Introduction:

The global workforce is estimated to have reached approximately 3.5 billion people, of which around 430 million are employed in the textile and clothing sector – making it one of the largest sectors, having a net worth of around 3 trillion US dollars (1). Asia is one of the biggest contributors to the textile sector both in terms of productivity and labour workforce, accounting for around 55% of global textile exports and employing around 60 million people (2). Pakistan is the fourth largest manufacturer of textile goods, contributing 60% to the country's total exports and 8.5% to its national GDP (3).

Workers in the textile industry are exposed to numerous health and safety hazards including cotton dust, containing gram-negative bacterial endotoxins, and various chemicals, noise, accidents and ergonomic hazards (4). Chronic exposure to endotoxins found in cotton dust was found to be associated with the development of byssinosis among textile workers (5, 6). The prevalence of byssinosis in many low- and middle-income countries (LMICs) remains high; ranging from 8% to 38% according to recent estimates (5). Lack of awareness and limited access to occupational health services in LMICs results in an economic loss of 4-6% of GDP in many countries (7, 8)

The framework of the hierarchy of control measures with a focus on engineering controls has been postulated to be effective in reducing work-related injuries and illnesses; although the evidence is generally lacking (9). A recent systematic review by Ohlander et al. reported that of the 146 interventions conducted in occupational settings more than half were related to behavioural change, use of personal protective equipment (PPE), and application of control measures, and these were mostly from the high-income countries, and were generally of poor study quality (10). Despite some evidence regarding the effectiveness of simple educational interventions to increase knowledge, change attitudes and improve practices of workers resulting in better health outcomes, the application of such control measures in low-resource settings remains challenging (11-14). We could not find trials testing the effectiveness of interventions for improving health outcomes among textile workers, although there were a few studies that focused on improving non-health-related (intermediary) outcomes. Hatemi et al. reported that educational interventions resulted in a significant increase in occupational health and safety-related knowledge, attitude, and behaviour scores of textile workers in Iran (13). Similarly, a quasi-experimental study comprising nine educational sessions found a significant improvement in safety practices related to noise exposure among Iranian textile workers (15).

The overall aim of our study was to pilot the development and implementation of a multifaceted intervention among Pakistani textile workers, test the methods that might be used to evaluate its impact, and generate estimates of the magnitude of its effects that would inform power calculations for a subsequent cluster-randomized controlled trial.

Methods:

Study design and settings:

A pre-post study design, without a control group was used to develop and pilot the intervention, carried out in four distinct phases between July 2015 and August 2017: needs assessment (including a qualitative case study) (16, 17); baseline survey (18); intervention rollout and follow-up (three surveys at 1, 6 and 12 months post-intervention).

A total of 498 male textile workers were enrolled from six purposively selected cotton mills in Karachi, Pakistan. Among the six mills, four were considered 'large' in terms of the number of employees (2500-5000) and the production capacity, while the remainder were 'small' (500-1000 employees). Those working in spinning and weaving sections as cleaners, machine operators, foremen (periodic maintenance and incidental repair of machinery) and supervisors (involved in administrative tasks) were included.

Intervention package:

The intervention package comprised four main components: occupational health and safety training of workers and their managers, promotion of cotton dust control measures at mills and the provision of facemasks to workers. Workers' training was directed towards health and hygiene prevention strategies and skills for practicing health and safety procedures at the workplace. Management training emphasized the role of managers in ensuring appropriate practices among workers, and the importance of a healthy workforce in improving business productivity. The dust control component included the development and implementation of an occupational health and safety plan in each textile mill. Face masks were regularly provided to textile workers during the course of the study.

Only those workers who participated in the baseline survey were considered eligible to receive the intervention (workers' training). Workers who received the intervention but failed to participate in any of the follow-up surveys were considered as lost to follow-up.

Sample size

Using NCSS pass software for sample size calculation, with 5% level of significance, power of 80% to detect a 10% (± 0.7) improvement in knowledge after intervention, we calculated a sample size of 320; which was 368 after inflating 15% for loss to follow-up. To adjust for the large turnover of workers, we actually oversampled and recruited 498 workers at baseline.

Questionnaire-based interviews:

We used a modified version of the locally validated American Thoracic Society Division of Lung Disease questionnaire (ATS-DLD-78A) (19, 20). This included sections on respiratory symptoms, past medical history, work exposures, knowledge, attitude, and practices. Chronic cough and phlegm were defined as having the symptoms for at least three consecutive months a year for at least two years. Similarly, those with whistling sounds from the chest (with or without a cold), for at least two years were categorized as having 'chronic wheeze'. Shortness of breath (SOB) grade II was defined as having to walk slower than persons of the same age, at an ordinary pace on level ground, because of breathlessness. Questions regarding chest tightness were added from the WHO respiratory questionnaire (21). Height and weight measurements were recorded.

Byssinosis was classified based on Schilling's criteria: Grade 0: no respiratory symptoms on the first day of the working week; Grade ½: occasional chest tightness on the first day of the working week; grade 1: chest tightness on the first day of the working week; grade 2: chest tightness on the first and more days of the working week; and grade 3: grade 2 plus chronic lung impairment, i.e., forced expiratory volume in the first second (FEV_1) <80% of the predicted value (22). The scoring criteria for calculating knowledge, attitude and practices (KAP) scores have been defined previously (17).

Lung function assessment:

We used the Vitalograph In2itive (Vitalograph, UK) spirometer to determine pre- and post-bronchodilator lung function values for FEV_1, forced vital capacity (FVC), and FEV_1/FVC ratio. Spirometry was conducted only on workers found eligible at the time of the interview on a screening checklist. The technician demonstrated the procedure to participants and let them practice until they felt comfortable. Participants were asked to refrain from smoking at least an hour before spirometry. Three consecutive readings were noted down and the highest of the readings were used for analysis.

We defined COPD as a post-bronchodilator FEV_1/FVC ratio less than the Lower Limit of Normality (LLN); and reversible airflow obstruction ('asthma') as an improvement in FEV_1 on post-bronchodilator test ≥200 ml, or 12%.

Statistical analyses:

We used Epidata version 3.1 for data entry and SPSS V.19.0 (SPSS Inc, Chicago, Illinois, USA) for analysis. Multicollinearity was assessed between all independent variables by applying appropriate statistical tests depending on the type of variables (Pearson for continuous, Kendall for ordinal, and Phi & Cramer for nominal type of variables). We did not find a high correlation between any of the independent variables.

For assessing linear trend in each of the outcome variables, we performed trend analysis using a non-parametric trend test. Direction of the trend was reported as either positive (increasing) or negative (decreasing). $P < 0.05$ was considered as significant.

We used Generalized Estimating Equations (GEE) regression models to determine associations between risk factors and the trends of the outcome variables. Only outcome variables found significant during the trend test were considered. Unstandardized beta and odd's ratios (OR) were reported for linear and logistic variants of GEE model, respectively. Interpretation was done in terms of unit increase / decrease in the trend of the outcome variable.

Ethical considerations:

Approval for the study was provided by the ethics review committee at Aga Khan University, Karachi (2423-CHS-ERC-12). Written, informed consent was taken from all participants, and confidentiality of data was strictly maintained. Spirometry reports were shared with the individual workers on request, while employers were provided with a summary report on dust exposure and health outcomes for respective mills. Workers with abnormal spirometry were counseled and referred to a government tertiary care hospital for further assessment and management.

Results

We recruited 498 textile workers at baseline while 230 (46% of baseline) participated in the intervention phase of the study. Following the intervention, we were able to include 152 workers at the first, 136 at the second, and 100 at the third follow-up survey. We had 66 workers from baseline who were present in each of the follow-up survey, while 45 were lost to follow-up during the study - giving a follow-up rate of 80% for participation post-intervention (see table 1). The primary reason for dropout was a high turnover of employees in the selected mills; in addition to the closing of an entire section in one mill (mill # 1). At baseline, we found that our study participants were relatively young (79% between ages 18-39 years); roughly a quarter had no formal education (n=126) and were ever-smokers (n=128). Most worked as machine operators (n=366; 74%) in the weaving section (n=392; 79%); with roughly half having a duration of work in textile mills of less than five years (n=244) (Table 1). Compared to those who participated in the intervention phase, those who were lost to follow-up later were younger, with less experience, less likely to be smokers and more likely to be hired on a contractual basis (Table 1).

We found a statistically significant increasing trend in KAP scores following the intervention ($p < 0.001$ for all categories) (Table 2). In GEE models, we found workers with 'primary and middle' (β: 5.77, 95% CI: 3.4, 8.15, $p< 0.001$), and 'matric or higher' level of education (β: 8.71, 95% CI: 6.29, 11.12, $p < 0.001$), and those from spinning sections (β: 2.04, 95% CI: 0.17, 3.92, p: 0.03) were more likely to show improvement in knowledge scores. Similarly, workers with primary and middle education (β: 2.29, 95% CI: 0.011, 4.58, p: 0.04), those who were smokers (β: 2.13, 95% CI:0.56, 3.69, p: 0.008), and had higher knowledge scores (β: 0.36, 95% CI: 0.26, 0.46, p: <0.001) were more likely to show improvement in attitude scores. Those with matric and higher education (β: 6.53, 95% CI: 3.01, 10.06, p-value: < 0.001), from spinning sections (β: 5.39, 95% CI: 2.52, 8.27, p< 0.001), with permanent employment status (β: 3.88, 95% CI: 1.40, 6.36, p: 0.002), morning duty shift (β: 4.19, 95% CI: 1.82, 6.57, p: 0.001), >5 years of work duration in textile mills (β: 2.59, 95% CI: 0.16, 5.02, p: 0.036), higher knowledge scores (β: 0.39, 95% CI: 0.279, 0.50, p <0.001), and higher attitude scores (β: 0.25, 95% CI: 0.13, 0.37, p < 0.001) were more likely to show improvement in the practices score (Table 3).

For respiratory symptoms (cough, phlegm, and wheeze) and conditions (COPD and asthma) a decreasing trend was noted, but statistically significant findings were only noted for cough (p: 0.035) (Table 2). A multivariable GEE model for factors affecting changes in cough showed that those with matric and higher education level (OR: 0.58, 95% CI: 0.344, 0.98, p: 0.04) were less likely to show reduction in cough while those working in the morning duty shift (β: 1.54, 95% CI: 1.08, 2.28, p: 0.017) were more likely to show reduction (Supplementary Table 1).

We found a decreasing trend in lung function (FVC, FEV_1, and FEV_1/FVC ratio) over the course of the study but, statistically significant findings were noted only for FVC (p: 0.001) and FEV_1 (p < 0.001) (Table 2). We found workers aged 40 years or more (β: -0.29, 95% CI: -0.42, -0.16, p < 0.001) and those with more than 5 years duration of work in textile mills (β: -0.13, 95% CI: -0.24, -0.02, p: 0.027) were more likely to show a reduction in FVC. Similarly, those aged 40 years or more (β: -0.35, 95% CI: -0.47, -0.24, p < 0.001) and those working a morning shift (β: -0.11, 95% CI: -0.20, -0.02, p: 0.02) were more likely to show a reduction in FEV_1. (Supplementary Table 2)

Discussion:

In this pilot study we successfully demonstrated the feasibility of implementing an intervention package in Pakistani textile mills – the intervention was acceptable to both textile workers and managers and led to an improvement in knowledge, attitude, and practices of textile workers. We believe that the multifaceted intervention package is the most comprehensive intervention worldwide designed to enhance workers' knowledge, attitude, and practices towards preventive measures, specifically targeted on exposure to cotton dust and resulting respiratory conditions.

We found that a 'primary and middle' and 'matric or higher' educational level was associated with an improvement in KAP scores. A quasi-experimental study conducted among 108 Egyptian textile workers similarly reported an association between the level of education and knowledge scores (15). An improved educational background makes it easier to understand the educational interventions and enhances not only the perceived health benefits of adopting such interventions, but also the transferability of behaviour change practices among study participants (23, 24).

We believe that the multifaceted approach of our intervention targeting not only the workers for the change in knowledge, attitude, and practices, but also administration of the textile mills including senior managers and supervisors, is one of the key reasons behind the successful implementation. Provision of a steady supply of facemasks with regular refresher sessions may have improved the uptake of this intervention. A recent Cochrane review reported that educational interventions with follow-ups at regular intervals have a far more profound impact on behaviour change and improved practices compared to other approaches (25). Similarly, another systematic review reported that workplace interventions comprising a combination of different strategies such as provision of PPE, educational sessions and training, tend to be more effective in reducing occupational exposures (26).

We found a declining trend in lung function, although it is difficult to say if that is simply a factor of age – since both age and the duration of textile exposure variables were included in our model, only the first being statistically significant for both FEV_1 and FVC. Similarly, we reported a decreasing trend in reported cough that may be attributed to the intervention. Its association with 'morning' shifts may be attributed to better provision and oversight of existing health and safety mechanisms during these shifts; this may also be a hint perhaps that the symptom may reflect byssinosis (6). Although there is evidence regarding a possible role of exposure reduction in improving respiratory symptoms and lung function of textile workers (27), studies with a larger sample size may better quantify the impact of occupational health interventions on health outcomes (27).

Several limitations need to be considered. The inclusion of only six mills may have led to a sampling bias however, considering that this pilot study was planned to determine the feasibility and acceptability of the intervention in the local industry in Pakistan, we believe this may not have seriously impacted our findings. The lack of a control group may have resulted in unadjusted confounding in the study, although again, as a pilot intervention, we believe that our study provides reasonable evidence regarding successful implementation of such interventions and further trials may provide a more robust scientific evidence in this regard. The large number of dropouts might have impacted our findings especially those who left work may have had worse health outcomes compared to those that stayed – thus leading to a healthy 'survivor' effect. Given the high turnover of workers in Pakistani textile mills, such a limitation may be difficult to address in research studies. Another possible limitation includes a reporting bias whereby workers may choose to report positive responses to knowledge, attitude and practices questions than is actually the case. However, the questionnaire used for this purpose was developed through a rigorous process and uses a combination of positive and negative responses in each section to limit such effects.

Conclusion:

To the best of our knowledge this was the first study of its kind using a multifaceted approach for provision of a health and safety intervention among textile workers. We found the multifaceted intervention package to be acceptable and feasible in the Pakistani textile mills, and it successfully improved knowledge, attitude, and practices of textile workers. Further larger studies, ideally randomised controlled trials, are required to determine the effectiveness of this intervention for reducing dust levels and improving respiratory health of textile workers.

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