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Contemporary Prevalence of Byssinosis in Low- and Middle-Income Countries: A Systematic Review

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Abstract

We aimed to identify the contemporary prevalence of byssinosis through a systematic review. We used Medline, Web of Science, Embase, and Global Health databases to identify studies published in any language between 2000 and 2019, reporting primary data on byssinosis among adults. We used the Joanna Briggs Institute checklist to estimate the risk of bias in studies and undertook a qualitative, narrative data analysis. The review considered the prevalence of byssinosis, chest tightness, and airflow obstruction in textile workers in low- and middle-income countries (LMICs). We found 26 relevant studies that included 6930 workers across 12 countries. Most of the studies (n = 19) were from Asia, and 7 from African countries. Twenty-five studies were cross-sectional surveys while 1 was a cohort study. The prevalence of byssinosis was reported by 18 studies, and ranged from 8% to 38%, without any clear associations, at the group level, between the prevalence of byssinosis and durations of workers' exposures. Prevalence of chest tightness ranged between 4% and 58% and that of airflow obstruction between 10% and 30%. We found a strong correlation (r = 0.72) between prevalence of byssinosis and cotton dust levels. Our findings indicate that byssinosis remains a significant, contemporary problem in some parts of the textile sector in LMICs.

Keywords

byssinosis, developing countries, textile industry, cotton fiber, prevalence

What We Already Know

- Byssinosis is a respiratory condition typically associated with exposure to cotton or jute dust among textile workers.
- The disease is conidered to be largely preventable by dust control measures in the workplace.
- There is no summary of current data on the prevalence of byssinosis in LMICs where much of the industry is now based.

What This Article Adds

- We found 26 relevant studies that included 6930 textile workers across 12 countries. The prevalence of byssinosis ranged from 8% to 38%. Prevalence of chest tightness ranged between 4% and 58% and that of airflow obstruction between 10% and 30%. We found a strong correlation (r = 0.72) between prevalence of byssinosis and cotton dust levels.
- This review indicates that byssinosis remains a significant cause of chronic respiratory disease in many LMICs.
- Risk reduction may be achieved through technological improvements, while there is a need for trials of low-cost interventions designed to reduce the effects of airborne textile dust.

Background

Annual global cotton production is upward of 25 million tons; around two-thirds is grown in low- and middle-income countries (LMICs), 3 of which are in Asia (India, China, and Pakistan) and among the 5 highest producers.[1,2] Approximately

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half of global textile exports come from LMICs, where collectively the sector contributes >4% of gross domestic product (GDP), signifying a major influence of the industry on the national economies of these countries.[3] The global workforce employed in the textile (including footwear) sector is estimated to around 24 million,[4] or a third of the total manufacturing workforce in some LMICs.[3]

Byssinosis is a respiratory condition typically associated with exposure to cotton or jute dust among textile workers. The disease develops progressively after prolonged exposure over several years, and classical symptoms include chest tightness, particularly occurring on the first day after return from a spell away from work. In its chronic form, there may be a gradual, "obstructive" loss of lung function.[5] The disease is largely preventable by dust control measures in the workplace.[6] A system of identifying and grading byssinosis was first proposed by Schilling and colleagues in 1963[7]; this was subsequently adapted by the World Health Organization (WHO) to include acute and chronic changes in FEV_1.[8]

There is no current summary of recent data on the prevalence of byssinosis in LMICs where much of the industry is now based. We aimed to rectify this deficiency through a systematic review of published literature and so provide information that will be helpful in planning primary preventive programs. Specifically, we set out to address the question, "among populations of textile workers in LMICs studied in the last 20 years, what is the prevalence of byssinosis?"

Methods

This review is registered on the PROSPERO database (registration #: CRD42020200564) and is being reported in accordance with the PRISMA guidelines.[9]

We undertook a systematic review of the available literature published in peer-reviewed journals using Medline, Web of Science, Embase, and Global Health databases. We aimed to identify studies published in any language between 2000 and 2019 which reported contemporary data on byssinosis among adult men and women employed in the primary production of cotton, jute, or other vegetable textiles in LMICs.[10]

We used the following [MeSH] terms in the search strategy of each database; health outcomes [byssinosis, respiratory tract diseases]; exposures: [cotton fiber, textiles, textile industry, flax, hemp, jute]; and measurement [prevalence, risk].

We considered all observational studies of any design but excluded review papers, case reports, and editorials or commentaries. We further excluded publications with no reports of health outcomes, those on non-respiratory disease outcomes, and those that were not directly attributable to vegetable textile dust exposure. We also omitted studies of non-industrial (domestic) workers. Where there were several reports from the same workforce, we selected that which was most relevant to our purpose[11,12] (Figure 1).

We first reviewed the titles and abstracts of all the retrieved articles and excluded those that were evidently out of scope. Two authors then reviewed, independently, the remaining manuscripts and recorded relevant information from each relevant study on a data extraction form. In cases where precise information was unreported, such as the average duration of a workforce's employment, we made estimates from grouped data. We resolved discrepancies between reviewers through discussion. Finally, we undertook a tailored qualitative assessment to estimate the risk of bias in individual studies, including considerations of design, sample size, response rates, and adjustment for confounders, using the Joanna Briggs Institute (JBI) checklist for the critical appraisal of studies reporting prevalence data.[13] We did not think it was appropriate to use a formal assessment of certainty tool in this review of observational data.

After data extraction, we undertook a qualitative, narrative data analysis. We anticipated (and found) too much heterogeneity in study design and outcome measures to allow for a formal meta-analysis. We considered the prevalence (or incidence) and potential determinants of byssinosis, chest tightness, and airflow obstruction in working populations exposed to cotton or jute dust in the primary manufacture of textiles in LMICs.

In 2 reports, the wording of the first 3 paragraphs of the Results sections was identical. One was a description of a survey of textile workers in Iran, undertaken in 2013[14]; the second[15] purported to be from a survey of cotton mill workers in Indore, India, in 2016-2017. For the sake of completeness, both are reported below.

Results

We found 26 relevant studies (Table 1) which included 6930 textile workers across 12 countries. Most of the studies (n = 19) were from Asia, including India (n = 8), Pakistan (6), China (1), Turkey (1), Bangladesh (1), Iran (1), and Taiwan (1). The remaining 7 were conducted in African countries, including Ethiopia (2), Benin (2), Morocco (1), Nigeria (1), and Egypt (1). All bar 2 of the studies were of cotton textile workers, the exceptions[16,17] being of workers in 3 jute mills in India.

We omitted a Nepalese study[38] as it included many home-based workers; a Congolese study[39] where a clear definition of byssinosis was missing; an Indian[40] and a Chinese study[41] where they did not report the prevalence of byssinosis or chest tightness; 3 Chinese studies[5,42,43] that belonged to the same cohort; and another Chinese[44] and a Turkish[45] study that included only newly hired workers with insufficient exposure to be at risk of byssinosis.

Among those included, 25 studies were cross-sectional surveys, 1 using a case-referent approach[21] in analysis. There was 1 prospective cohort study of 15 years duration.[12] Sample sizes varied from 83 in a cross-sectional study in Pakistan to 800 in another survey of textile workers in Pakistan. Thirteen

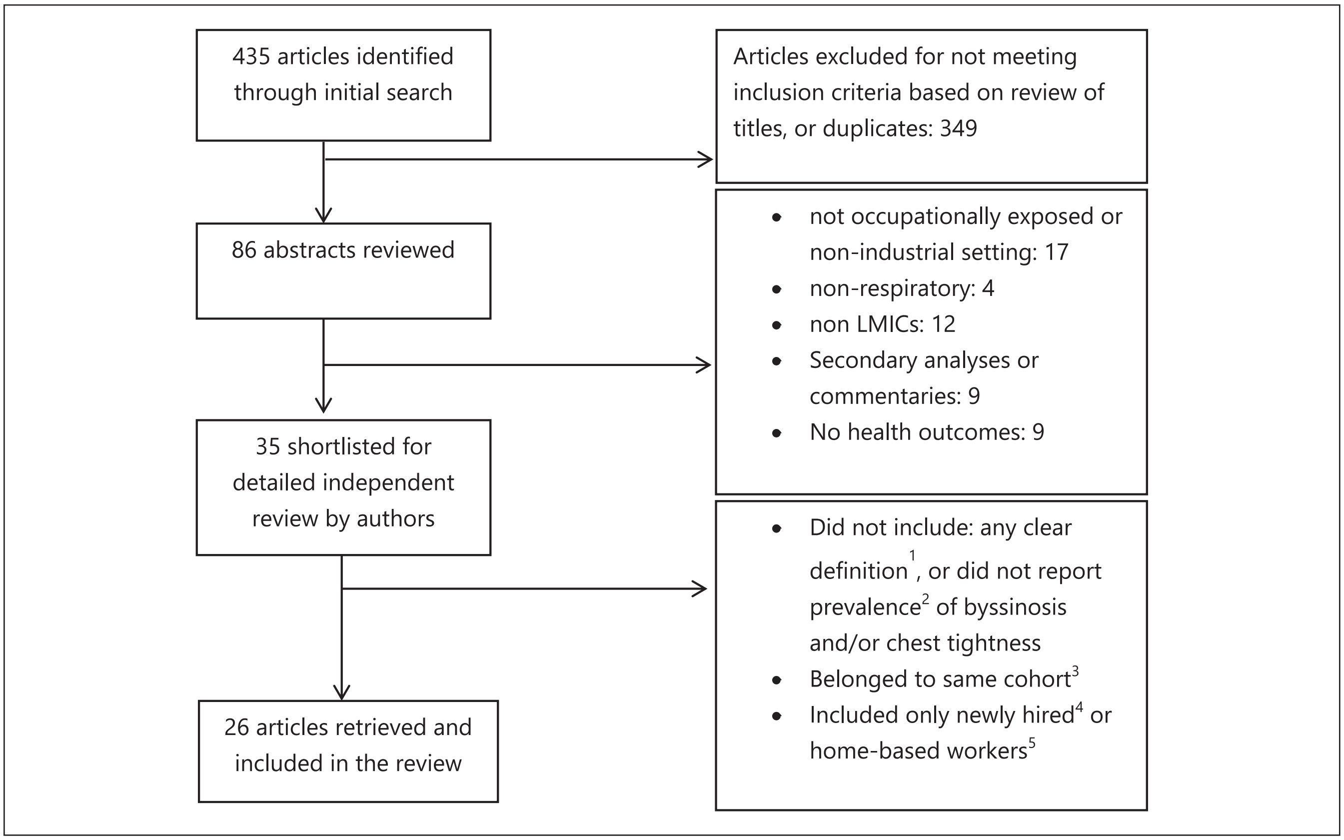

Figure 1. PRISMA flow diagram showing process of literature review.
[a]Kitronza and Brouwer (2010).
[b]Jaiswal (2012) and Shi et al (2010).
[c]Wang et al (2003); Wang et al (2005) and Shi et al (2010).
[d]Wang et al (2003) (early pulmonary responses); Bakirci et al (2007).
[e]Paudyal et al (2015).

papers reported response rates, which in almost all cases were very high. We found 10 studies that included only men but none that reported the prevalence of byssinosis separately for men and women. The average age of participants ranged between 26[19] and 47[27] years. The JBI quality scores ranged from 1 to 8 with a median of 5 (Supplementary Table).

Nine studies included direct, gravimetric measurements of dust exposures; in 6, area measurements were made, and in 3, personal exposures were estimated. The numbers of such measurements ranged widely, from just 2,[24] to more than 800.[12] One study also used particle counting.[33] The remaining studies used estimates of group exposure based on mill section or subjective assessments. Among the 9 studies that reported gravimetric analyses, mean dust exposures ranged between 0.2 and 26.8 mg/m^3 with some individual values as high as 61 mg/m^3.

Outcomes

The prevalence of byssinosis was reported by 18 studies, 13 of which used Schilling's criteria, 3, the WHO criteria; and 2, the criterion of "chest tightness at work." Table 2 sets out these findings, ordered by prevalence which ranged more than 4-fold, from 8% to 38%. There were no clear associations, at the group level, between the prevalence of byssinosis and either mill dust concentrations (reported in 7 studies) or duration of exposure (11 studies). Five studies, however,[11,12,16,21,35] reported that some outcomes were related to duration of employment although it was not always clear that the association was independent of dust concentration. Several studies found higher prevalences of byssinosis in employees working in spinning, blowing, and carding sections.

Table 2 also summarizes the findings of 8 studies which did not report on byssinosis but did describe prevalences of chest tightness; it was generally unclear whether an enquiry had been made into the work-relatedness of this symptom. Again, frequencies varied widely without any clear relationships to dust exposures or durations of employment; in the 4 studies that included one, chest tightness was less frequent in an unexposed referent group. Nine studies reporting the prevalence of byssinosis also reported the frequency of chest tightness; in 3 cases,[20,27,34] reports of chest tightness were less frequent than those of byssinosis.

Table 1. Description of Studies Included in the Review.

Reference	Country; year of study	Design and setting	Inclusion criteria	Sample size (exposed); response rate	Age; mean years	Sex	Exposure assessment method	Quality grade (number of "yes")
Ahasan et al[18]	Bangladesh; NA	Cross-sectional survey; 3 cotton mills	All exposed workers	210; 36%	36	M	Subjective; workers' and expert opinions	3
Christiani et al[12]	China; 1981-1996	Prospective cohort (15-year follow-up); 2 cotton mills	Employed >2 years; no active asthma	447; 90% at baseline (follow-up rates 76%-88%)	37	M/F	Area measurements (gravimetric) in different sections; n = 802	6
Altin et al[19]	Turkey; 1998	Cross-sectional survey; cotton mill	All exposed workers	182; 98%	26	M/F	Area measurements (gravimetric) in different sections; n = NA	5
Laraqui et al[20]	Morocco; 1997	Cross-sectional; 2 cotton mills	Employed >18 months; no respiratory or cardiac disease	224; NA	NA	NA	NA (section only)	6
Mishra et al[21]	India; 1998-2000	Cross-sectional survey followed by case-control analysis; cotton mill	Age > 30 and ≥10 years of employment	761; NA case-control analysis: 102 cases and 204 control	>30	M	NA (section only)	5
Su et al[11]	Taiwan; 1996	Cross-sectional survey (second); cotton mil	>1 year of employment; no active cardiac or pulmonary disease	175; NA	44 (M), 42 (F)	M/F	Personal measurements (gravimetric); n = 84	5
Mukherjee et al[22]	India; 1995	Cross-sectional survey; jute mill	≥7 years employment	148; NA	45	M	Area measurements (gravimetric) in different sections; n = 7	6
Osibogun et al[23]	Nigeria	Cross-sectional survey; cotton mill	NA	321; 75%	35	M/F	NA (section only)	7
Shobha et al[24]	India; 1993-1994	Cross-sectional survey; cotton mill	All exposed workers	130; 48%	NA	M/F	Area measurements (gravimetric) in different sections; n = 2	5
Memon et al[25]	Pakistan	Cross-sectional survey; 3 cotton factories	≥5 years of employment; no (other) respiratory disease	362; NA	NA (range, 18-84)	M	NA (section only)	7
Farooque et al[26]	Pakistan; 2006	Cross-sectional survey; cotton mill	≥5 years of employment	83; NA	30	M	NA (section only)	3
Alemu et al[27]	Ethiopia; 2007	Cross-sectional survey; cotton mill	≥1 year of employment	417; NA	47	M/F	Area measurements (gravimetric) in different sections; n = NA	6
Dube et al[28]	India	Cross-sectional survey; 10 cotton ginning factories	Employed >1 year; age < 55 years; no respiratory disease; non-smokers	188; 90%	35	M	Personal measurements (gravimetric); n = NA	5

(continued)

Table 1. (continued)

Reference	Country; year of study	Design and setting	Inclusion criteria	Sample size (exposed); response rate	Age; mean years	Sex	Exposure assessment method	Quality grade (number of "yes")
Nafees et al[29]	Pakistan; 2009	Cross-sectional survey; 15 cotton factories	Employed ≥1 year; age ≥ 18 years	372; 96%	27	M	NA (section only)	8
Rahman[30]	Pakistan	Cross-sectional survey; cotton mills	Employed ≥1 year	100; 77%	27	NA	NA (section only)	4
Mandal and Majumder[16]	India; 2009	Cross-sectional survey; jute mill	All exposed workers	203; NA	NA	M	Area measurements (gravimetric) in different sections; n = NA	4
Hinson et al[31]	Benin; 2008	Cross-sectional survey; cotton factory	All exposed workers	109; 100%	46	M	NA (section only)	8
Talikoti et al[32]	India	Cross-sectional survey; cotton ginning factory	NA	110; NA	NA	NA	NA (section only)	3
Khan et al[33]	Pakistan; 2014	Cross-sectional survey; 47 cotton factories	>6 months of experience	800; 90%	NA	M	Dust exposures estimated by particle counters (n = 2966); personal measurements (gravimetric); n = NA	6
Hinson et al[34]	Benin; 2013	Cross-sectional survey; 1 cotton factory	≥2 years exposure	656; 100%	29 (exposed)	M/F	NA (section only)	8
Mansouri et al[14]	Iran; 2013	Cross-sectional survey; cotton textile workers	Exposed >3 years; no respiratory disease; never smokers only	100; NA	37	NA	NA (section only)	1
Tageldin et al[35]	Egypt; 2013-14	Cross-sectional survey; cotton factory	Those with exposure to other occupational dusts, smokers or history of asthma and COPD excluded	100; NA	NA (38-42 depending on section)	M/F	NA (section only)	3
Muhammad[36]	Pakistan; 2013	Cross-sectional survey; 11 cotton spinning factories	NA	206; 98%	28	M/F	Subjective; workers' opinions	7
Dosi et al[15]	India; 2016-2017	Cross-sectional survey; cotton textile workers	Employed >9 years; those with respiratory disease or smokers were excluded	100; NA	NA	NA	NA (section only)	1
Saha et al[17]	India	Cross-sectional survey; 2 jute factories	≥5 years' employment	150; NA	40-41	NA	NA (section only)	7
Wami et al[37]	Ethiopia	Cross-sectional survey; cotton factories	≥1 year employment; those with "other occupational exposures" or with asthma or COPD were excluded	276; 97%	28 (exposed)	M/F	NA (section only)	8

Abbreviation: NA, not available; COPD, Chronic Obstructive Pulmonary Disease.

Table 2. Prevalences of Byssinosis, Chest Tightness, and Airflow Obstruction, by Dust Concentrations and Mean Durations of Exposure, Where Available.

Reference	Criteria used to assess byssinosis	Prevalence of byssinosis in exposed groups	Dust concentration measured by gravimetry; mean (range) (mg/m^3)	Duration of exposure; mean (≈duration of employment)	Prevalence of chest tightness in exposed (referent) groups	Prevalence of airflow obstruction in exposed (referent) groups	Notes
Studies reporting byssinosis							
Alemu et al[27]	Schilling	38%	14 (NA-61)	26 years	15% (NA)	NA	Byssinosis more common in carding, blowing, and spinning sections than weaving.
Laraqui et al[20]	WHO	37%	NA	9 years	17% (5%)	19% (9%)	Byssinosis more common in spinners than weavers. Referent group unexposed mill employees (n = 80). Predicted lung function values based on "valeurs de références prévisionnelles de la CECA de 1993." Only small airways airflow obstruction reported
Memon et al[25]	Schilling	36%	NA	15 years (estimate)	NA	NA	Byssinosis more common in spinners than weavers
Mandal and Majumder[16]	Chest tightness at work	33%	NA (0.2-5.1)	NA	33% (NA)	NA	"Byssinosis" related to smoking and, weakly, to duration of employment. Referent group office workers and school/college employees (n = 141)
Muhammad[36]	Schilling	22%	NA	NA	NA	NA	Byssinosis more common in blowing and carding sections
Hinson et al[31]	Schilling	21%	NA	NA	28% (15%)	14% (5%)	Grade 3 byssinosis only. Referent group unexposed mill employees or local unexposed population (n = 109). Predicted lung function values based on US population. No cross-shift changes in FEV_1
Mishra et al[21]	WHO	20%	NA	NA	NA	NA	Byssinosis independently related to work in spinning, duration of employment > 30 years and heavy smoking
Hinson et al[34]	Schilling	18%	NA	6 years ("seniority")	7% (3%)	44% (24%)	Referent group unexposed mill employees or local unexposed population (n = 109). Lung function predicted values from US population. Smoking related to byssinosis symptoms but not to reduced lung function
Farooque et al[26]	Chest tightness at work	19%	NA	NA (22% ≥15 years)	NA	18% (NA)	Basis for comparison of spirometry unclear
Shobha et al[24]	Schilling	16%	26.8 (22.4-31.1)	NA	NA	20% (NA)	Mill 55 years old. Probable selection bias toward symptomatic workers. Referent group medical school staff (n = 130). Predicted values for spirometry derived from Indian population. No byssinosis in winding section
Su et al[11]	Schilling	15%	2.13 (0.12-34.35)	15 years	NA	13% (NA)	Basis for comparison of spirometry unclear.[10] Lung function impairment related to dust exposure
Altin et al[19]	WHO	14%	NA (0.1-0.4)	NA (range 3 months-26 years)	20% (NA)	NA	Lung function not used in identification of byssinosis. Byssinosis only in bobbin and thread workers
Mukherjee et al[22]	Schilling	34%	5.8 (0.8-14.0)	NA (66% >20 years)	NA	NA	Participant selection criteria unclear
Nafees et al[29]	Schilling	11%	NA	9 years (estimate)	33% (NA)	10% (NA)	Byssinosis and airflow obstruction more common in spinning section. Predicted values derived from European Community for Steel and Coal (ECSC) 1993 equations with a correction factor of 0.9.

(continued)

Table 2. (continued)

Reference	Criteria used to assess byssinosis	Prevalence of byssinosis in exposed groups	Dust concentration measured by gravimetry; mean (range) (mg/m^3)	Duration of exposure; mean (≈duration of employment)	Prevalence of chest tightness in exposed (referent) groups	Prevalence of airflow obstruction in exposed (referent) groups	Notes
Talikoti et al[32]	Schilling	9%	NA	NA	NA	NA	Grammatical and spelling errors throughout the manuscript. Very short and incomplete information provided in different sections of the manuscript
Rahman[30]	Schilling	8%	NA	9 years (estimate)	22% (NA)	NA	Byssinosis more common in blowing and carding sections. Basis for comparison of spirometry unclear
Christiani et al[12]	Schilling	8% (baseline)	0.2-1.6 (NA)	16 years at baseline	8% (0.2%)	NA	Longitudinal study; inconsistency in reporting byssinosis at different time points. Decline in FEV_1 related to byssinosis, to cross-shift changes, to duration of exposures and to endotoxin.
Osibogun et al[23]	Schilling	6%	NA	7 years	NA	NA	Byssinosis more common in spinning section
Studies reporting other respiratory outcomes only							
			Dust concentration measured by gravimetry; mean (range) (mg/m^3)	Duration of exposure; mean (≈duration of employment)	Prevalence of chest tightness in exposed (referent) groups	Prevalence of airflow obstruction in exposed (referent) groups	Notes
Dube et al[28]			NA (2.0-6.0)	7 years (estimate)	58% (9%)	70% (12%)	(Assuming FEV_1 and FVC transposed in Table 6) Referent group included bank and school workers from village ($n = 59$). "Byssinosis symptoms were observed among the workers." Reduction in FEV_1 associated with increasing duration of exposure; basis for comparison of spirometry unclear
Khan et al[33]			NA	NA	31% (NA)	NA	Respiratory symptoms correlated with factory size and smoking; no more common in spinning than weaving factories
Wami et al[37]			NA	5 years (estimate)	30% (8%)	NA	Unexposed group comprised general administration staff members of the textile mill, and informal sector workers from surrounding areas
Mansouri et al[14]			NA	9 years	26% (9%)	28% (5%)	Control group "office workers." Basis for comparison of spirometry unclear; 25% of workers with obstruction had "reversibility" (unspecified) after bronchodilator
Dosi et al[15]			NA	NA (>9 years)	26% (7%)	28% (5%)	Control group unspecified. Basis for comparison of spirometry unclear; 25% of workers with obstruction had "reversibility" (unspecified) after bronchodilator. Wording of "Results" identical to Mansouri et al[14]
Tageldin et al[35]			NA	NA	17% (0%)	13% (NA)	Participant selection criteria unclear; control group unspecified ($n = 15$). Basis for comparison of spirometry and definition of "obstruction" unclear. Symptoms related to duration of exposure but not to mill section.
Saha et al[17]			NA	15-19 years	6% (NA)	10% (NA)	Authors noted differences in terms of "old" vs "new" technology being used at different mills
Ahasan et al[18]			NA	14 years	4% (NA)	NA	Authors noted that many participants struggled to "grasp the meaning of the questionnaire"

Abbreviation: WHO, World Health Organization; CECA, Communauté européenne du charbon et de l'acier; FVC, Forced Vital Capacity.

Twelve studies reported on the prevalence of airflow obstruction, usually defined by reduced Forced Expiratory Volume in first second (FEV_1) or FEV_1/Forced Vital Capacity (FVC) ratio, based on spirometry which in 2 cases[14,15] included measurements made before and after the use of a bronchodilator. Prevalences of obstruction were generally between 10% and 30% but were considerably higher in 2 reports[34,28]; in all studies that included an unexposed referent group, the prevalence of obstruction was higher in textile workers.

We looked for possible correlation between cotton dust levels and prevalence of byssinosis and found 7 studies that reported both. The Spearman correlation coefficient was 0.43 but after omission of 1 study with unusually high cotton dust level,[24] the coefficient was 0.75. We also determined the correlation (rho = 0.25) between byssinosis and duration of employment from 11 studies that reported both.

A separate review of those reports with a quality score ≥6 did not reveal any major differences to the above.

Discussion

Our findings indicate that byssinosis is a significant, contemporary problem in parts of the textile sector in LMICs with, in some cases, prevalence rates almost as high as those in the employees of cotton mills in Lancashire, United Kingdom, in the 1950s.[46] Even in the mills with the lowest prevalences of byssinosis, our review suggests that 1 in 6 workers are afflicted. Almost 75% of the studies in our review, and 70% of the employees surveyed, were of workforces in Asia, highlighting the regional importance of this industry and its attendant risks.

The 4-fold variation in the prevalence of byssinosis across the 18 studies that reported this outcome is partially explained by the data that are available—We found a strong correlation between prevalence of byssinosis and dust exposure but not with duration of employment. Available evidence shows that risk of the disease is driven largely by the intensity and duration of exposure to textile dust,[47] neither of which may have been captured or reported well in some studies. A minority of studies used direct measurements of dust exposure and in some cases, few samples were collected; even large numbers of measurements may not accurately capture the exposures of individual workers.[12] Moreover, contemporary measurements may not reflect earlier exposures that are likely to be important in a disease of relatively long latency. Nonetheless, we found evidence that dust exposures in textile mills in LMICs may be very high indeed, and frequently greater than recommended levels.[48,49] In the United Kingdom, reductions in the incidence of byssinosis in cotton mill workers were attributed to the elimination of especially dusty tasks, the use of "cleaner" raw cotton and improvements in machinery and dust extraction.[50] The papers we reviewed here did not provide enough detail to make comparative assessments of these factors although some did suggest an effect of using very old premises and equipment.[24] In Taiwan, the "remodeling" of an old cotton mill with the introduction of more modern machinery was followed by reductions in cotton dust levels and significant declines in the prevalence of respiratory symptoms and lung function impairment.[11] Cross-sectional surveys, the design used in almost all the studies we reviewed, are prone to bias from survival effects whereby those with the longest durations of employment may be relatively healthy; this may explain the difficulty we found in relating prevalence rates of byssinosis to average durations of employment.

While variations in dust exposures and employment patterns may explain much of the heterogeneity in our findings, we suspect that an additional factor is the difficulty in measuring byssinosis in epidemiological studies of workforce populations. While "chest tightness," the cardinal symptom of the disease, may (or may not) be readily understood by study participants, inaccuracies are almost certainly introduced by the complex, temporal relationship of symptoms to periods at and away from work that are characteristic of byssinosis. Arguably, the classification systems in widespread use are better suited to individual clinical assessments than to surveys based on questionnaires. Ahasan and colleagues, for example, in surveying the workforce of 3 cotton mills in Bangladesh reported that participants struggled to "grasp the meaning of the questionnaire,"[18] a sentiment reflected by surveys of multinational workforces in Lancashire in the 1970s.[50] In their very careful, prospective study of a cohort of Chinese cotton textile workers, Christiani and his colleagues described considerable individual variation in the reporting of byssinotic symptoms at different points of follow-up.[12] This issue is further complicated by the very different (and in some cases, unreported) approaches to the assessment of airflow "obstruction" through spirometry. We have shown that the prevalence of chronic byssinosis is critically dependent on the choice of a suitable set of normal lung function values as reference (Nafees, 2021; OEM; *submitted*).[51]

We believe that our review is, within the confines we set, comprehensive; following the extraction of relevant papers from the search of 4 databases, we failed to find additional studies in their reference lists. Nonetheless, we are aware that we have included only studies that have been published in peer-reviewed scientific journals and that we will have omitted data from the "gray" literature. Furthermore, we have no way of knowing how representative are the workplaces described in the studies we reviewed because, with 1 exception,[33] none reported on how these had been selected.

Despite its several limitations, this review indicates that byssinosis remains a significant cause of chronic respiratory disease in many LMICs in Asia and Africa, and may serve as a reminder to public health experts, should they need it, that workplace exposures are a significant cause of non-communicable disease. Legislative controls of these exposures are weak in many LMICs and require strengthening, but as with most occupational causes of disease, the solution lies in the control of workplace risks. In this context, risk reduction can be readily achieved through technological improvements in textile manufacturing machinery and dust extraction. Where these options are uneconomical, however, there is a need for (randomized) trials of low-cost interventions designed to reduce the effects of airborne textile dust.

Author Contributions

AAN led this work in conceptualization, analysis, and write-up. SDM, PB, and PC provided supervision throughout this work. All authors read and approved the manuscript before submission.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Sharing/Data Availability

Data are available on reasonable request.

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Registration

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Ethics Approval Statement

Not required in this case.

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Supplemental Material

Supplemental material for this article is available online.

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