tract diseases. The result was statistically significant ($P < 0.001$).

The chronic changes in FEV_1 among exposed workers also analysed (Table 8). According to Bouhuys et al (1979), workers with FEV_1 greater than 80% of the predicted values were considered to have no chronic ventilatory impairment, those with FEV_1 60 to 80% slight to moderate and those with FEV_1, less than 60% to have from moderate to severe impairment. The latter was noted to increase with grades by byssinosis.

While 24% of byssinotics developed FEV_1 moderate to severe chronic changes ($P < 0.001$), only 10% of the non-respiratory tract disease group (controls) showed similar changes. Apart from those with byssinosis, 31% of the workers in the control group showed slight to moderate impairment and 68% had no chronic impairment.

TABLE 7: ACUTE CHANGES IN FEV_1* DURING DUST EXPOSURE

SECTION	Number Examined	Control Group (No. R.T.D.)						Number Examined	Case Study Group I (Byssinosis - All Grades)					
		FEV_1 ACUTE CHANGES							FEV_1 ACUTE CHANGES					
		No Change <0.06 litres		Slight 0.06-0.2lit.		Acute ** >0.2 litres			No Change <0.06 litres		Slight 0.06-0.2 litres		Acute** >0.2 litres	
		No.	%	No.	%	No.	%		No.	%	No.	%	No.	%
BLOWING	18	1	5.6	11	61.1	6	33.3	17	-	-	-	-	17	100
CARDING	15	-	-	8	53.3	7	46.7	13	-	-	-	-	13	100
DRAWING	7	-	-	4	57.1	3	42.9	6	-	-	-	-	6	100
SIMPLEX	20	1	5	12	60	7	35	9	-	-	2	22.2	7	77.8
RINGFRAME	91	-	-	60	65.9	31	34.1	27	-	-	7	25.9	20	74.1
PREPARATORY	70	-	-	53	75.7	17	24.3	11	-	-	3	27.3	8	72.7
WEAVING	88	1	1.1	52	59.1	35	39.8	6	-	-	2	33.3	4	66.7
TOTAL	309	3	.97	200	64.72	106	34.3	89	-	-	14	15.73	75	84.27

Lung function was not recorded for 32 subjects.

* Graded according to Bouhuys et al (1970).

** The FEV_1 acute changes difference between cases and controls is highly significant ($P < 0.001$)

(Bahir Dar, 1988)

TABLE: 8 CHRONIC CHANGES IN FEV_1 AMONG EXPOSED WORKERS

Byssinosis Prevalence	Number Examined	FEV_1 CHRONIC CHANGES*					
		No. Change > 80% of Predicted Value		Moderate 60-80% of Predicted Value		Severe <60% of Predicted Value	
		No.	%	No.	%	No.	%
No. R.T.D(Controls)	309 (51.93)	210	67.96	96	31.07	3	.97
Byssinosis							
Grade ½	34 (5.71)	20	58.82	13	38.24	1	2.94
Grade I	24 (4.03)	11	45.83	8	33.33	5	20.83
Grade II	42 (7.06)	9	21.43	15	35.71	18	42.86
All Grades	100(16.81)	40	40	36	36	24	24**
Total	595 (100)	376	63.19	191	32.1	28	4.71

Lung function was not recorded for 32 subjects

* Graded according to Bouhuys et al. (1970)

** $P < 0.001$

(Bahir Dar, 1988)

The group without respiratory tract disease (control group) was compared to both case study groups (all respiratory tract disease group), byssinotic group (case study group I) and chronic bronchitis and bronchial asthma group (case study group II) in respect of age, period of exposure to cotton dust, height and weight, pulmonary function, dust concentration and time weighted dust concentration (Tables 9, 10, 11 and 12).

The cotton textile workers in the case study groups were slightly older in age and had slightly longer work tenures than those in the control group, and this difference in age and period of exposure to cotton dust was statistically significant ($P<0.001$).

There was no signifcant difference regarding height and weight between the controls and the study cases ($P > 0.05$).

TABLE: 9 *Comparison of Byssinosis (case) with no Respiratory Tract Diseases (Controls) in Respect of Age, Period of Exposure, Dust Concentration, Time-Weighted Dust Concentration, Sex, Height, Weight (Mean ± SD) and Pulmonary Function*

	Byssinosis (Case)	No. R.T.D. (Control)	T-Value (d.f = 407)	P-Value
Number	100	309		
Sex	M 51	M 176		
	F 49	F 133		
Age (Year)	41.9 ± 6	36.7 ± 6.9	6.75	$p < 0.001$
Period of exposure (months)	252.1 ± 61.3	205.1 ± 82.1	5.05	$P < 0.001$
Height (cms.)	161.8 ± 7.9	162.8 ± 8.4	- 1.05	N.S
Weight (kg)	55.6 ± 9.2	57.2 ± 9.8	- 1.45	N.S
FEV_1	415.7 ± 219	179.6 ± 167.2	10.86	$P<0.001$
FVC	203.8 ± 114.7	120 ± 46.2	10.06	$P<0.001$
% predicted FEV_1	74.4 ± 20	86 ± 12.8	- 6.48	$P<0.001$
Dust Concentration (mg/m^3)	1.89± 0.84	1.37 ± 0.85	5.2	$P<0.001$
Time Weighted Dust Concentration ($mg\ years/m^3$)	551.3 ± 190.3	270.6 ± 196.7	11.99	$P<0.001$

Lung function for 32 subjects was not recorded

(Bahir Dar, 1988)

TABLE: 10 Comparison of Chronic Bronchitis (Case) with no Respiratory Tract Diseases (Controls) in Respect of Age, Period of Exposure, Dust Concentration, Time Weighted Dust Concentration, Sex, Height, Weight (Mean ± SD) And Pulmonary Function

	Chronic Bronchitis (Case)	No. R.T.D. (Control)	T-Value (dif = 444)	P-Value
Number	137	309		
Sex	M 83	M 176		
	F 54	F 133		
Age (Year)	40.3 ± 6.5	36.7 ± 6.9	5.29	P < 0.001
Period of Exposure (months)	257.2 ± 58.2	205.1 ± 82.1	6.89	P < 0.001
Height (cms.)	162.5 ± 7.8	162.8 ± 8.4	- 0.34	N.S
Weight (kg.)	56.2 ± 8.6	57.2 ± 9.8	- 1.04	N.S
FEV_1	275.2 ± 187	179.6 ± 167.2	5.51	P< 0.001
FVC	155.9 ± 85.4	120 ± 46.2	5.89	P< 0.001
% Predicted FEV_1	78.8 ± 16.8	86 ± 12.8	- 5.11	P< 0.001
Dust Concentration (mg/m^3)	1.51 ± 0.94	1.37 ± 0.85	1.56	N.S
Time Weighted Dust Concentration ($mg\ years/m^3$)	388.6 ± 287.8	270.6 ± 196.7	5.16	P< 0.001

Lung function for 32 subjects was not recorded

(Bahir Dar, 1988)

A statistically significant ($P < 0.001$) across-shift decrements in FEV_1 and FVC and also a decrease in the percentage predicted FEV_1 were noted in the case study groups when compared with the control group. The byssinotic group showed a significantly greater across-shift decrements in FEV_1 as compared to the other case study groups and the control group ($P < 0.001$).

The mean dust concentration was higher in the case study groups than in the control group, though the differences were significant only in the byssinotic group and when all the respiratory tract diseases were considered together ($P < 0.001$).

The time weighted dust concentration was markedly high in the byssinotic group ($P < 0.001$) as compared to the other case study groups and the control group. A significantly high ($P < 0.001$) time weighted dust concentration between the case study groups and the control group was also noted.

TABLE: 11 Comparison of Bronchial Asthma (Case) With no Respiratory Tract Diseases (Controls) in Respect of Age, Period of Exposure, Dust Concentration, Time Weighted Dust Concentration, Sex, Height, Weight (Mean ± SD) and Pulmonary Function

VARIABLE	Bronchial Asthma (Case)	No. R.T.D. (Control)	T-Value (d.f=371)	P-Value
Number	64	309		
Sex	M 32	M 176		
	F 32	F 133		
Age (Year)	42.7 ± 5.6	36.7 ± 6.9	6.38	P < 0.001
Period of Exposure (months)	265.8 ± 55.6	205.1 ± 82.1	5.54	P < 0.001
Height (cms)	161.9 ± 8.1	162.8 ± 8.4	- 0.78	N.S
Weight (kg)	55.8 ± 9.1	57.2 ± 9.8	- 1.05	N.S
FEV_1	292.1 ± 208.9	179.6 ± 167.2	4.59	P < 0.001
FVC	161.6 ± 122.5	120 ± 46.2	4.52	P < 0.001
% Predicted FEV_1	78.8 ± 17	86 ± 12.8	- 3.79	P < 0.001
Dust Concentration (mg/m^3)	1.55 ± 0.9	1.37 ± 0.85	1.5	N.S
Time Weighted Dust Concentration (mg years/m^3)	411.7 ± 272.3	270.6 ± 196.7	4.77	P < 0.001

Lung function for 32 subjects was not recorded.

(Bahir Dar, 1988)

TABLE: 12 Comparison of All Respiratory Tract Diseases (Cases) With No Respiratory Tract Diseases (Controls) In Respect of Age, Period of Exposure, Dust Concentration, Time Weighted Dust Concentration, Sex, Height, Weight (Mean ± SD) And Pulmonary Function

V A R I A B L E	All R.T.D. (Case)	No. R.T.D. (Control)	T-Value (d.f=593)	P-Value
Number	286	309		
Sex	M 147	M 176		
	F 139	F 133		
Age (Year)	39.41 ± 6.71	36.72 ± 6.89	4.98	P < 0.001
Period of Exposure (months)	231.56 ± 73.33	205.11 ± 82.05	4.24	P < 0.001
Height (cms)	161.72 ± 8.36	162.8 ± 8.38	- 1.61	N.S
Weight (kg)	56.29 ± 9.65	57.22 ± 9.76	- 1.19	N.S
FEV_1	258.6 ± 180.7	179.6 ± 167.2	5.68	P < 0.001
FVC	149.3 ± 88.3	120 ± 46.2	5.26	P < 0.001
% Predicted FEV_1	82.1 ± 16.5	86 ± 12.8	- 3.31	P < 0.001
Dust Concentration (mg/m^3)	1.61 ± 0.94	1.37 ± 0.85	3.43	P < 0.001
Time Weighted Dust Concentration (mg years/m^3)	367.82 ± 246.84	270.61 ± 196.7	5.47	P < 0.001

Lung function for 32 subjects was not recorded.

(Bahir Dar, 1988)

The case study and control groups of cotton textile workers in the study were regrouped according to the frequency distribution of the time weighted dust concentration, i.e. those rated in the upper third of the time weighted dust concentration (between 366.72 and 1182.72 mg months/m^3) as those with a high cumulative dust exposure, and others rated in the lower third of the time weighted dust concentration (between 183.36 and 206.4 mg months/m^3) as those with a low cumulative dust exposure; assuming the present dust levels were more or less similiar to the past ones.

Then each respiratory tract disease - identified either by interview through questionnaire, pulmonary function test and/or past history of illness - the identified respiratory tract diseases all together, and the symptoms of respiratory impairment and period of absence from work due to sickness in all these cases, considered as individual cases, were cross-tabulated with the control group with respect to the high and low cumulative dust exposure (Table 13 and 14).

The significance of the degreee of association between the cumulative dust exposure and the occurrence of the diseases was determined by the magnitude of the results obtained from chi-square analysis. Further, the degree of association between the cumulative dust exposure and the individual respiratory tract diseases and these altogether was measured by the odds ratio. Finally, the 95% confidence interval of the odds ratio was determined.

From the cross-tabulated analysis it was found that the estimated relative risk with which a cotton textile worker could contract byssinosis and/or other respiratory tract diseases from high cumulative cotton dust exposure was statistically significant ($P < 0.001$) than from low cumulative cotton dust exposure.

The estimated relative risk of developing byssinosis in high cotton dust exposure compared to low exposure was 21.76 with a 95% confidence interval of 8.41 and 56.26 ($x^2=64.41$, $P<0.001$)

TABLE: 13 COMPARISON OF CASES (BYSSINOSIS AND OTHER RESPIRATORY TRACT DISEASES GROUPS) WITH CONTROL (NO RESPIRATORY TRACT DISEASE GROUP) USING TIME WEIGHTED DUST CONCENTRATION

Group	High Time Weighted Dust Concentration (366.72 – 1182.72) (mg months/m^3)		Low Time Weighted Dust Concentration (183.36 — 206.4) (mg months/m^3)		X^2 (1 d.f.)	P-Value	Odds Ratio	95% Confidence Interval (C.I.)
	No.	%	No.	%			%	
Control								
. No R.T.D	78	(38.8)	123	(61.2)				
Cases								
. All R.T.D	122	(63.2)	71	(36.8)	23.46	P<0.001	2.71	(2.48,2.94)
. Byssinosis	69	(93.2)	5	(6.8)	64.41	P<0.001	21.76	(8.41, 56.26)
. Chronic Bronchitis	67	(69.8)	29	(30.2)	24.96	P<0.001	3.64	(2.16, 6.11)
. Bronchial Asthma	29	(78.4)	8	(21.6)	19.79	P<0.001	5.72	(2.48, 13.07)
. Pulmonary Tuberculosis	12	(75)	4	(25)	7.99	P<0.01	4.73	(1.46, 15.18)
. Pneumonia	32	(61.5)	20	(38.5)	8.68	P<0.01	2.52	(1.34, 4.71)
. Hay Fever	67	(61.5)	42	(38.5)	14.59	P<0.001	2.52	(1.55, 4.06)

(Bahir Dar, 1988)

The estimated relative risk of developing bronchial asthma, pulmonary tuberculosis, chronic bronchitis, pneumonia and hay fever accountable to high cumulative dust exposure was statistically signifcant ($P < 0.01$ and $P < 0.001$). The odds ratio were 5.72, 4.73, 3.64, 2.52 and 2.52 respectively, with a 95% confidence interval of (2.48 - 13.04), (1.46 - 15.18), (2.16 - 6.11), (1.34 - 4.71), and (1.55 - 4.06) respectively.

The estimated relative risk of manifesting shortness of breath while walking up a slight hill or hurrying on level ground was 3.86 with a 95% confidence interval of 2.36 and 5.7 ($x^2 = 34.77$, $P< 0.001$), that of shortness of breath while walking on level ground with persons of the same age was 6.39 with a 95% confidence interval of 3.6 and 11.25 ($x^2 = 46.18$, $P< 0.001$) and that of shortness of breath even when walking at own pace was 11.43 with a confidence interval of 6.62 and 19.89 ($x^2 = 27.5$, $P<0.001$) for those exposed to high cumulative cotton dust and then developed respiratory tract diseases compared to low cumulative cotton dust exposure.

TABLE 14 COMPARISON OF SYMPTOMS OF RESPIRATORY IMPAIRMENT AND PERIOD OF ABSENCE FROM WORK DUE TO SICKNESS IN THOSE CASES WITH HIGH AND LOW TIME-WEIGHTED DUST CONCENTRATION WITH "NO RESPIRATORY TRACT DISEASE" GROUP AS CONTROL

GROUP	High Time Weighted Dust Concetration (366.72 – 1182.72) (mg months/m^3) No.	(%)	Low Time Weighted Dust Concentration (183.36 – 206.4) (mg months/m^3) No.	(%)	x^2 (1 d.f.)	P Value	ODDS Ratio ¥	95% Confidence Interval (C.I.)
Control								
. No R.T.D.	78	(38.8)	123	(61.2)				
Cases								
. Sob Hill	112	(70)	48	(30)	34.77	P<0.001	3.68	(2.36, 5.7)
. Sob Level	81	(80.2)	20	(19.8)	46.18	P<0.001	6.39	(3.6, 11.25)
. Sob Pace	29	(87.9)	4	(12.1)	27.5	P<0.001	11.43	(6.62, 19.89)
. Sick Week	64	(71.9)	25	(28.1)	27.05	P<0.001	4.04	(2.36, 6.96)
. More Illness	32	(69.6)	14	(30.4)	13.77	P<0.001	3.6	(1.8, 7.17)

(Bahir Dar, 1988)

Also, those who developed the respiratory tract diseases accountable to high cumulative cotton dust exposure exercised a four-fold period of absence from work for one week or more in a year than those exposed to low cumulative cotton dust. The difference was statistically significant ($P<0.001$).

The coefficients and their significant levels for exposure variables derived from multiple regression models for $\Delta FEV_1\%$, $\Delta FVC\%$, prevalence of byssinosis, chronic bronchitis, bronchial asthma, pulmonary tuberculosis, pneumonia, and hay fever are shown in Tables 15 and 16.

The regression variables described in the models and presented in Table 15 were age, height, weight, $\Delta FEV_1\%$, $\Delta FVC\%$, byssinosis and total dust. The dependent variables were ΔFEV_1, ΔFVC and byssinosis. The type of multivariable analysis carried out was stepwise multiple regression.

The results indicate a highly significant ($P<0.001$) dose-response relationship between across-shift percentage changes in FEV_1 and FVC and time weighted cotton dust concentration, and also between the prevalence of byssinosis and cumulative time weighted dust concentration.

A significant negative relationship ($P<0.05$) with weight was noted in all workers in the byssinosis model and in the case of Δ FVC% models, it was noted only in males. Also, a significant positive relationship ($P<0.05$) with age was observed in all workers in the Δ FVC% model.

A linear dose-response relationship was estimated in each model by the regression coefficient for cumulative exposure, controlling age, height and weight and a highly significant ($P<0.001$) dose-response relationship was noted.

TABLE: 15 REGRESSION COEFFICIENTS FOR TIME WEIGHTED COTTON DUST CONCENTRATION, AGE, HEIGHT AND WEIGHT IN BYSSINOSIS AND PULMONARY FUNCTION MODELS

	VARIABLE	MALE (N = 323)	FEMALE (N = 272)	ALL WORKERS (N = 597)
Byssinosis*	Total Dust	0.002±	0.002±	0.002±
	Age	0.059	0.104*	0.079
	Weight	- 0.012+	- 0.109*	- 0.01+
	Height	- 0.01	0.002	0.033
△ FEV_1**	Total Dust	0.221±	0.167±	0.207±
	Age	0.095	0.009	0.06
	Weight	- 0.07	- 0.017	- 0.045
	Height	- 0.018	- 0.044	0.011
△ FVC***	Total Dust	0.085±	0.044±	0.061±
	Age	0.115	0.015	1.088+
	Weight	- 1.029+	0.033	- 0.019
	Height	0.039	0.072	0.048

Lung function was not recorded for 32 subjects

± P< 0.001

\+ P< 0.05

N.B. For differences between sexes, after allowance for age, height and weight

*MALE F (1 and 320 d.f.) = 98.96 P< 0.000 and R^2 = 0.23621

*FEMALE F (1 and 271 d.f.) = 44.96 P< 0.000 and R^2 = 0.14229

** MALE F (1 and 302 d.f.) = 52.53 P<0.000 and R^2 = 0.14100

** FEMALE F (1 and 257 d.f.) = 17.2 P< 0.0000 and R^2 = 0.05967

*** MALE F (1 and 302 d.f.) = 22.14 P< 0.000 and R^2 = 0.06471

*** FEMALE F (1 and 257 d.f.) = 4.05 P< 0.0452 and R^2 = 0.01472

(Bahir Dar, 1988)

A significant ($P < 0.05$) dose-response relationship with cumulative cotton dust exposure was shown by the pulmonary tuberculosis prevalence model but like that of pneumonia, no significant relationship was observed either with the current cotton dust exposure or with the work tenure.

Models for bronchial asthma and hay fever prevalences indicate that there was a significant dose-response relationship with the cumulative cotton dust exposure ($P < 0.05$, one tail test). Otherwise, no significant relationship with the current cotton dust exposure (elutriator dust measurement) was observed.

Furthermore, hay fever and bronchial asthma prevalence models showed a significant relationship ($P < 0.01$ and $P < 0.05$) with longevity in the cotton textile mill.

Models for ΔFEV_1 and ΔFVC showed a highly significant ($P < 0.001$) relationship with the time-weighted cotton dust concentration; however, no signifcant relationship was observed with the current cotton dust exposure and longevity in the cotton textile mill.

TABLE: 16 Regression Coefficients for Period of Exposure, Current Cotton Dust Exposure and Cumulative Cotton Dust Exposure in Byssinosis, Chronic Bronchitis, Bronchial Asthma, Pulmonary Tuberculosis, Pneumonia, Hay Fever & Pulmonary Function Models

Symptom	Period of Exposure (months)	Current Exposure Cotton Dust Concentration (mg/m^3)	Cumulative Exposure Cotton Dust Concentration (mg months/m^3)
Byssinosis	0.002#	0.308#	0.001#
Chronic Bronchitis	0.042**	0.065	3.76 E-04#
Bronchial Asthma	0.066*	0.117	0.075**
Pulmonary Tuberculosis	8.65 E-04	0.011	7.26 E-05*
Pneumonia	0.046	0.055	1.84 E-04+
Hay Fever	7.14 E-04+	0.066	0.077**
Δ FEV_1	0.427	0.054	0.154##
Δ FVC	0.005	0.006	0.06#

# $P < 0.001$

+ $P < 0.01$

* $P < 0.05$

** $P < 0.05$ in one tail test (this is considered since the hypothesis from the outset was unindirectional)

N.B. General Models: $Symptom = \beta_0 + \beta_1 (age) + \beta_2 (sex) + \beta_3 (height) + \beta_4 (weight) + \beta_5 (exposure) \times \varepsilon$

(Bahir Dar 1988)

A stepwise multiple regression analysis was also carried out where the symptoms of respiratory impairment and the period of absence from work due to illness were considered as dependent variables. The independent variables in the analysis were age, height, weight, sex, monthly income, household size and time weighted dust concentration.

In all the models for symptoms of respiratory impairment, i.e. shortness of breath when walking up a slight hill or hurrying on level ground model, shortness of breath when walking on level ground with persons of the same age and shortness of breath even when walking at own pace model, the dose-response relationship with time weighted cotton dust concentration was highly significant ($P<0.0000$).

CHAPTER V

DISCUSSION

V. DISCUSSION

Though initially described in Lancashire and Northern Ireland, byssinosis is now known to occur world-wide despite the fact that reports from eastern Europe and developing nations are few. When developing countries expand their textile industries and begin to recognise the problem of cotton dust exposure as a significant public health problem, they will undoubtedly begin to report to the rest of the world. Such reports have been documented from Egypt (41), Sudan (40), Tanzania (67) and Hong Kong (68).

This paper describes the first epidemiological study of cotton textile workers in Ethiopia using diagnostic criteria and equipment similar to those used in the United States and Great Britain.

A few studies of cotton textile workers have looked into the prevalence of respiratory symptoms and lung function compared with those of control subjects (14, 42, 45, 81). There is also a limited number of studies that have reviewed lung function in cotton textile workers with and without byssinosis or bronchitis (65, 80, 82). Our analysis considers workers exposed to cotton dust in the textile factory with respiratory tract diseases as case study group and without respiratory tract disease as control group.

The resutls of our study showed that the concentrations of airborne cotton dust in the different sections of the surveyed

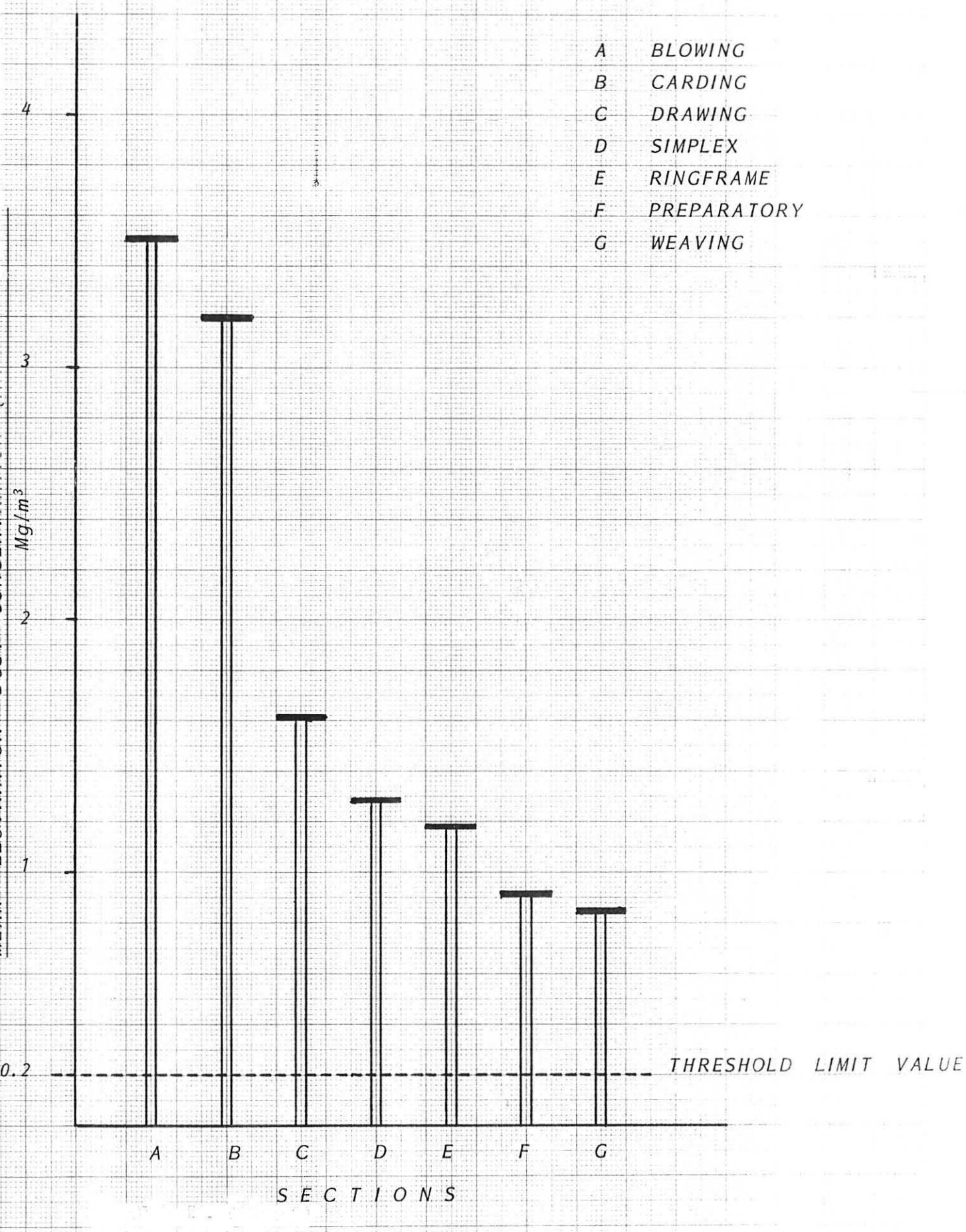
textile mill, which is a typical example of the cotton industry in Ethiopia, were very high, with concentrations greatly in excess (nearly 4 to 17 times) of 0.2 mg/m³ of dust - the Threshold Limit Value (TLV) recommended for cotton dust - collected by a vertical elutriator sampler (ACGIH, 1983) (69) (see Fig. 4). This was in accordance with reports on other cotton mills (42,71, 72).

Our results showed that the concentrations of cotton dust collected by the vertical elutriator sampler were slightly less than those collected by the personal gravimetric dust sampler. The 'inhalable' and 'respirable' fraction was highest in dust collected at the early stages of yarn production. The results obtained are similar to those reported by others. The earlier processes are dustier than the later ones (70, 71, 74).

Our study showed an overall prevalence of byssinosis of 16.8% (15.8% in males and 18% in females) among textile workers in Bahir Dar Cotton Textile Mill.

Inspite of observations in some recent studies (93) regarding the considerable confusion that existed about the characteristic clinical manifestations of byssinosis in textile workers, namely chest tightness,'Monday sickness', and presence of symptoms of respiratory tract irritation, i.e. cough and phlegm, we found chest tightness and occurrence of one or more of the

FIG. 4 CONCENTRATION OF AIRBORNE COTTON DUST IN THE STUDY SECTIONS OF BAHIR DAR TEXTILE MILL*



* Collected by vertical elutriator sampler.
(Bahir Dar, 1988)

characteristic respiratory symptoms on the first working day after absence from work for at least one day in 100 percent of the byssinotic workers. This was similar to Schilling's classic description of byssinosis (24).

The relationship of these manifestations with work was also one of the important features of the disease, i.e. symptoms develop soon or after a few hours of exposure to cotton dust and most often after the weekend break, that was considered in our study.

Another observation was that, in the majority of cases, the weekend break in the Bahir Dar Textile Mill was only for one day and the workers still complained of the symptoms even after this shorter period of absence from work, which is 48 hours or more in western countries. Byssinotics also suffered from a greater intensity of the symptoms after returning to work from holidays or from a leave of a few days duration.

Eventhough the majority of byssinotics had symptoms of chronic bronchitis (55%), bronchial asthma (34%), intermittent allergic rhnitis (60%), and also a past history of pneumonia (24%) and pulmonary tuberculosis (10%), chest tightness and 'Monday' (first day working) sickness were found in 100 percent of the byssinotic workers in our study, and this, therefore, distinguished byssinosis from other respiratory diseases.

Thus, in general, estimates for the prevalence of byssinosis in cotton textile workers in different countries are very much varied. In 1956, Schilling (14) reported on two groups of workers with 42% (among 304 cardroom workers) and 57% (among 183 middle-aged male cardroom and blowroom workers) prevalences of byssinosis grades I and II. Merchant and colleagues (56) estimated a 12.7% prevalence of byssinosis at 0.2 mg/m^3 of dust exposure. Martin and Higgins (78) found only 8% of more than 6,600 current employees with byssinosis. Imbus and Suh (54) found only 3% of female and 5.7% of male cotton textile workers with byssinosis in their study for over 10,000 current employees. Eisen EA and colleagues (76) found only 7.7% prevalence of byssinosis in workers employed in the opening through spinning operations at two cotton textile plants in Shanghai, China. Beck and colleagues (66) reported byssinosis prevalences of 22% in males and 16% in females in cotton textile workers in Columbia, South Carolina. Molness and colleagues (74) estimated an 11% prevalence of byssinotic symptoms in 191 workers from two textile mills in Ontario, Canada, and Molyneaux and Tombleson (42) found an even higher 51% prevalence of byssinosis in the coarse mills in Lancashire, where symptoms of the disease developed in less than five years of exposure (25% of exposed workers developed byssinosis in two years). From Africa, Noweir and colleagues (70) found that more than 7% of total examined workers in an Egyptian cotton textile industry were byssinotics.

El Karim and colleagues (71) reported a 46% prevalence of byssinosis in the Khartoum weaving and spinning company.

We hypothesized that the prevalence of byssinosis directly corresponds to the level of cotton dust and our results support this hypothesis. It was originally believed that byssinosis is closely related to overall dustiness (23) but it has been shown more recently that the 'respirable' and 'medium' components of the total dust correlate most significantly with the prevalence of symptoms (107). According to Gilson et al (108) cotton dusts have been conveniently classified into 'coarse' - > 2mm; 'medium' - 2 mm down to 7 mm; and 'respirable' < 7mm. Thus, with the high concentration of 'inhalable' and 'respirable' cotton dust in the different sections of the textile mill where this study was carried out, our findings completely agree with Molyneux and Berry (107). The high prevalence of byssinosis in the blowing (43.2%) and carding (37.5%) process in Bahir Dar Textile Mill correspond to the high dust level and is similar to that reported by Khogali (40), El Karim (71), Cinkotai (86), Oug et al (87) and Parikh (88). Byssinosis grade I was more than two-fold prevalent among blowers and carders where dust concentration was twice than in other sections. The high prevalence of byssinosis in drawing, simplex and ringframe spinners may be due to the fact that the level of cotton dust was still high in these sections. These sections are not segregated from the card room and this may also explain the closeness of dust levels in these three sections.

We also hypothesized that the prevalence of byssinosis directly correspond to the duration of exposure to cotton dust and again our results support this hypothesis. In spite of the controversy surrounding the relationship between the prevelance of byssinosis and the duration of exposure, our study showed a significant increase in the prevalence of byssinosis with duration. The same relationship has also been observed in Sudan and Egypt (70, 71, 72). The progression in the stages of the disease in relation to the duration of exposure observed in our finding support previously reported conclusions that the different grades of byssinosis succeed each other in diseased subjects (70, 71, 72).

Our results also showed that there was a significant association between the prevalence of byssinosis and time-weighted dust concentration (cumulative cotton dust exposure). This is in agreement with Fox et al (46), where dust exposure expressed in terms of a time-weighted dust measurement has been reckoned that approximately 10 percent of workers exposed to 0.5 mg/m^3 of cotton dust for 40 years will have byssinosis.

In general possible explanations of dissimilar prevalences of byssinosis in this study between sections are variations between dust at different stages in cotton processing and, in part, differences between dust levels experienced by individual workers and dust sampling results as is exemplified by the stationary vertical elutriator and the personal dust sampler that moved with

the worker over a large working area. This observation is in agreement with Berry, Molyneux and Tombleson (45).

The differences in byssinosis prevalence reported for operatives working on similar processes in various countries may be due to dissimilar working conditions and longevity in the textile factory, and dust composition and concentrations on one hand and individual idiosyncracy and immunological reactivity on the other.

We had a hypothesis that the prevalence of byssinosis among textile workers involved in dusty operations is more pronounced in smokers than non-smokers. Our results showed that smoking had no significant relationship with the prevalence of byssinosis, probably because of the small number of smokers in our study. Hence, due to this small number, there was a risk of a type II error. Otherwise, according to Elwood et al (51), Bouhuys et al (18), Fox et al(46), Merchant et al (52) and Berry Molyneux & Tombleson(45) among cotton workers smokers have significantly more byssinosis of each grade than non-smokers after dust concentration and length of exposure are allowed for. Merchant et al(53) had also concluded that byssinosis and 'chronic bronchitis' (mucus hypersecretion) are both influenced by cotton dust exposure and cigarette smoking.

In our study, the overall prevalence of chronic bronchitis was 23% and it was more prevalent among workers in sections with greater dust levels, i.e.Blowers (47.7%) and carders (45%). A significant dose response relationship between

chronic bronchitis and time-weighted dust concentration had also been observed in our study. Although Fox et al (46) and Berry, Molyneux and Tombleson (45) found that the prevalence of 'chronic bronchitis' is not related to dust concentrations, this relationship of dust concentration with prevalence of chronic bronchitis in our study is in agreement with those of Berry et al (45) El Karim (71), Khogali (89) and Merchant et al(52).

Eventhough 55 workers with byssinosis and 20 with bronchial asthma had symptoms of chronic bronchitis, in our finding chronic bronchitis was diagnosed by its typical history of excessive mucous production sufficient to cause cough with expectoration for at least 3 months in a year for more than 2 consecutive years. Since chronic bronchitis, with or without obstruction by usual functional criteria, can be diagnosed by history obtained from standard questionnaires, it is not surprising that there are good prevalence data for only chronic bronchitis in chronic obstructive pulmonary diseases (94).

Several subclassifications of chronic bronchitis have been proposed: 'Simple chronic bronchitis' describes a condition characterized by mucoid sputum production and 'chronic muco-purulent bronchitis' by persistent or recurrent purulence of sputum in the absence of localized suppurative diseases such as bronchiectasis. Since there may or may not be obstruction as assessed by the use of the forced expiratory vital capacity

manoeuvre, 'chronic bronchitis with obstruction' deserves a separate classification. There is a further subset of patients with chronic bronchitis and obstruction who experience severe dyspnonea and wheezing in association with inhaled irritants or during acute respiratory infections. Such patients are said to have 'chronic infective asthma' or 'chronic asthmatic bronchitis'. Patients with this condition and asthma who may also have 'chronic airways obstruction' may present a confusion. The patient with chronic asthmatic bronchitis has a long history of cough and sputum production with a later onset of wheezing, whereas the asthmatic with chronic obstruction gives a long history of wheezing with later onset of chronic productive cough (94). According to all surveys, females are less often affected than males which was also true in our findings.

Although cigarette smoking is the single most important etiologic factor of chronic bronchitis, as also supported by our finding, occupational and environmental exposures are now receiving more attention (94). 22 chronic bronchitis cases also complained of signs and symptoms of intermittent allergic rhinitis and also among cases of chronic bronchitis, 5 gave a past history of pneumonia and 19 of pulmonary tuberculosis.

Although chronic bronchitis, in the context of mucous hypersecretion is often associated with byssinosis (54), a state of irreversible (i.e. non-asthmatic) air flow obstruction in textile

workers which is primarily attributable to vegetable fibre dust and not to smoking is much less certain. But, a study of a large number of male and female textile workers over the age of 45 compared against control subjects in respect of age, sex and smoking habits suggested that there was an excess of chronic cough, wheezing, dypnoea and persistent ventilatory impairment in the workers. Work in textile mills was the main variable affecting the prevalence of the symptoms but smoking was an additional significant variable related to all those features except dyspnoea (81). However, the pathological studies do not support the notion that irreversible airflow obstruction is an ultimate stage of byssinosis.

Our finding also showed that the overall prevalence of bronchial asthma was 10.8% and, like that of byssinosis and chronic bronchitis, was also highest among the blowers (20.5%) and had a significant relationship with the cumulative cotton dust exposure. A majority of the asthmatics developed the problem after they had worked for several years in Bahir Dar Textile Mill.

Asthma is a disease of the airways characterized by increased responsiveness of the tracheobronchial tree to multiple stimuli. It is physiologically manifested by a widespread narrowing of the air passages which may be relieved spontaneously or by therapy. Asthma is clinically manifested by paroxysms of dyspnoea, cough and wheezing. It is an epidosic disease, acute exacerbations being interspersed with symptom free period.

In the textile mill where we carried out our study, a majority of the asthmatics gave seasonal histories of attacks which were short-lived, lasting from minutes to hours, after which they seemed to recover completely. However, some experienced a certain degree of obstruction daily without superimposed severe episodes and a few, severe obstruction persisting for days and even weeks for which they were admitted and managed in the textile mill clinic and Felege Hiwot Hospital in Bahir Dar. However, when we carried out data collection, only a few had mild episodes that subsided with treatment and few days rest; otherwise, a majority of the cases were asymptomatic.

The prevalence and incidence of asthma in various parts of the world is difficult to assess with certainty because of lack of reliable population-based figures where uniform diagnostic criteria was used. However, in the United States, data from a national health survey indicates that 3% of the population suffers from this disease. Similar figures have been reported from other countries, but for unknown reasons, asthma is uncommon in New Zealand highlanders, American Indians, Eskimoes and West Africans (94).

Bronchial asthma occurs at all ages but is predominant at early age. About one-half of cases develop before the age of 10 and another third before 40. In childhood, there is a 2:1 male to female preponderance which equalizes by the age of 30[94]. In our finding, the mean age of the asthmatics was

42.7 which was relatively higher than the other respiratory case groups and control group; but otherwise, no significant variation in age and sex was observed.

In our study, a majority of the asthmatics gave negative family histories of allergy but 34.4 percent had had intermittent symptoms of rhinitis which was mostly seasonal. Usually, they had attacks between the months of July and November and some experienced a non-seasonal form with aggravation of the symptoms when working continuously in the dusty sections of the textile mill, as a consequence of which developed a habit of taking regular medical rest.

Some agents in the working environment induce asthma by effects similar to those of pharmacologic agonists. In such condtions, it is expected that there could be a dose-response relationship between exposure and response. When the dose is high enough, all exposed subjects are expected to develop bronchoconstriction. There is considerable controversy as to whether these agents, by causing reversible air-flow obstruction, actually give rise to 'asthma' in the usual sense because they do not give rise to eosinophilia or nonspecific bronchial hyperactivity.

Cotton dust extracts were found to induce histamine release from isolated human, pig, cow and sheep lungs and were also found to contain histamine (90). However, it is thought

that the amount of histamine present in cotton dust extracts is too small to induce bronchoconstriction in vivo (91). Cotton dust is known to be contaminated with bacteria and fungi and thus the presence of endotoxin in it had been described. The endotoxin was found to activate the complement system (92) with subsequent generation of anaphylotoxins and release of histamine and leukotactic substances.

From an etiologic stand point, asthma is a heterogenous disease and attempts to define it in etiologic terms have proved difficult. However, it is important to emphasize that the common denominator underlying the asthmatic diathesis is a non-specific hyper-irritability of the tracheobronchial tree.

Thus, the distinction between various types of asthma may often be artificial, and the response of a given substance may be initiated by more than one type of stimulus. With this reservation in mind, one can describe two broad groups: 'extrinsic asthma' due to specific external allergens, and 'cryptogenic' or 'intrinsic' asthma, in which no external agent is evident.

Occupational asthma, therefore, is caused by some specific extrinisic agent or agents in the form of dust, fume or vapour in an industrial environment. Byssinosis satisfies this definition of extrinsic asthma and is considered as such in some reports (4), even if the underlying mechanism is not

fully understood, but recovery during the working week largely differentiates it from the majority of other occupational asthmas.

Though wheezing is a common feature in asthma, it is not a criterion of the definition nor, therefore, of diagnosis, and is absent in some cases. Similarly, episodic dyspnoea, though usual, may be slight or absent; and on occasions, airflow obstruction may persist for long periods - weeks or even months.

It is impossible to give an overall indication for the prevalence of occupational asthma. It varies widely between countries and industries, with the nature of the causal agent, and depending on the number of exposed workers. It has been estimated that about 2 percent of all cases of asthma are occupational (95). In Japan, some 15 percent of asthma in adult males is believed to be occupational (96). Among exposed workers, however, only a minority develop asthma. In recent years, there has been a steady increase in potential asthma-provoking agents in industry and this can be expected to continue for the forseeable future (4). The development of asthma may also be influenced by whether exposure to the offending agent is continuous or intermittent.

Although in some industries there is a clear increase in the risk of sensitization in atopic workers, eg. those exposed to grain dust, biological detergents, platinum salts and locusts,

the extent of assocaition between cotton dust and asthma, and between byssinosis and asthma and also the role of atopy in these cases has to be adequately assessed.

Our findings also showed that the overall prevalence of hayfever was 30.3% which was the highest of all the respiratory symptoms in the textile mill. Hay fever was also highly prevalent among the blowers (36.4%), carders (32.5%) and drawers (32%). No significant relationship with the current dust exposure was observed in hay fever.

The regression model for hayfever prevalence showed a highly significant ($P < 0.01$) relationship with longevity in the cotton textile mill and a significant dose-response relationship with the cumualtive cotton dust exposure ($P < 0.05$, one tail test). We considered one tail test in some of our observations when the p - value was borderline, since our hypothesis regarding dose-response relationship from the outset was unidirectional.

This finding probably might be due to the reason that an allergic reaction does not occur on first exposure. The latent interval during which sensitization occurs varies from a few weeks to many years. When hay fever, for that matter even asthma first develop some years after an employee entered an industry, it is easy to understand that an occupational origin may be completely overlooked.

The majority of hay fever (allergic rhinitis)* cases in our study had the characteristic manifestations, i.e. sneezing, rhinorrhoea, obstruction of the nasal passage, conjunctival and pharyngeal itching and lacrimation. Though the majority had the problem mostly from July to November like the asthmatics, some had had it intermittently throughout the year. Some said that the symptoms became worse and persistent when they worked continuously in dusty environments in the textile mill for which they were usually excused from duty for a few day on medical grounds.

Allergic rhinitis (hay fever) generally presents itself in atopic individuals, i.e. in persons with a family history of a similar or related symptom complex and a personal history of collateral allergy expressed as eczematous dermatitis, urticaria and/or asthma. Though the majority of the cases in our study gave no family history of allergy because they couldn't recall any, 25 cases had bronchial asthma. Otherwise, 8 cases of hay fever gave a past history of pneumonia and 10 cases of pulmonary tuberculosis.

Symptoms of allergic rhinitis appear before the fourth decade of life and tend to diminish gradually with againg, although complete spontaneous remission are uncommon (94). In our study a majority of the cases developed the symptom complex after many years of longevity in the textile mill.

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* Eventhough 'hay fever' is literally inappropriate to describe seasonal allergic rhinitis because the symptom complex is neither produced by hay nor associated with fever, we used it interchangeably with allergic rhinitis in our study as it is a common convention.

Perennial allergic rhinitis occurs in response to allergens that are present throughout the year such as desquamating epithelium in animal dander, the plant materials processed or chemicals utilized in an industrial setting, or the dust accumulating at work or at home. Dust has a diverse content including mites, and many patients with allergic rhinitis are sensitive to only house dust. Moreover, in many patients with the disease, no clear cut allergen can be demonstrated. When present, the ability of allergens to cause rather than to lower respiratory symptoms may be attributed to their size, 10 to 100 μ. When inhaled they are retained in the nose without progressing to the lower respiratory tract.

As mentioned earlier in our study, we showed that the 'inhalable' fraction (< 15μ) and 'respirable' fraction (< 7μ) of the dust concentration in the different sections was very high nearly four to twenty-seven fold than the recommended threshold limit value for cotton dust. Thus, there may be a very high possibility for the responsble agent in the dust to cause lower respiratory symptoms despite the fact that the mechanism by which cotton dust causes narrowing of airways is not yet understood; but a number of hypothesis have been suggested, the most important of which are non-immunological local release of histamine in the lungs: an antigen antibody reaction; bacterial endotoxins fungus enzymes. However, whichever (if any) of these is correct, the responsible agent is known to be water-soluble (56, 109).

Eventhough there is some evidence that byssinosis is not more prevalent among atopic than non-atopic workers according to Bouhuys (49), our findings revealed that the majority of byssinotics (55%) had clear-cut characteristic symptom complex of hay fever (allergic rhinitis). Added to this, the prevalence of hay fever was very high (30.3%) in our study population. In agreement to this and as described by Jones et al, there is also an evidence that atopic workers in cotton seed crushing mills have a greater broncho-constrictor response to cotton dust aerosol than non-atopics. This suggests that atopy is an important risk factor in the development of byssinotics and indicates the importance of identifying atopic workers. Thus, keeping in mind that cotton dust has a diverse content as stated earlier, the extent of association between exposure to cotton dust and hay fever and also the extent of development of byssinosis among atopic and non-atopic workers should be further investigated and analysed in depth.

Acute Changes in Forced Expiratory Volume in One Second

Our study demostrated that byssinotics had a significantly greater ($P < 0.001$) acute decrements in FEV_1 throughout a workshift than those without respiratory tract diseases. These decrements were evident in cotton textile workers exposed to elutriated dust levels of 0.86 to 3.5 mg/m^3 from processing coarse, medium and fine quality cotton. The acute decreases

in function were observed in both the case and control workers, and in both men and women, upon exposure to dust after a 2 days rest. These results support the findings of earlier investigators (65, 97, 98). The fact that virtually all the cotton used in these mills was hand-picked provides some evidence against the hypothesis that hand-picked cotton contains lower trash content and is, therefore, less 'potent' than machine picked cotton. It is quite possible that hand-picking provides grossly cleaner cotton (less soild and stem contamination) but not less bract content. Since at least some of the active agents are located in bract (99), hand picking is not sufficient to remove the responsible agents.

Our results showed that a highly significant ($P < 0.001$) dose-response relationship between across-shift percentage changes in FEV_1 and FVC and time-weighted dust concentration. Furthermore, after adjusting for age, height and weight, the regression model showed a highly significant dose response relationship in males and females.

Our results also showed that the workers in the blowing, carding and drawing sections had a greater acute across-shift decrements in FEV_1 than those in the simplex, ringframe, preparatory and weaving sections. This is in agrement with the findings of Holness et al (74) and Merchant et al (56).

While a dose-response effect is documented, its meaning is yet to be questioned. The effect of an acute change in FEV_1 may not be specific for cotton. Mckerrow et al (98) found no decline in FEV_1 over a shift in coal workers while Lapp et al (100) documented a decline. Zuskin et al (101) found a fall in FEV_1 over the shift following exposure to wool dust. Even if the effect is specific for cotton the relationship between acute change in FEV_1 and permanent impairment has not been firmly established, although Zuskin and Valic (102), while doing a follow-up on a group for 10 years, found some evidence to suggest that those with byssinosis have a greater annual decline.

Chronic Changes in Forced Expiratory Volume in One Second

The cotton exposed workers with byssinosis had a significantly lower percent-predicted FEV_1 than those in the group without respiratory tract disease (controls). This finding is in agreement with El Karim et al (71) and Berry et al (65) who demonstrated a greater annual decrement in FEV_1 (54 ml per year) and FVC in Lancashire cotton textile workers than in workers processing synthetic fibres (32 ml per year). The workers in that study had a median work tenure of 15 - 19 years and were followed for three years. A survivor population of active and retired cotton textile workers in South Carolina had lower FEV_1 and FVC levels than non-textile community referrents from Connecticut (81, 103, 104), and an older study of 18 plants

in the United States concluded that chronic lung disease was more prevalent in cotton textile workers and that there was a 'significant deficit in predicted normal FEV_1 in carders (4.9%) compared with non-carders (0.6%) [105]. Prospective follow-up studies in Yugoslavia revealed that chronic changes in pulmonary function develop only after prolonged exposure to cotton dust (22). More recently, a prospective study on chronic lung disease in American cotton textile workers (active and retired) also demonstrated an accelerated annual FEV_1 decrement (42 ml) in comparison with referents (25 ml) and that the chronic losses continued after exposure to cotton dust had ended (106).

Though many attempted, none succeed to show clearly the possible mechanisms by which cotton dust brings about the acute and chronic changes in pulmonary function.

There were many observations that suggest the acute changes of lung function provoked in normal persons might be due to histamine release from the lungs. A variety of many chemical compounds in cotton dust have been suggested as the cause of byssinosis by stimulating the release of histamine but none has yet been positively identified to be the responsible agent (111). The weaknesses in this hypothesis are that direct histamine-release alone does not satisfactorily explain the time relationships of byssinosis nor does the immediate response provoked by bronchial challenge in healthy volunteers(112).

However, histamine may be released indirectly by other mechanisms because the "Monday" fall in FEV_1 can be reduced by antihistamines (113).

Though as stated earlier, the mechanism by which cotton dust causes narrowing of airways is not understood, a number of hypothesis have been suggested, the most important of which are non-immunological local release of histamine in the lungs; an antigen-antibody reaction; bacterial endotoxins and fungus enzymes. However, whichever (if any) of these is correct the responsible agent is known to be water soluble (56, 109).

In general, 48.1% of the study population in Bahir Dar Textile Mill had one or more respiratory tract symptoms and/or illnesses while the remaining 51.9% had neither symptoms nor gave past histories of respiratory tract illnesses.

Our findings clearly showed that there is a significantly high estimated risk of developig respiratory tract illnesses and impairment as well as leading workers to absence from work due to illness in high time-weighted dust exposure than in low time-weighted dust exposure signifying the extent of the occupatonal health hazards that calls for due consideration by all those concerned.

Chronic non-specific respiratory disease (CNRD) is a general term used to describe the group of conditions in which there is chronic sputum production and/or shortness of breath at rest and/or during exercise. These conditions include chronic bronchitis, emphysema, and bronchial asthma. All of these diseases may be acutely or chronically exacerbated and complicated by respiratory infections. Immunological mechanisms may be involved in some of them. They are undoubtedly diseases of multiple etiology and represent a classic example of diseases that may mainly be occupational in origin or partly work-related, as well as related to the social phenomena or urbanization and industrialization[118]. *This is in agreement with our observation.*

It is well known that the various conditions designated as CNRD are diseases of multiple etiology, where smoking, level of air pollution in the community, individual susceptibility and repeated respiratory infection all play major roles in causing it. When workers are exposed to any of the above risk factors in addition to particulate matter or respiratory irritants at work the prevalence of CNRD may be increased. CNRD may therefor, be work-related when the known causal agents in the work environment are not sufficient when acting alone to induce the disorder or to cause the increased prevalences observed, and for this reason it has been included among the examples of work-related diseases.

At times problem arises in differentiating between occupational diseases caused by workplace dusts (e.g. byssinosis) and CNRD caused by the same dust; thus, due emphasis to medical and occupational history should be given.

It is difficult to estimate the impact of CNRD morbidity and mortality because of intercountry difference in medical traditions and the use of diagnostic facilities.

In the United States of America, these disorders are a primary or contributing cause of about 5% deaths. Prevalence surveys report that between 12% and 50% of various population groups are affected depending on age, sex, and definition of the disorder used. A total of 1-1.5 million new cases are diagnosed each year, of which roughly 35,000 become completely disabled. It has been estimated that over one million men who would otherwise be in the mature segment of the workforce (age 40-60 years) are premanently disabled[118].

High morbidity and mortality rates are not confined to developed countries, such as the United Kingdom and the United States of America, comparable rates having been reported from Papua New Guinea, Egypt, and Malaysia. This also agrees with our observation. In most countries, age-adjusted and age-specific mortablity rates are higher for men than for women, and death rates increase with age in both sexes. The rateof increase with aging is generally greater among men than in women[118].

CHAPTER VI

CONCLUSION

VI. CONCLUSION

As investigators working on occupational lung diseases (OLD), we realise that, results may impact social, ethical and moral issues and create economic dilemmas. This is different from most research endeavours which evolve warm appreciation for research findings. We also realise that finally, the researcher may be placed in an adverse position to argue or to extrapolate beyond the scientific findings which is usually not so in research. Many are poorly equipped to deal with these issues; therefore, confusion and distrust occasionally result. Working on OLD requires enormous understanding from interested parties. Researchers' recommendations that fail to consider non-medical and non-scientific needs for industry and labour are not likely to be welcomed or implemented.

With this in mind, the results of our epidemiologic study suggest, as a conclusion, the following important observations.

1. There may be a high risk in the development of byssinosis, chronic bronchitis, bronchial asthma and also other respiratory problems on exposure to high time-weighted dust concentration than low time-weighted dust concentration.

2. *The higher the cotton dust concentration a person is exposed to, the higher the risk may be to develop byssinosis, bronchial asthma and chronic bronchitis, as exemplified by the high prevalence of byssinosis, chronic bronchitis and bronchial asthma in areas with higher dust levels i.e. carding and blowing sections.*

3. *The longer the duration a person is exposed to cotton dust the higher the risk may be to develop byssinosis, chronic bronchitis and bronchial asthma, as exemplified by the high prevalence of byssinosis, chronic bronchitis and bronchial asthma for a period of exposure of more than 20 years.*

4. *An immunologic dysfunction such as atopy, may be a risk factor in the development of cotton dust induced respiratory disease, as exemplified by the high prevalence of hay fever (allergic rhinitis) in byssinotics, bronchial asthmatics and cases of chronic bronchitis.*

5. *Chest tightness and 'Monday' sickness (occurrence of one or more of the characteristic respiratory symptoms on the first working day after absence from work for at lease one day) were found in 100 percent of byssinotic workers and these, therefore, characterize byssinosis from other respiratory disease.*

A. RECOMMENDATIONS

1. General

1. The protection of workers' health against hazards due to contamination of air by cotton dust at the workplace and the prevention of the contamination of the working environment by cotton dust should be the concern of all those involved in the design, organisation and performance of the work and all those concerned with the protection of workers' health.

2. The National Textile Corporation (NTC) and the Cotton Textile Mill Management are responsible for organizing the prevention of contamination of the working environment by cotton dust. They should, therefore, equip and maintain buildings, installations, machines and work places and organise work in such a way that the working environment is not contaminated or at least that any contamination by cotton dust resulting from working operations is limited as far as is practicable and is within the exposure limits, where they exist.

3. *The National Textile Corporation, the Cotton Textile Mill Management and any other cocerned body should investigate the health hazards of the types of cotton before their production or use so as to identify the preventive measures appropriate against such hazards without such measures the substances should not be produced or used.*

4. *The NTC, CTMM, MLSA - Workers' Safety and Health Section, and any other concerned body should supply or procure the equipment or services necessary for monitoring the working environment of the Textile Mill.*

5. *The NTC, CTMM, MLSA - WSHS and any other concerned body should ensure the surveillance necessary to enable workers to perform their tasks in the best possible hygienic conditions; in particular, provision should be made for the regular inspection and maintenance of installations and machinery liable to contaminate the working environment with cotton dust.*

6. *The NTC, CTMM, MOH, MLSA - WSHS should ensure that all workers are appropriately informed*

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about the hazards associated with the tasks assigned to them and about the measures to be taken to prevent damage to their health.

7. *The NTC and CTMM should ensure that their managerial staff are fully aware of their duties, with regard to occupational hygiene and in particular, that they are appropriately trained so that they may thoroughly instruct the workers regarding the precautions to be taken in their jobs and in the event of dangerous occurrences.*

8. *In order to protect their own health as well as that of their colleagues, textile workers should do everything in their power to prevent contamination of the working environment with cotton dust.*

9. *Workers should abide by any instructions given to them in connection with the prevention of contamination of the working environment:*

   - *workers should submit themselves to medical surveillance where appropriate;*
   - *workers should wear personal samplers when necessary to measure personal exposure to the 'respirable' content of cotton dust.*

. *workers should wear the personal protective equipment provided when other methods of control of contamination are not feasible, eg. masks, respirators, etc.*

10. *When workers, through their job experience, have reason to believe that there would be a high risk to life or health if a task assigned to them were carried out, they should have the right to ask for a full investigation before commencing or, if appropriate, continuing work.*

11. *Workers should inform the Textile Mill Health Officer or the plant service responsible for the application of the exposure limits of any changes in their state of health or of any subjective reactions in order to contribute to a better knowledge of the dose-effect relationship.*

12. *In addition to their specific activities, industrial hyginists, the factory health personnel and safety committee and technicans should donate the important part of their efforts to:*

. *information activities among workers and employers to alert them to the importance of protecting workers' health against the hazards caused by contamination of the working environment.*

. *applying their observations and the results of their inspections to epidemiological studies of the hazards of the working environment.*

. *the constant updating of their knowledge in this field.*

13. *The occupational health standards followed in developing countries should be equivalent to those in developed countries, with regard to the construction and operation of plant and other textile industry undertakings. This also applies to the buying, leasing and sale of machinery and other equipment.*

14. *In order that more effective prevention measures may be taken, scientific research institutions should strengthen their investigation into the effects of contaminats on the health and well-being of workers.*

15. *Research should be undertaken with a view of replacing harmful substances or processes by harmless or less harmful substances or processes, wherever possible.*

16. *Where appropriate, there should be full co-operation at all levels between the competent authority, scientific research institutions, employers, workers, scientific representatives and occupational health officers.*

17. *Joint employers 'and workers' committees should be set-up to give due attention to the prevention of health hazards. Any agreements reached in such committees may be included in the general conditions of employment.*

B. RECOMMENDATIONS REGARDING SPECIFIC MEDICAL SURVEILLANCE OF WORKERS EXPOSED TO HARMFUL AIR BORNE SUBSTANCES.

- *Includes specific medical examinations, biological monitoring and epidemiological surveillance.*

1. MEDICAL EXAMINATION

- *to see whether one is medically fit for the job under consideration .*
- *to determine the jobs to which one should not be assigned from a medical pront of view, and those which suit one best; and*
- *to establish for each worker a biological and breath reference baseline.*

1.1. PRE-EMPLOYMENT (INITIAL) MEDICAL EXAMINATION.

- *should consist of a general clinical examination backed up, by a test of ventilatory capacity - preferably the forced expiratory volume (FEV_1).*

- *should aim at excluding from the dusty processes persons of all ages who have evidence of chronic non-specific lung disease, pulmonary tuberculosis, allergic asthma, or any other lung disease which may cause respiratory disability.*

1.2. *PERIODIC MEDICAL EXAMINATION*

- *should be carried out each time that a change of job may involve a change in the nature of the hazard to which the worker is exposed.*
- *should if possible be at yearly intervals and include the following:-*

(a) *a standardised questionnaire relating to the characteristic symptoms occurring in byssinosis, as well as the more common symptoms of chronic non-specific chest disease.*

(b) *The FEV_1 and its change during a work-shift. This will detect those who are adversely affected by the dust. This test should be done on the first day on returning to work after the weekend break.*

- *Workers who have chest tightness and/or shortness of breath on most first working days, those who exhibit a fall in FEV_1 over the work shift of more than 10% of the pre-shift value and those with pre-shift FEV_1 of less than 60% of the predicted value, should be removed from further dust exposure.*

- *Workers who show less severe effects, such as pre-shift FEV_1 of more than 60% but less than 80% of predicted value or a work shift decrement in FEV_1 of more than 5% of the pre-shift value should be re-examined in 6 months.*

2. *BIOLOGICAL MONITORING*

- *Whenever valid biological monitoring methods are available, they should be used to complement monitoring of the working environment in order to increase protection of worker's health .*

3. *BIOLOGICAL LIMITS*

- *Evaluation of the over-all hazard prevented by the working environment should be based on the results from the group of workers exposed to given level of the harmful substance, in order to offset the effect of individual biological variability.*

- *any worker for whom the findings exceed the biological limits should undergo further and repeated biological and medical investigations.*

C. *RECOMMENDATIONS REGARDING EXPOSURE LIMITS FOR HARMFUL SUBSTANCES.*

1. *ESTABLISHMENT OF EXPOSURE LIMITS*

- *the principle of exposure limits in the working environment should be established:*

  (a) by legislation; or

  (b) by collective agreement or by any other agreements drawn up between the employers and workers; or

(c) by any other channel approved by the competent authority after consulting the employers' and workers' Organisations

- when exposure limits have been established, the wording of the relevant provisions should be sufficienly flexible to permit updating as scientific knowledge, technology and socio-economic conditions progress.
- exposure limits should be based on a study of the dose-effect and dose-response relationship.
- if exposure limits established in another country are adopted, account should be taken of possible differences with regard to climate, altitude, pollution of the living and general environment, conditions of work and physical effort social (rating) habits, cultures, traditions and health of the population, authropometric data, distribution of workers by age and sex, and the general level of protection against occupational hazards.

2. APPLICATION OF EXPOSURE LIMITS.

- exposure limits should neither be considered as relative toxicity criteria not be used in non-occupational control of contamination, nor should they be applied to an exposure longer than the normal work period, nor be quoted to establish the existence or non-existence of an occupational disease.
- the concentration of dust in the working environment should be promptly monitored after every technical or other modification which could produce significant changes in the exposure of workers.

- *neither the exposure limits nor the action levels should apply to confined spaces, where special precautions need to be taken.*

4. *MEASUREMENT AND CONTROL OF HARMFUL AIRBORNE SUBSTANCES IN THE WORKING ENVIRONMENT.*

- *air samples should be collected in the workers' breathing zone whenever the purpose is to evaluate the health hazard. Personal samplers may conveniently be used for this purpose.*
- *in order to obtain indications of the distribution of contamination throughout the general atmosphere of the working area, samples should be taken:*

  (a) as close as possible to pollutant sources, to indicate the standard of process control; and

  (b) at various places in the working area.

- *the minimum valume of air sample to be taken for each analysis should be determined according to the sensitivity of the analytical method.*
- *sampling should always be carried out during working hours when the process is in operation.*
- *where concentrations may vary from one work operation or phase to another, sampling should be done in such a manner as to be able to determine the average level and, in any case, the maximum exposure.*

- *the sampling of substances for which time -weighted averages exist should take place throughout the work period and be supplemented, where necessary, by short-time sampling during periods of peak concentration, unless it is certain that the concentration remained constant.*
- *in general, only analytical methods already applied successfully in occupational hygiene should be adopted for determining the concentrations of harmful airborne substances in the working environment.*
- *in applying the exposure limits for dust, account should be taken not only of fibrogenic dust but also of the accompanying inert/nuisance dust.*
- *when the dust concentrations in the working environment approach the esposure limits, it is recommended that data for the various seasons of the year be considered before drawing conclusions regarding the contamination level.*
- *in other cases, where the main risk is that of an accidental release, it is necessary both to provide individual and technical protection for workers and to monitor the working environment.*

D. RECOMMENDATIONS REGARDING PREVENTION OF CONTAMINATION OF THE WORKING ENVIRONMENT

The ultimate aim of programmes for the prevention of contamination of the working environment is to eliminate contamination in order to protect the health of workers; and if that is not possible, the intermediate objective is to keep contamination at as low a level as possible by choosing the least harmful materials and products or by taking other technical measures to reduce the contamination of the working environment to the lowest possible level and at any rate to the exposure limit established by the competent authority or recommended by scientific bodies.

E. RECOMMENDATIONS ON OCCUPATIONAL LUNG DISEASE

1. *Research into mechanisms of interactions between occupational and nonoccupational factors that are harmful to the lung;*

2. *development of diagnostic techniques sensitive and specific enough to discriminate between disease of occupational and non-occupational origin;*

3. *surveillance of workers exposed using these techniques;*

4. *enhanced use of techniques to reduce exposure to hazards combined with methods to measure individual worker exposure;*

ANNEX 1

CODING AND DATA ENTRY FORM

1. STUDY NUMBER — ID — [ ][ ][ ] (1 - 3)

2. A G E — AGE — [ ][ ] (4 - 5)

3. S E X — SEX

1. [ ] MALE

2. [ ] FEMALE

4. MARITAL STATUS — MSTATUS — [ ] (6)

1. [ ] SINGLE

2. [ ] MARRIED

3. [ ] DIVORCED

4. [ ] WIDOWED

5. [ ] SEPARATED

[ ] (7)

5. ETHNIC GROUP — ETHGROUP

1. [ ] AMHARA

2. [ ] TIGRE

3. [ ] OROMO

[ ] (8)

4. [ ] AGEW

5. [ ] OTHER: SPECIFY _____

6. DEPARTMENT — DEPT

1. ☐ SPINNING
2. ☐ WEAVING — ☐ (9)

7. SECTION — SECTION ☐☐ (10 - 11)

1. ☐ BLOWING
2. ☐ CARDING
3. ☐ DRAWING
4. ☐ SIMPLEX
5. ☐ RING FRAME
6. ☐ REELING
7. ☐ PREPARATORY
8. ☐ LOOM SHADE - 1
9. ☐ LOOM SHADE - 2
10. ☐ INSPECTION

8. PERIOD OF EMPLOYMENT _____ MONTHS — POEMPLOY ☐☐☐ (12 - 14)

9. MONTHLY INCOME _____ ETH. BIRR — MINCOME ☐☐☐☐ (15 - 18)

10. NO. OF HOUSEHOLD MEMBERS _____ — HHSIZE ☐☐ (19 - 20)

11. STANDING HEIGHT — HEIGHT ☐☐☐ (21 - 23)

12. WEIGHT

_____KGS

WEIGHT [ ][ ] 24-25

13. FEV_1 PRESHIFT

_____ML

PREFEV [ ][ ][ ][ ] 26 - 29

14. FEV_1 POSTSHIFT

_____ML

POSTFEV [ ][ ][ ][ ] 30 - 33

15. Δ FEV_1

_____ML

DIFFFEV [ ][ ][ ][ ] 34 - 37

16. FVC PRESHIFT

_____ML

PREFVC [ ][ ][ ][ ] 38 - 41

17. FVC POSTSHIFT

_____ML

POSTFVC [ ][ ][ ][ ] 42 - 45

18. Δ FVC

_____ML

DIFFVC [ ][ ][ ] 46 - 49

19. $\frac{FEV_1 \text{ PRESHIFT}}{FEV_1 \text{ STANDARD}}$

_____%

FEVSTAND [ ][ ][ ] 50 - 52

20. COTTON DUST CONCENTRATION

_____MG/M^3

DUSTCONC [ ][ ][ ] 53 - 55

21. DO YOU USUALLY COUGH FIRST THING IN THE MORNING?

MORCOUGH

0 [ ] NO

1 [ ] YES

[ ] 56

22. DO YOU USUALLY COUGH DURING THE DAY OR AT NIGHT? DONCOUGH

0 ☐ NO

1 ☐ YES

☐ 57

23. IF YES TO 21 OR 22, DO YOU COUGH LIKE THIS ON MOST DAYS FOR AS MUCH AS 3 MONTHS EACH YEAR? TREMCOGH

0 ☐ NO

1 ☐ YES

9 ☐ NOT APPLICABLE

☐ 58

24. DO YOU COUGH MOST ON ANY PARTICULAR ENVIRONMENTAL CONDITION? ENVTCOND

0 ☐ NO

1 ☐ IN DUSTY ENVIRONMENT

2 ☐ IN COLD ENVIRONMENT

3 ☐ IN HOT ENVIRONMENT

4 ☐ OTHER, SPECIFY_____

_____

_____

9 ☐ NOT APPLICABLE

☐ 59

25. DO YOU USUALLY BRING UP ANY PHLEGM FROM YOUR CHEST FIRST THING IN THE MORNING? MORPHLEM

0 ☐ NO

1 ☐ YES

☐ 60

26. DO YOU USUALLY BRING UP ANY PHLEGM FROM YOUR CHEST DURING THE DAY OR AT NIGHT? DONPHLEM

0 ☐ NO

1 ☐ YES

☐ 61

27. IF YES TO 25 OR 26, DO YOU BRING UP PHLEGM LIKE THIS ON MOST DAYS FOR AS MUCH AS 3 MONTHS EACH YEAR? TRMPHLEM

0 ☐ NO

1 ☐ YES_____MONTHS

999 ☐ NOT APPLICABLE

☐☐☐ 62 - 64

28. IN THE PAST 3 YEARS, HAVE YOU HAD A PERIOD OF RECURRENT COUGH AND PHLEGM ON MOST DAYS FOR AT LEAST 3 MONTHS PER YEAR FOR 2 SUCCESSIVE YEARS? TREMCAP

0 ☐ NO

1 ☐ YES

☐ 65

29. IF YES TO 28, HAVE YOU HAD MORE THAN ONE SUCH PERIOD? MOREPSOD

0 ☐ NO

1 ☐ YES

9 ☐ NOT APPLICABLE

☐ 66

30. DOES YOUR CHEST EVER FEEL TIGHT OR YOUR BREATHING BECOME DIFFICULT? CHSTIGHT

0 ☐ NO

1 ☐ YES

☐ 67

31. DO YOU GET THIS APART FROM COLDS? APRTCOLD

0 ☐ NO

1 ☐ IN DUSTY ENVIRONMENT

2 ☐ IN COLD ENVIRONMENT

3 ☐ IN HOT ENVIRONMENT

4 ☐ OTHER, SPECIFY _____
_____
_____ ☐ 68

9 ☐ NOT APPLICABLE

32. IS YOUR CHEST TIGHT OR YOUR BREATHING DIFFICULT ON ANY PARTICULAR DAY? CTPARDAY

0 ☐ NO

1 ☐ OCCASIONALLY ON THE FIRST DAY OF THE WORKING WEEK

2 ☐ ON EACH FIRST DAY ONLY OF THE WORKING WEEK

3 ☐ ON THE FIRST AND OTHER DAYS OF THE WORKING WEEK

4 ☐ SYMPTOMS ON EFFORT ARE PRESENT EVERY DAY AND MAY BE SEVERE ENOUGH TO PREVENT FROM CONTINUING THE WORK ☐ 69

33. IF NO TO 32, HAS YOUR CHEST EVER BEEN TIGHT OR YOUR BREATHING DIFFICULT ON ANY PARTICULAR DAY? PRETIGHT

0 ☐ NO

1 ☐ OCCASIONALLY ON THE FIRST DAY OF THE WORKING WEEK

2 ☐ ON EACH FIRST DAY ONLY OF THE WORKING WEEK

3. ☐ ON THE FIRST AND OTHER DAYS OF THE WORKING WEEK

4. ☐ SYMPTOMS ON EFFORT ARE PRESENT EVERY DAY AND MAY BE SEVERE ENOUGH TO PREVENT FROM CONTINUING THE WORK

9. ☐ NOT APPLICABLE ☐ 70

34. ARE YOU TROUBLED BY SHORTNESS OF BREATH WHEN HURRYING ON LEVEL GROUND OR WALKING UP A SLIGHT HILL? SOBHILL

0 ☐ NO

1 ☐ YES ☐ 71

35. IF YEST TO 34, DO YOU GET SHORT OF BREATH WALKING WITH OTHER PEOPLE OF YOUR OWN AGE ON LEVEL GROUND? SOBLEVEL

0 ☐ NO

1 ☐ YES

9 ☐ NOT APPLICABLE ☐ 72

36. IF YES TO 35, DO YOU HAVE TO STOP FOR BREATH WHEN WALKING AT YOUR OWN PACE ON LEVEL GROUND? SOBPACE

0 ☐ NO

1 ☐ YES

9 ☐ NOT APPLICABLE ☐ 73

37. IS YOUR BREATHLESSNESS WORSE ON ANY PARTICULAR ENVIRONMENTAL CONDITION? SOBPDAY

0 ☐ NO

1. ☐ IN DUSTY ENVIRONMENT

2. ☐ IN COLD ENVIRONMENT

3. ☐ IN HOT ENVIRONMENT

4. ☐ OTHER, SPECIFY _____
_____
_____

9. ☐ NOT APPLICABLE ☐ 74

38. DURING THE PAST 3 YEARS HAVE YOU HAD ANY CHEST ILLNESS WHICH HAS KEPT YOU AWAY FROM YOUR USUAL ACTIVITIES FOR AS MUCH AS ONE WEEK? SICKWEEK

0 ☐ NO

1 ☐ YES ☐ 75

39. IF YES TO 38, DID YOU BRING UP MORE PHLEGM THAN USUAL DURING ANY OF THESE ILLNESSES? PHLEMMOR

0 ☐ NO

1 ☐ YES

9 ☐ NOT APPLICABLE ☐ 76

40. IF YES TO 39, HAVE YOU HAD MORE THAN ONE ILLNESS LIKE THIS IN THE PAST 3 YEARS? MORILNES

0 ☐ NO

1 ☐ YES

9 ☐ NOT APPLICABLE ☐ 77

41. HAVE YOU EVER HAD AN INJURY OR OPERATION AFFECTING YOUR CHEST? INJOPART

0 ☐ NO ☐ YES ☐ 78

42. HAVE YOU EVER HAD HEART TROUBLE? HARTSICK

0 ☐ NO

1 ☐ YES

☐ 79

43. HAVE YOU EVER HAD BRONCHITIS? BRONCHIT

0 ☐ NO

1 ☐ YES

☐ 80

44. HAVE YOU EVER HAD PNEUMONIA? PNEMONIA

0 ☐ NO

1 ☐ YES

☐ 81

45. HAVE YOU EVER HAD PLEURISY? PLEURISY

0 ☐ NO

1 ☐ YES

☐ 82

46. HAVE YOU EVER HAD PULMONARY TUBERCULOSIS PULMTBC

0 ☐ NO

1 ☐ YES

☐ 83

47. HAVE YOU EVER HAD BRONCHIAL ASTHMA ? ASTHMA

0 ☐ NO

1 ☐ YES_____MONTHS

☐☐☐ 84 - 86

48. HAVE YOU EVER HAD HAY FEVER? HAYFEVER

0 ☐ NO

1 ☐ YES

☐ 87

49. DO YOU SMOKE? (RECORD 'YES' IF REGULAR SMOKER UP TO 1 MONTH AGO) — YOUSMOKE

0 ☐ NO

1 ☐ YES____MONTHS

☐☐☐ 88 - 90

50. NUMBER OF CIGARETTES SMOKED PER DAY: _____CIGARETTES — CIGARNO

99 ☐ NOT APPLICABLE

☐☐ 91 - 92

51. IF NO TO 49, HAVE YOU EVER SMOKED? (RECORD 'NO' IF SUBJECT HAS NEVER SMOKED AS MUCH AS 1 CIGARETTE A DAY FOR AS LONG AS 1 YEAR) — EVERSMOK

0 ☐ NOT

1 ☐ YES_____MONTHS

999 ☐ NOT APPLICABLE

☐☐☐ 93 - 95

52. IF YES TO 51, NUMBER OF CIGARETTES SMOKED PER DAY? — NOSMOKED

_____CIGARETTES

99 ☐ NOT APPLICABLE

☐☐ 96 - 97

53. NUMBER OF MONTHS STOPPED — MTHSTOP

_____ MONTHS

999 ☐ NOT APPLICABLE

☐☐☐ 98 - 100

54. HAVE YOU EVER WORKED IN ANY OTHER DUST JOB? — DUSTYJOB

0 ☐ NO

1 ☐ IN A COAL MINE

2 ☐ IN ANY OTHER MINE

3 ☐ IN A QUARRY

4. ☐ IN A FOUNDRY

5. ☐ IN A POTTERY

6. ☐ IN A COTTON, FLAX, OR HEMP HILL

7. ☐ WITH ASBESTOS

8. ☐ OTHER, SPECIFY_____

_____

_____

☐ 101

55. HAVE YOU EVER BEEN EXPOSED REGULARLY TO AN IRRITATING GAS OR TO CHEMICAL FUMES? GASFUMES

0 ☐ NO

1 ☐ BENZENE

2 ☐ KEROSENE

3 ☐ GREASE

4 ☐ OIL

5 ☐ 1, 2, 3 & 4

6 ☐ OTHERS, SPECIFY_____

_____

_____

☐ 102

56. IF YES TO 55, FOR HOW LONG HAVE YOU BEEN EXPOSED? EXPOSURE

_____MONTHS

☐☐☐ 103 - 105

999 ☐ NOT APPLICABLE

ANNEX: 2.

BAHIR DAR AWRAJA

A. GEOGRAPHIC FEATURES & CLIMATES:-

- one of the seven awrajas of Gojjam Administrative Region.
- has an area of 8,274.65 sq.kms.
- the principal town is Bahir Dar, which is also a North Western zonal and industrial town:
- middle land plateau lying about 1,840 meters above sea level.
- has variable climatic conditions: kolla, weinadega and dega (hot, worm, and cold weather)
- the months of June to October are cold while April and May are the hottest months.
- the highest rainfall is during the months of June to September.
- January to May is the dry season.

B. POPULATION:

- projected awraja population to mid 1987 was 751,539
- 12.4% lived in urban areas and 87.6% in villages in rural areas.
- population density is 90.8 persons per square kilometre.
- sex ratio for urban population is 84.6
  - rural population is 102.5
  - total " " 100.1
- total population of Bahir Dar town is 62,109
- sex ration of Bahir Dar town is 89.8
- overall awraja has a relatively young population.
  .- 47% under 15 years of age
  .- 58% below 20 years of age.
- children under 15 years of age and women in their child bearing age made up 69% of the total population.

- average size of household is 43
- vital statistics of Bahir Dar Awraja :-
  - ° crude birth rate is 58 per 1000 population
  - ° crude death rate is 13 per 1000 population
  - ° Infant mortality rate is 87 per 1000 live births
- Literacy rate over 40%

C. ECONOMIC DEVELOPMENT

- economy mainly dependent on agriculture.
- two middle scale industries in the principal town of the Awraja:
  - ° Bahir Dar Cotton Textile Mill has 3,500 workers
  - ° Bahir Dar Food Oil Mill has 200 workers.
- there is some fishing and cattle rasing
- some petty trading in the Awraja.

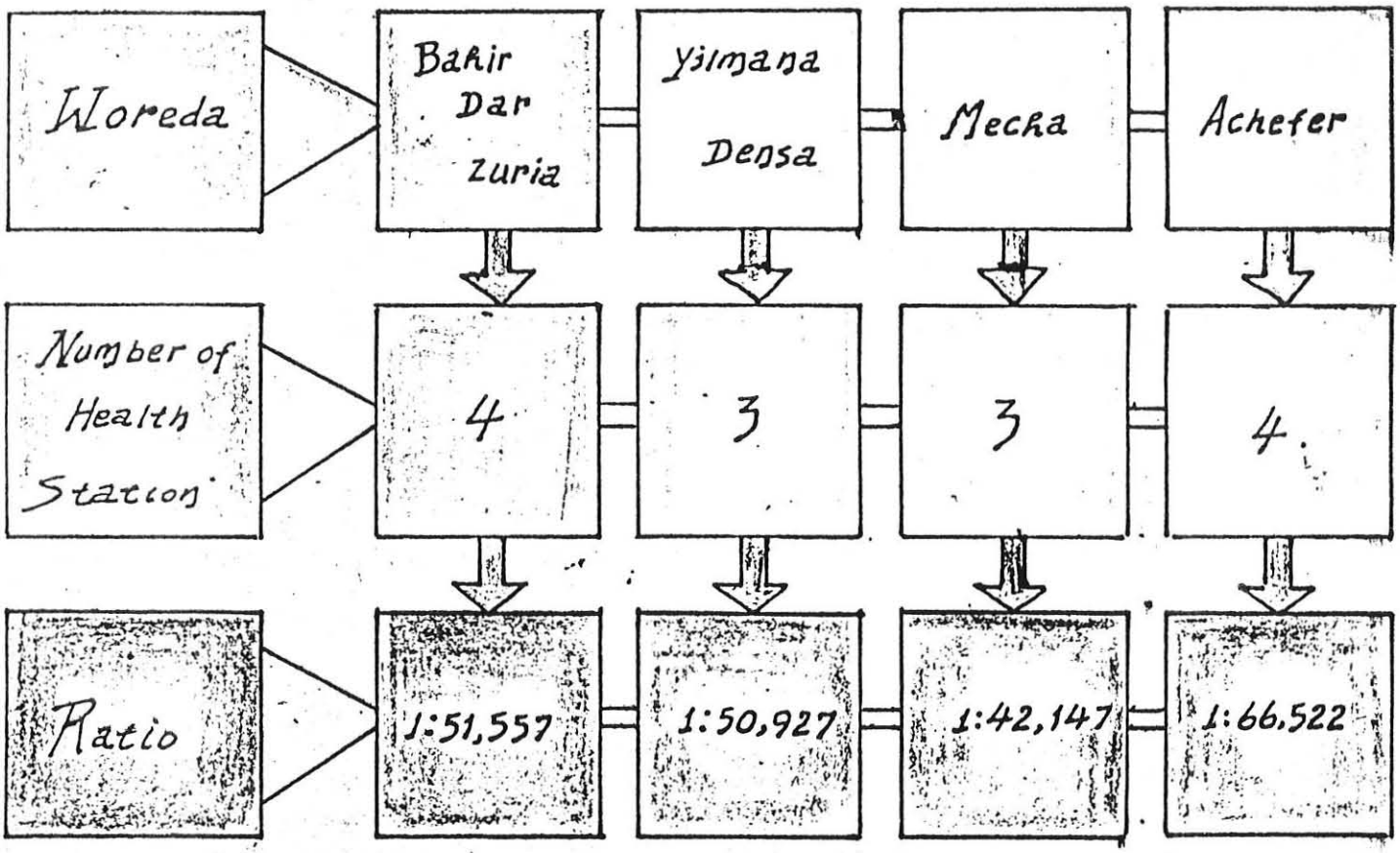
D. HEALTH FACILITIES AND SUPPORTING SERVICES.

- 64.9% of the total Awraja population is covered by the present health institutions i.e. 1 hospital, 1 health centre, 14 health stations and 2 community health posts.
- on top of the above mentioned health institutions under the Ministy of Health there are 8 governmental clinics in other sectors, one of which being Bahir Dar Cotton Textile Mill clinic.
- the man -power mix and manpower population ratio of the Awraja elucidates that the technical staff to administration staff ratio is 1.24:1, physician to Nurse ratio 1:1.87 and Nurse to Health Assistant ratio is 1: 3.36 which reflects the poor manpower planning in the awraja.

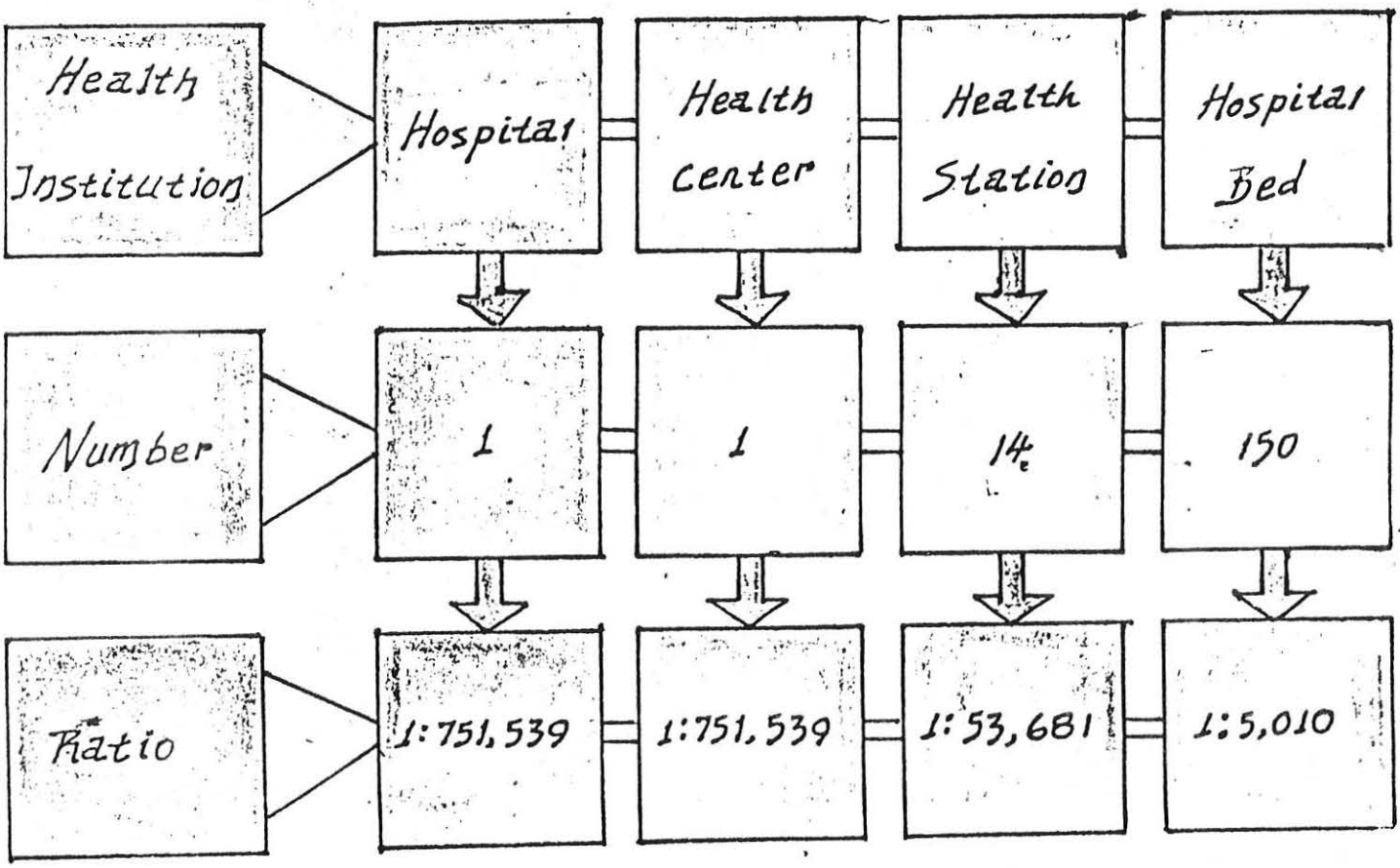
THE RATIO OF HEALTH WORKERS TO POPULATION

HEALTH WORKER	NUMBER	R A T I O
MEDICAL DOCTORS	15	1: 50,103
HEALTH OFFICERS	3	1: 250,513
PHARMACISTS	6	1: 125,257
ANAESTHETIST	2	1: 375,770
N U R S E S	31	1: 24,243
SANITERIANS	4	1: 187,885
LAB-TECHNICIANS	7	1: 107,363
X-RAY TECHNICIANS	4	1: 187,885
PHARMACY TECHNICIANS	5	1: 150,308
HEALTH ASSISTANTS	83	1: 9,055
C H A S	207	1: 3,631
T B As	194	1: 3,874

Health Station Population Ratio By Woreda



Health Institution Population Ratio By Awraja



Financing of Health Services in the Awraja

The total allocated budget on health services in Bahr Dar Awraja including institutions outside of Ministry of Health is Birr 2,102,732.80 with a per capita health expenditure of Birr 2.80.

Ministry of Health allocated budget for the Awraja is Birr 1,329,866.10 which brings about a MOH allocated budget per capita of Birr 1.77 (National MOH allocated budget per capita is Birr 2.19 and for Gojam Region Birr 1.25*).

Of the total allocated budget Birr 978,383 i.e. 46.5% is allocated to Felege Hiwot Hospital, Birr 237,480.49, i.e. 11.3% is allocated to Bahr Dar Health Centre, Birr 357,221.31, i.e. 17.0% is allocated to the fourteen health stations and Birr 312,023, i.e. 14.8% is allocated to Bahr Dar Textile Mill.

59.8% of the total budget, i.e. Birr 1,256,536 is allocated for salary, 19.8%, i.e. 415,999.97 is allocated for drugs and 20.4%, i.e. Birr 430,196.92 is allocated for other activities. This shows clearly that the majority of the budget is allocated for salary; and Felege Hiwot Hospital gets the lion's share of the total budget of the Awraja. What is also interesting is that Bahr Dar Textile Mill Health Expenditure is higher than that of Bahr Dar Health Centre, clearly revealing unequitability. (See Table 19 & 20).

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