# Health Hazards, Injury Problems, and Workplace Conditions of Carpet-Weaving Children in Three Districts of Punjab, Pakistan

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Carpet weaving among children is common in rural Pakistan, but little information is available on the health effects of this work. A total of 628 carpet-weaving children and 292 non-working children from 10 rural villages were evaluated with questionnaires and physical exams. Fifty-five home-based and 30 shed-based worksites in these villages were assessed. Girls comprised the majority of working (73%) and non-working (69%) children; the mean age for both boys and girls was 10 years. The mean number of hours worked daily was 7.2 for males and 6.8 for females. Dust exposure in homes was generally higher than in sheds. Working children had significantly greater odds of joint pain (OR = 2.8), dry cough (OR = 2.5), cuts/bruises (OR = 22.1), Phalen's sign (OR = 17.2), and neck/shoulder abnormalities (OR = 14.2). Symptoms and signs of acute and repetitive injury and respiratory symptoms were more common among carpet-weaving children than their non-working peers. *Key words*: carpet weaving; child labor; carpet loom; wool; musculoskeletal; workplace; injuries; Punjab, Pakistan.

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## BACKGROUND

Weaving of hand-knotted carpets is an important industry in developing countries. Carpet weaving is a highly labor-intensive task. The use of child labor in the hand-knotted carpet industry has been widely reported and documented in recent years.[1] With traditional carpet looms, the weaver is often forced to squat to operate the loom (Figure 1).[2]

As the diameter of the carpet increases, the weaver must lean forward to complete the task. Research has shown that the knotting of carpets is hazardous to the health of workers, particularly to children as they are more prone to develop skeletal problems due to poor posture[3,4] as well as impaired vision and blindness.[5] Head-ache, blurring of vision, backache, abdominal pain, limb pains, and respiratory tract infections have been found to be more prevalent in carpet-weaving children.[6] Carpet-weaving children also suffer injuries due to the use of sharp instruments during their work.[6] Other studies have concluded that persistent cough, expectoration, backache, common colds, and joint pains were the most frequent health complaints among adult carpet weavers.[7] In addition, the risk of developing carpal tunnel syndrome is high among adult carpet weavers, but this has not been explored in child carpet weavers.[4]

The manufacture of hand-knotted carpets is an important craft-based industry in rural areas of Pakistan. Because of increasing demand for carpets, the industry has expanded in these areas, where abundant and cheap labor is available. Carpet weaving is a highly labor-intensive task: up to 65% of the production cost of a carpet is the labor cost. The bulk of the carpets in Pakistan are made in rural areas of Punjab province, where families are engaged to make carpets either at homes or at production centers called "sheds." The rising demand for carpets, coupled with low wages, illiteracy, and the availability of children able to work at home has created ripe conditions for the use of children as carpet weavers. According to a recent survey[8] there are over 150,000 carpet-weaving children in Punjab province, of whom 69% (41% males and 59% females) are in the age group of 5 to 14 years. The remaining 37% are in the age group of 15 to 17 years. According to the results of this survey, females, including children, form approximately 80% of the workforce in the carpet-weaving sector. Carpet weaving is one of the prohibited occupations under the law in Pakistan for children below the age of 14,[9–11] but since

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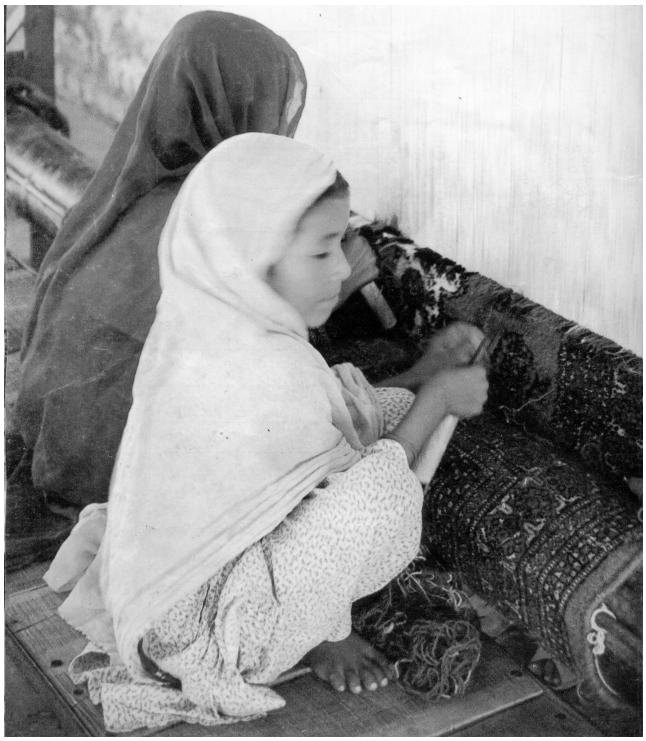

*Figure 1— Carpet weaving children at working site*

the law is not applicable in homes, the use of child labor is rampant among poor families in rural areas as it provides a needed source of income.

Previous studies have shown that school-going children residing in rural areas have been found to be grossly stunted, malnourished, and underweight, with females being affected more than males.[12] In addition, poor sanitation, lack of drinking water, and poor hygiene are more prevalent among rural children.[13] Exposures among working children increase their risk for various illnesses and injuries.[14]

Despite the involvement of large numbers of child and adult workers in carpet weaving in Pakistan, no systematic study has been carried out to document the impact of work on the health and safety of the workers. We focused on the weaving phase of the process, in which most of the workforce is engaged and child labor is used most extensively.

This project was undertaken in September and October 2001 to evaluate the health and safety risks faced by the child carpet weavers in order to plan interventions in this area. The objectives were to: (1) identify hazards in the living and working environments of child carpet weavers; (2) examine health conditions faced by child carpet weavers based on questionnaires and physical examinations; and (3) assess the health implications of work in the carpet-weaving sector by comparing the health profiles of child carpet weavers with school-going children from the same communities.

## METHODS AND MATERIALS

### *Setting*

The project was undertaken on the invitation of the International Programme on Elimination of Child Labor (IPEC) of International Labour Organization (ILO). The intent was to establish a baseline understanding of the health and safety issues faced by carpet-weaving children in order to subsequently design and evaluate an intervention to improve working conditions. Thus the project was considered part of a child labor surveillance project not requiring institutional board review. The project was conducted in 198 villages of Punjab province of Pakistan where Non-Formal Education centers (NFEs) for carpet-weaving children were established under the ILO-IPEC Carpet Project. Two-hundred-and-sixty-one NFE centers were established in which 8713 children (7325 carpet weavers and 1388 younger siblings) were enrolled.

### *Sample*

Ten villages were selected for the project, comprising 5% of all villages in the Punjab province. In order to cover all geographical regions, the 10 villages were selected from all three of the province's districts depending on the concentration of carpet-weaving activity. A total of 21 NFE centers were found in these 10 villages. All the carpet weaving children (628) enrolled in these 21 NFE centers and available at the time of visits by the project team were included. A total of 55 home-based and 30 shed-based worksites in these 10 villages were selected to assess the working environment's hazards.

Children from the same villages were selected as a control group. The size of the control group was predetermined to be approximately 50% of the working children's group. Thus 314 control group children were included in the project, 22 of whom were later excluded due to the following inconsistencies: missing gender in the questionnaire, age > 14 years, or being the sibling of a working child. Thus the sample size of the control group in the project was 292. The children and their parents had been informed of this project before our visit by a teacher from the NFE.

### *Data Collection*

A team of data collectors, including a physician, was oriented and trained before the project. Three different data collection forms were developed. Form I was used to collect data about working conditions in homes and sheds, including the physical measurements of dust exposures and illumination levels. Air sampling for dust was conducted at 45 sites using the National Institute for Occupational Safety and Health (NIOSH) Sampling Method 0500 for over four hours in each

case. The time weighted average (TWA) for an eight-hour workday was then calculated assuming the same exposure for the whole period. The data were compared with the American Conference of Governmental and Industrial Hygienists' (ACGIH) recommended standard for particulate matter. The lighting levels in the workplaces were measured using a Tecpel 530 lux meter in the horizontal position during normal working hours. The readings were then compared with recommended illumination levels for such work.[15]

Form II was a questionnaire in which the responses of children (carpet weavers as well as the control group) were recorded. These questions pertained to their age, family size, working hours (only for working children), and whether they suffered frequently from a selection of health problems, including headache, cough, diarrhea, and musculoskeletal pain. The questionnaires were administered in the local language (Punjabi) by trained interviewers, who recorded the responses in English. When a child was unable to complete the questionnaire, input was sought from his or her parents or elder siblings. The questionnaire was pretested for a week at three different locations within our selected sites.

Form III was completed by a physician, who carried out a physical examination of each child that included general and musculoskeletal examination. With the assistance of a technician, the physician also measured the children's height and weight. The physician was not blinded to the children's working status.

### *Inclusion and Exclusion Criteria*

Male and female children aged five to 14 years who were enrolled in the NFE centers and engaged in carpet weaving were included in the project. Children over the age of 14 were not included since 14 years is the legal age limit for work in this sector in Pakistan. Children engaged in work in other sectors were not included.

The control group consisted of male and female children aged five to 14 years from the same localities who were enrolled in regular government schools and not engaged in carpet weaving. Children not engaged in carpet weaving who were from carpet-weaving families were excluded.

### *Statistical Analysis*

All the data forms were manually checked, then coded and entered into a database and analysed using SPSS 15.0 software. The descriptive statistics for various health indicators were calculated. The differences in health and safety and other parameters between the working and control-group children were analysed by Student's t-test and chi-square tests. We calculated unadjusted odds ratios (ORs) to compare the prevalence of health indicators among working children and the control group. We conducted an explorative analysis of work experience and physical examination findings using point biserial correlation.[16] We considered two-tailed p-value of ≤ 0.05 to be statistically significant. We did not correct for multiple inferences for this analysis.

**TABLE 1 Results of Sampling for Airborne Dust in Children's Workplaces (Homes or Sheds)[a]**

| | Dust Exposure mg/m$^3$ | | |
|---|---|---|---|
| | Home-based | Shed-based | Recommended TWA* (8-hr) |
| Minimum | 0.6 | 0.9 | 10 |
| Maximum | 8.5 | 4.2 | |
| Mean | 3.3 | 2.1 | |

*Note*: The recommended exposure limit is for adults (not children) and does not take into account the chemicals present in dust in the form of dyes and salts that may be present in wool fibres.

[a]ACGIH (American Conference of Governmental and Industrial Hygienists) recommendation for particulates not otherwise classified.

## RESULTS

### *Participant Demographics*

A total of 456 (72.6%) of 628 participating working children and 200 (68.6%) of 292 participating control-group children were female. The mean age of working and control-group children was 10.4 years (SD ± 2.2). The mean family size for the working children was 8.7, while that of the control group was 8.0 ($p < 0.001$). The majority (93%) of both working children (n = 582) and control-group children (n = 272) had two living parents at the time of the interview.

All 628 working children lived with their parents or with extended family. Most (n = 506; 80.6%) of the working children (75.6% of males and 82.4% of females) worked at home, while the remainder worked at sheds. The mean number of hours worked per day was 7.2 (SD ± 3.9) for males and 6.8 (SD ± 4.4) for females. The mean work experience for females was 4.4 years (SD ± 3.2), while that of male children was 4.1 years (SD ± 3.0). The overall mean work experience for all working children was 4.3 years SD (± 3.1).

### *Assessment of Workplace Environment*

Sanitary facilities such as a toilet or latrine were present in 64% (n = 35) of home workplaces and 18% (n = 5) of shed workplaces. All workplaces had drinking water available. Electric fans were noted in 53% (n = 29) of home workplaces and 100% (n = 30) of shed workplaces. None of the workers was observed using any personal protective equipment such as a respirator.

In general, homes had limited natural light, and light bulbs (typically one per room) were often not lit during the day. As a result, the mean illumination level

**TABLE 2 Prevalence of Health-Related Complaints of 628 Working Children and 292 Control Group Children**

| Complaints | Working Children n (%) | Control Group n (%) | Odds Ratios (95%CI) |
|---|---|---|---|
| Cuts/bruises* | 87 (13.8) | 5 (1.7) | 9.2 (3.7–23.0) |
| Fatigue* | 120 (19.1) | 22 (7.5) | 2.9 (1.8–4.7) |
| Joint pain* | 135 (21.5) | 26 (8.9) | 2.8 (1.8–4.4) |
| Headache* | 347 (55.2) | 105 (35.9) | 2.2 (1.7–2.9) |
| Stomachache* | 134 (21.3) | 32 (10.9) | 2.2 (1.5–3.3) |
| Backache* | 169 (26.9) | 48 (16.4) | 1.9 (1.3–2.7) |
| Skin problems* | 119 (18.9) | 35 (12.0) | 1.7 (1.1–2.6) |
| Hunger | | | |
| Severe* | 178 (28.3) | 58 (19.9) | 1.6 (1.1–2.2) |
| Mild* | 150 (23.9) | 47 (16.1) | 1.6 (1.1–2.3) |
| Cough | | | |
| Productive* | 268 (42.7) | 100 (34.2) | 1.4 (1.1–1.9) |
| Dry* | 279 (44.4) | 70 (24.0) | 2.5 (1.9–3.5) |
| Common cold | 201 (32.0) | 80 (27.4) | 1.2 (0.9–1.7) |
| Diarrhea | 18 (2.9) | 7 (2.4) | 1.2 (0.5–2.9) |

*p-value < 0.05

was 136 lux (range, 41–670) in home workplaces and 221 lux (range, 51–390) in shed workplaces. Thus both home and shed workplaces had mean illumination levels below the 500 lux recommended for precision or office work.

Table 1 summarizes the results of sampling for airborne dust in the working children's workplaces (homes or sheds). Dust exposure in homes was generally higher than in sheds. The values did not exceed the level recommended by ACGIH.

*Health Indicators*

*Health-related complaints.* Table 2 shows the prevalence of reported health complaints of working and control-group children and the associated ORs. The prevalence of the common cold did not differ significantly between working and control-group children ($p = 0.66$). This was also true of diarrhea ($p = 0.68$). For the remaining health complaints, a higher proportion of working children reported the complaint than control-group children ($p < 0 .05$ for each). The health complaints with the highest ORs were cuts/bruises, with working children having a nine-fold greater odds than control-group children, and fatigue and joint pain, with working children having a nearly three-fold greater odds than control group children.

*Physical examination findings.* Heights and weights of working children and control-group children did not differ systematically, as shown in Figures 2 (boys) and 3 (girls). Table 3 shows the prevalence of physical examination findings of working and control-group children and the associated ORs. The prevalence of palpable lymph nodes; abnormality on abdominal palpation, such as enlarged liver or spleen, or abdominal tenderness; and visual abnormalities did not differ significantly between working and control-group children ($p > 0.05$ for each). Signs of tonsillitis were significantly more common among the control-group children ($p < 0.001$). For the

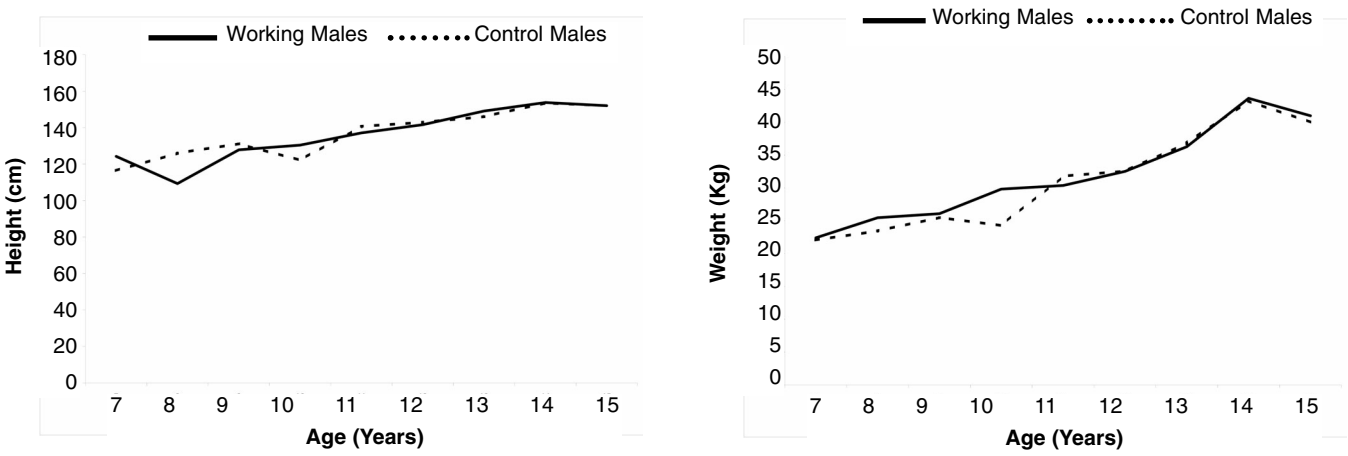


*Figure 2—Height and Weight (Male Children)*

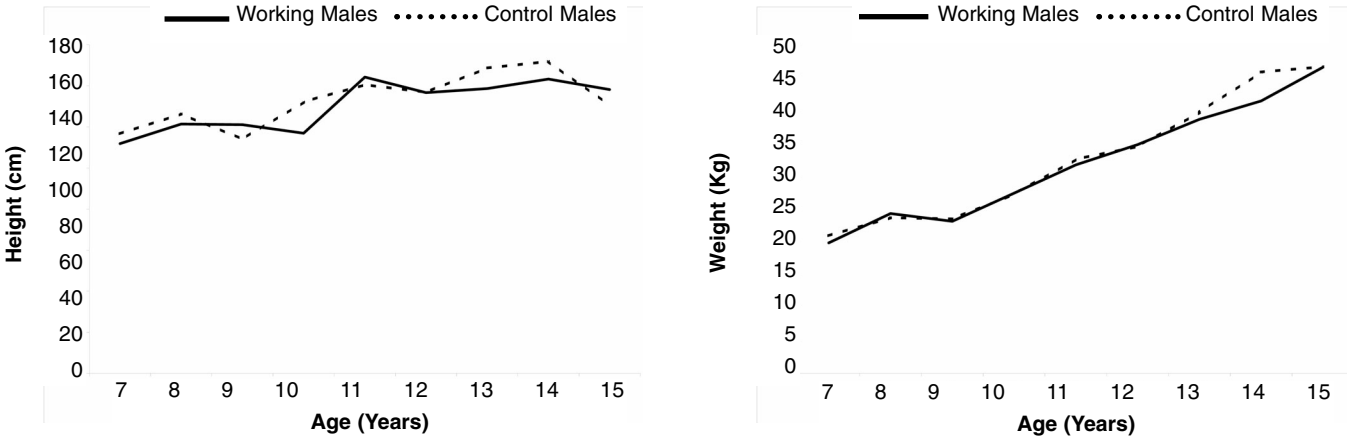


*Figure 3—Height and Weight (Female Children)*

remaining examination findings, prevalence in working children was significantly higher than in control-group children ($p < 0.05$ for each). The physical examination findings with the highest ORs were cuts/bruises, with working children having twenty-two-fold greater odds than control-group children; Phalen's sign, with working children having seventeen-fold greater odds; and neck and shoulder musculoskeletal abnormalities, such as tendinitis or tenosinovitis, or ganglionic cysts, with working children having fourteen-fold greater odds.

Using point biserial correlation, we determined that among working children, work experience was positively correlated with decreased visual acuity ($R = 0.09$; $p = 0.02$); Phalen's sign ($R=0.12$; $p < 0.01$); abnormalities on low back examination, such as kyphosis or other spine abnormalities ($R = 0.17$; $p < 0.01$); and abnormalities on neck and shoulder examination ($R = 0.18$; $p < 0.01$). Work experience was negatively correlated with palpable lymph nodes ($R = 0.09$; $p = 0.02$), tonsillitis ($R = 0.12$; $p < 0.01$), and cuts and bruises ($R = 0.18$; $p < 0.01$) (data not shown).

## DISCUSSION

In this investigation of conditions faced by carpet-weaving children in rural Pakistan, we found that working children were more likely than non-working children from the same villages to report cuts and bruises, fatigue, and musculoskeletal symptoms, as well as productive and non-productive cough. Similarly, physical examination revealed that working children had a higher prevalence of signs of acute injury, musculoskeletal abnormalities, and nasal allergies. In addition, working children had a two-fold greater odds of

**TABLE 3 Prevalence of Health Problems among 628 Working Children and 292 Control Group Children on Physical Examination**

| Complaints | Working Children n (%) | Control Group n (%) | Odds Ratios (95%CI) |
|---|---|---|---|
| I. General physical examination | | | |
| Conjunctival pallor* | 155 (24.7) | 54 (18.5) | 1.4 (1.0–2.0) |
| Palpable lymph nodes | 459 (73.1) | 206 (70.5) | 1.1 (0.8–1.5) |
| Enlarged thyroid* | 125 (19.9) | 37 (12.7) | 1.7 (1.2–2.5) |
| Abdominal tenderness* | 360 (57.3) | 116 (39.7) | 2.0 (1.5–2.7) |
| Abnormality on abdominal palpation | 34 (5.4) | 9 (3.1) | 1.8 (0.9–3.8) |
| Decreased visual acuity or visual field defects | 13 (2.1) | 3 (1.0) | 2.0 (0.6–7.2) |
| Conjunctivitis* | 192 (30.6) | 51 (17.5) | 2.1 (1.5–2.9) |
| Nasal Allergies* | 78 (12.4) | 6 (2.1) | 6.8 (2.9–15.7) |
| Tonsillitis* | 302 (48.1) | 178 (61.0) | 0.6 (0.4–0.8) |
| II. Musculoskeletal problems | | | |
| Knee deformity (bowlegs)* | 284 (45.2) | 60 (20.5) | 3.2 (2.3–4.4) |
| Chest tenderness* | 312 (49.7) | 60 (20.5) | 3.8 (2.8–5.3) |
| Positive Phalen's test* | 205 (32.6) | 8 (2.7) | 17.2 (8.4–35.4) |
| Abnormalities on lower back examination* | 253 (40.3) | 37 (12.7) | 4.6 (3.2–6.8) |
| Abnormalities on neck and shoulder examination* | 238 (37.9) | 12 (4.1) | 14.2 (7.8–25.9) |
| III. Others | | | |
| Cuts and bruises* | 440 (70.1) | 28 (9.5) | 22.1 (14.4–33.8) |

*p-value < 0.05

visual abnormalities than non-working children, although this difference did not reach statistical significance. Many of the physical examination findings were statistically correlated with work experience. These health findings are consistent with previous observations about the ergonomics of traditional looms,[3,6,7] and the insufficient ventilation and lighting associated with carpet weaving.[17] Our environmental evaluation of workplaces also provided evidence for these health discrepancies by demonstrating excessive airborne dust levels and low lighting levels, particularly in home-based workplaces. Notably, our evaluation was conducted during a temperate season; dust levels could be higher in hotter months due to increased fan use.

Our project benefited from the inclusion of a control group of non-working children from the same localities as the working children. Control-group children in our project attended school rather than working. These children likely came from relatively more affluent families than the working children, as suggested by their significantly lower family size and lower prevalence of hunger. However, we found that many important measures that would not be expected to be associated with work, such as reported symptoms of common cold and diarrhea, as well as measured height and weight, did not differ between working and control group children. These baseline similarities suggest that socioeconomic differences between the working and control-group children may not account for the health differences we found. Rather, the observed increased in musculoskeletal and respiratory problems among working children are potentially explained by their occupational exposures.

We documented a high prevalence of Phalen's sign among working children. Strong evidence of carpal tunnel syndrome based on this sign has been found in adult carpet weavers in a prior study[4] though it is rare in children,[18] especially below the age of 10 years.[19] To our knowledge, an increased risk of carpal tunnel syndrome has not been reported in child carpet weavers previously. These workers make repetitive use of their wrists, fingers, and shoulders, which, coupled with long working hours, may lead to carpal tunnel syndrome. It is possible that a loom with improved ergonomic features could prevent some cases of carpal tunnel syndrome in child carpet weavers.

Psychosocial risks and work-related stress are common in carpet weavers in countries that are in economic transition, including newly industrialized and developing countries.[20] Working children in our project had a number of health complaints that could reflect social and psychological stresses. Headache was the most common complaint of both the working children and the control group in our project, with a greater prevalence among working children. Similarly, working children were more likely to report stomachache than control-group children. Whether such symptoms among carpet-weaving children represent physical manifestations of stress deserves further investigation.

Our project has several limitations. As with any cross-sectional survey, the associations we found between poor environmental conditions and common health problems among working children may not be causative. However, the consistency between our findings and those of previous studies, as well as the observations afforded by our inclusion of a control group, suggest that the workplace has some negative impact on the health of these children. It is important to note that the physician conducting the physical examinations was not blinded to the children's working status, which could introduce bias. Working children evaluated in our project were enrolled in the NFE centers and present at the time of the evaluation. Working children not enrolled in an NFE center or not present for the evaluation may work more frequently than the working children in our project. Thus our sample may not be representative of children with even more intense work schedules, who would presumably be at higher risk of occupational health problems. Finally, we did not include quantitative measures of ergonomics, which may have allowed statistical correlations between posture while working and health outcomes.

Despite these limitations, our project offers unique descriptive data on the health of children working in carpet weaving in Pakistan. Given the paucity of information on this topic, our findings provide a much-needed foundation for further work in this area, including interventions designed to address musculoskeletal and respiratory risk factors. Ultimately, providing children and their families with alternatives to child labor will be the most effective preventive approach to this issue of great public health concern.

To conclude, there are considerable health and workplace hazards in the carpet-weaving industry for working children. Prevention programs are needed to reduce potential hazards among carpet-weaving children.

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