Prevalence of musculoskeletal symptoms among garment workers in Kandal province, Cambodia

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Abstract: Prevalence of musculoskeletal symptoms among garment workers in Kandal province, Cambodia: Leap Van, et al. Department of Community Medicine, Faculty of Medicine, Khon Kaen University, Thailand—Objectives: The main objectives of this cross-sectional descriptive study were to identify the prevalence of musculoskeletal symptoms and workstation biomechanical risk levels for garment workers in Kandal Province, Cambodia. Methods: This cross-sectional descriptive study used multistage sampling techniques to select 714 workers from three garment factories among 22 medium-size factories (250–1,000 workers). Face-to-face interviews and direct observation using the rapid upper limb assessment scale (RULA) were used to collect data. Results: The response rate was 98.3% (702/714), and the majority (89.3%) of the respondents were female. Ninety-two percent (95% CI=90.0−94.0) of the workers reported musculoskeletal symptoms in at least one body region in the previous 12 months and 89.0% (95% CI=86.7−91.3) of the workers reported such symptoms in the past seven-day period. The neck, shoulder, and lower back were the most affected body regions. In addition, the RULA data showed that 81.2% of the workers’ postures were rated as action level 3, indicating that investigation and change were required soon, and that 7.5% their postures were rated as action level 4, indicating that investigation and change were required immediately. Conclusions: Cambodian garment workers reported a high prevalence of musculoskeletal symptoms in upper body regions, and their workplaces were rated as high risk ergonomically. (J Occup Health 2016; 58: 107–117)

Key words: Chronic illness, Garment workers, Musculoskeletal symptoms, Workplace ergonomics

The prevalence of musculoskeletal disorders is increasing worldwide¹ with the extent of musculoskeletal disorders in developing countries approaching that in developed countries². Work-related musculoskeletal complaints are serious concerns in the workforce because they are the most prevalent work-related reasons for absenteeism in workers in many industries³. In the United States, Canada, Finland, Sweden, and England, musculoskeletal disorders were shown to be the cause of more work absence or disability than other groups of diseases⁴. Globally, work-related musculoskeletal disorders account for around 40% of the total compensated cost of occupational diseases and injuries, and the symptoms are caused by work activities or the work environment such as rapid or repetitive motion, forceful exertion, excessive mechanical force concentration, awkward posture or non-neutral posture, prolonged stationary postures, and vibration⁵,⁶. Gender, age, ethnicity, economic status, cigarette smoking, lack of physical exercise, and length of occupational exposure are risk factors for musculoskeletal symptoms as well⁶–⁹.

Previous studies have shown musculoskeletal symptoms in various groups of workers such as healthcare workers, farmers, dentist, drivers, factory workers, and office workers¹⁰–¹⁵. In a literature review, Hague et al. indicated that many studies consistently found a high prevalence of musculoskeletal symptoms in the garment and textile industry, with the neck, shoulder, and back regions mostly affected¹⁶. The research on ergonomic workplace evaluation of Asian garment factories shows that most of the reported incidences in the back, neck, and shoulders are relatively high and most likely the result of working with constrained postures, poorly designed workstations, and non-ergonomic tools¹⁷.

Cambodia has become the sixth largest global
garment exporter, and this industry provides numerous employment opportunities and greatly contributes to the country’s economic development. It accounts for about 15% of Cambodia’s total gross domestic product and 50% of manufacturing employment, with the manufacturing workforce comprised of predominantly women (90%) from rural villages. Almost 90% of all garment factories are concentrated in the capital city of Cambodia, Phnom Penh and Kandal Province, and 55% of garment factories employ less than 1,000 workers. In Kandal Province, 52.4% of garment factories are medium-sized factories with 250 to 1,000 workers.

The working conditions and health of Cambodian garment workers are still the main issue in the industry. Roughly 78.4% of all occupational accidents occur in the garment industry, with one out of 20 occupational accidents being fatal and 99% of occupational accidents resulting in temporary disablement, and fainting is a common type of accident, which is caused by panic, the hot, stuffy, and dusty environment, lack of a ventilation system, and overtime work. The health of most workers was found to worsen after they started working in garment factories, and more than three quarters of garment workers perceived that their current health condition had worsened in the previous 12 months. Unfortunately, work-related musculoskeletal symptoms in workers employed in Cambodian garment factories have never been researched adequately. Hence, the current study was conducted in three garment factories in Kandal Province, Cambodia, to establish the prevalence of musculoskeletal symptoms among garment workers in Kandal Province, to assess the ergonomic risk in work setting, and to determine the potential risk factors associated with musculoskeletal symptoms in the most affected sites of body.

Method

Design/setting
A descriptive cross-sectional research design was employed to study the prevalence of musculoskeletal symptoms, and the work-posture risk among garment factory workers in Kandal Province, Cambodia. Medium-sized factories (250–1,000 workers) that had operated for at least one year prior to the study were the focus for this study.

Study population
The target population included all workers who were at least 18 years old, had worked in their factories for at least one year prior to interview and performed work related to the sections of sewing, ironing, cutting, buttoning, quality control, packing and finishing, cleaning, maintenance, or other sections in the clothes production chain in medium-sized garment factories (250–1,000 workers). The total target population was approximately 12,000 workers. After foreign workers were excluded from this study, there were 10,634 workers in the study population.

Sample determination
Multistage sampling techniques were used for sample determination; three factories were selected from 22 medium-sized factories by probability proportional to size cluster sampling techniques. A simple random sampling technique was then performed to choose the 714 participants from the three factories selected.

Worker classification
Workers were divided into three work classifications: sewing workers (sewing machine operators), non-sewing workers (workers in the sections of ironing, cutting, buttoning, quality control, packing and finishing, screen printing, laundry, and cleaning and mobile workers), and support staff (team assistants, team leaders, warehouse guards, and mechanics).

Research instruments
The modified standardized Nordic questionnaire (SNQ) and the rapid upper limb assessment (RULA) method were used to collect data.

1. The modified SNQ was used for interviews. It was divided into three sections: sociodemographic information, work and workplace characteristics, and the standardized Nordic questionnaire. Sociodemographic information included personal data, smoking status, weight, height, alcohol consumption, and chronic disease or illness. Work/workplace characteristics included total working hour per day and week, duration of employment, work section, working posture, type of chair for sitting, and perception of the work environment. The modified SNQ, which includes a body map, was used to get information about musculoskeletal symptoms and absence from work caused by the symptoms in nine body regions, the neck, shoulder, elbow, wrist/hand, upper back, lower back, hip/thigh, knee, and ankle/foot, during the last 7 days and the last 12-month period.

2. The RULA is a tool used to assess biomechanical or postural risk factors through direct observation in the workstation. Its development took place in the garment-making industry through assessment of operators who performed tasks including cutting while standing at a cutting block, use of a variety of sewing machines, clipping, inspection operations, and packing. This method scores the segments of the body with regard to posture, motion, external force/load, and muscle function. For instance, the score is 1, if
the upper arm in the range of 20° extension to 20° of flexion, whereas if the load or force is 2 kg or less and is held intermittently, the score is 0; the muscle score is 1 if an action is repeated 4 times per minute or more.

The RULA is divided into three parts. Part A: The combination of the scores of the upper arm, lower arm, wrist, and wrist twist with muscle use score and force/load score is called the final wrist and arm score. Part B: The combination of the scores of the neck, trunk, and leg with muscle score and force/load score is called the final neck, trunk, and leg score. Part C: The final grand score is obtained from combination of the scores in Part A and Part B. The final grand scores were classified into 4 action levels: 1 or 2 for action level 1, “acceptable”; 3 or 4 for action level 2, “investigate further”; 5 or 6 for action level 3, “investigate further and change soon”; and 7 for action level 4, “investigate and change immediately”.

Data collection
For the purpose of data collection, three research assistants, who were at least senior students in the field of sociology and psychology and had prior research interview experience, helped the researcher interview the workers. The principal researcher gave them training on interviewing, the questionnaire, the data collection procedure, the objectives of the study, and the ethics of research. Then, all research assistants went along with the principal researcher and started data collection. Face-to-face interviews, which took about 5−10 minutes, were carried out by the researcher and research assistants during worker lunch breaks. For scoring using the RULA method, only the main researcher made observations, which took about 5−10 minutes. The RULA rating of body posture was determined during working hours. The observations were made for clusters of workers after their interviews. Data collection was performed between September 09 and November 30, 2013.

Data analysis
All data was coded and analyzed using IBM SPSS Statistics for Windows (Version 19.0). Descriptive statistics such as means, standard deviations, percentages, and 95% confident intervals were used to describe sociodemographic information, work and workplace characteristics, and prevalence of musculoskeletal symptoms. Associations between specific sites of musculoskeletal symptoms and risk factors were analyzed by logistic regression to find adjusted odds ratios after controlling confounding factors (age, gender and underlying disease) with their 95% confident intervals.

Ethical consideration
This research was approved by the Human Research Ethics Committee of Khon Kaen University (HE:561193) and National Ethics Committee for Health Research of the Ministry of Health, Cambodia.

Results
Seven hundred and two workers, 98.3% (702/714) of those approached, participated in this study. The mean age of the respondents was 27.3 ± 7.45 years, and they were predominantly female workers (89.3%). Almost half of them had a primary level education. Approximately 13% of all respondents had chronic illnesses with musculoskeletal symptoms. Detailed sociodemographic information is summarized in Table 1.

Nearly two-thirds of the respondents were sewing machine operators, and most participants (96.7%) worked overtime. Of the 679 garment workers who did overtime work, 92.9% worked 2 hours extra per day. The majority (89.0%) of participants reported that they worked 58 hours per week. Nearly half of the participants had worked in the garment industry less than 3 years, and 80.9% had worked less than 3 years in their current garment factory. Seventy-eight percent of them sat in a chair while working. Of the 551 respondents who had a chair for sitting, only 35.8% of them had a chair with a backrest. Sitting (65.0%) was the most common posture in the garment industry. Detailed results are given in Table 2.

Eighty-nine percent (95% CI: 86.7–91.3) and 92.0% (95% CI: 90.0–94.0) of respondents reported musculoskeletal symptoms in at least one body region in the last 7 days and last 12 months, respectively. In the last 7 days and in the last 12 months, symptoms in the neck (pain, discomfort, or ache) had the highest prevalence (54.7 vs. 72.1%), followed by symptoms in the shoulder (54.4 vs. 63.5%), lower back (53.7 vs. 62.3%), upper back (44.6 vs. 52.7%), and elbows (13.1 vs. 18.5%). In the last 12 months, the highest prevalence of symptoms for sickness absence were in the neck (11.4%), followed by the shoulder (6.8%) and upper back (6.0%). In subgroup analysis, the prevalence of symptoms in the nine body regions was not different between the respondents sitting in chairs with and without a backrest. More detailed results are given in Table 3.

In the last 12 months, sewing machine operators (74.4%) and non-sewing machine operators (67.7%) had musculoskeletal symptoms in the neck. However, lower back discomfort (64.7%) was reported as the second most common site for the sewing machine operators, whereas the shoulder was the second most common site affected for the non-sewing machine operators. In addition, the highest prevalence of
musculoskeletal symptoms amongst support staff was found in the shoulder (75.0%), followed by the neck (70.0%). More detailed results are shown in Fig. 1. According to the RULA ratings, 81.2% of final wrist and arm scores were 5, and 63.0% of final neck, trunk and leg scores were 4. For wrist and arm scores, 57.7% and 23.5% of the final scores were 5 and 6, respectively. Overall, 81.2% of grand scores, which were the final wrist and arm scores combined with the final neck, trunk, and leg scores, were at action level 3-requiring investigation and change soon. Furthermore, 7.5% were at action level 4-requiring investigation and change immediately. More detailed results are shown in Table 4.

The results of logistic regression analysis in Table 5 show the association between potential risk factors and musculoskeletal symptoms in the neck, shoulder, upper back, and lower back after adjustments for controlling confounders such as age, gender, and...
underlying diseases. Feeling stressed with work was significantly associated with musculoskeletal symptoms in the neck (AOR=1.49, 95% CI: 1.06–2.08), shoulder (AOR=1.64, 95% CI: 1.20–2.25), upper back (AOR=2.07, 95% CI: 1.52–2.82), and lower back (AOR=1.60, 95% CI: 1.17–2.18). Workplace with vibration was significantly associated with musculoskeletal symptoms in the neck (AOR=1.80, 95% CI: 1.20–2.70), shoulder (AOR=1.93, 95% CI: 1.33–2.79), upper back (AOR=1.78, 95% CI: 1.26–2.25) and lower back (AOR=1.54, 95% CI: 1.07–2.21). Subjects with repetitive or monotonous movement had a higher risk of shoulder symptoms (AOR=1.72, 95% CI: 1.25–2.37) and upper back symptoms (AOR=1.92,
Subjects with work requiring forceful exertion had a higher risk of lower back pain (AOR=2.45, 95% CI: 1.68−3.59) than subjects without work requiring forceful exertion.

Discussion

The current study showed that 89.0% of Cambodian garment workers reported having musculoskeletal symptoms in at least one body region in the last 7 days and that 92.0% reported having musculoskeletal symptoms in the last 12 months. About two-thirds (64.1%) perceived that their symptoms were caused by their work in the garment factory. Previous international studies found similarly high rates of musculoskeletal symptoms in the garment manufacturing industry, with rates of 91.0, 75.0, and 65.0% in New York, Sweden and Turkey, respectively.

The prevalence of musculoskeletal symptoms in the current study is higher than that found among other factory workers (50.0%) and palm plantation work.

Table 4. The distribution of RULA scores for body segments and grand scores (N=702)

<table>
<thead>
<tr>
<th>RULA score</th>
<th>Upper arm</th>
<th>Lower arm</th>
<th>Wrist</th>
<th>Final wrist and arm score</th>
<th>Neck</th>
<th>Trunk</th>
<th>Leg</th>
<th>Final neck, trunk, and leg score</th>
<th>Grand Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>1 (0.1)</td>
<td>—</td>
<td>1 (0.1)</td>
<td>31 (4.4)</td>
<td>239 (34.0)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>6 (0.9)</td>
<td>3 (0.4)</td>
<td>143 (20.4)</td>
<td>—</td>
<td>242 (34.5)</td>
<td>586 (83.5)</td>
<td>463 (66.0)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>681 (97.0)</td>
<td>699 (99.6)</td>
<td>269 (79.5)</td>
<td>—</td>
<td>458 (65.2)</td>
<td>83 (11.8)</td>
<td>4 (0.6)</td>
<td>1 (0.1)</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>15 (2.1)</td>
<td>—</td>
<td>—</td>
<td>123 (17.5)</td>
<td>1 (0.1)</td>
<td>2 (0.3)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>5</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>570 (81.2)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>195 (27.8)</td>
<td>405 (57.7)</td>
</tr>
<tr>
<td>6</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>9 (1.3)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>60 (8.5)</td>
<td>165 (23.5)</td>
</tr>
<tr>
<td>7</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>53 (7.5)</td>
</tr>
<tr>
<td>8</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1 (0.1)</td>
<td>—</td>
</tr>
</tbody>
</table>

Mean (SD) — — — 4.8 (0.40) — — — 4.4 (0.70) 5.3 (0.76)

*aAction level 2 (11.3%). bAction level 3 (81.2%). cAction level 4 (7.5%).

Table 5. Risk factors associated with musculoskeletal symptoms in the neck, shoulder, lower back, and upper back during 12 months among garment workers (N=702)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Neck</th>
<th></th>
<th>Shoulder</th>
<th></th>
<th>Upper back</th>
<th></th>
<th>Lower back</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AOR</td>
<td>(95% CI)</td>
<td>p</td>
<td>AOR</td>
<td>(95% CI)</td>
<td>p</td>
<td>AOR</td>
<td>(95% CI)</td>
</tr>
<tr>
<td>Feeling stressed with work</td>
<td>No</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1.49</td>
<td>(1.06−2.08)</td>
<td><strong>0.02</strong></td>
<td>1.64</td>
<td>(1.20−2.25)</td>
<td><strong>0.002</strong></td>
<td>2.07</td>
</tr>
<tr>
<td>Repetitive or monotonous movement</td>
<td>No</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0.82</td>
<td>(0.58−1.16)</td>
<td>0.26</td>
<td>1.72</td>
<td>(1.25−2.37)</td>
<td><strong>0.001</strong></td>
<td>1.92</td>
</tr>
<tr>
<td>Forceful exertion</td>
<td>No</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0.92</td>
<td>(0.63−1.34)</td>
<td>0.65</td>
<td>1.15</td>
<td>(0.81−1.63)</td>
<td>0.49</td>
<td>0.8</td>
</tr>
<tr>
<td>Vibration</td>
<td>No</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1.8</td>
<td>(1.20−2.70)</td>
<td><strong>0.01</strong></td>
<td>1.93</td>
<td>(1.33−2.79)</td>
<td>&lt;0.001</td>
<td>1.78</td>
</tr>
<tr>
<td>Duration of exposure (years)</td>
<td>&lt;3</td>
<td>0.99</td>
<td>(0.64−1.52)</td>
<td>0.96</td>
<td>0.87</td>
<td>(0.58−1.29)</td>
<td>0.48</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>≥3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

AOR=adjusted odds ratio for controlling confounders: age, underlying disease, and gender. Bolded p-values indicates significant (p<α=0.05).

95% CI: 1.40−2.63). Subjects with work requiring forceful exertion had a higher risk of lower back pain (AOR=2.45, 95% CI: 1.68−3.59) than subjects without work requiring forceful exertion.

Discussion

The current study showed that 89.0% of Cambodian garment workers reported having musculoskeletal symptoms in at least one body region in the last 7 days and that 92.0% reported having musculoskeletal symptoms in the last 12 months. About two-thirds (64.1%) perceived that their symptoms were caused by their work in the garment factory. Previous international studies found similarly high rates of musculoskeletal symptoms in the garment manufacturing industry, with rates of 91.0, 75.0, and 65.0% in New York, Sweden and Turkey, respectively.

The prevalence of musculoskeletal symptoms in the current study is higher than that found among other factory workers (50.0%) and palm plantation work.
ers (58.3%)\textsuperscript{39}, although it is similar to the prevalence in Thai sugarcane farmers (88.7%)\textsuperscript{15}, surgical healthcare workers (90.0%)\textsuperscript{11}, and computer mouse users (89.0%)\textsuperscript{32}. The difference may be related to differences in work characteristics, working conditions, and workplace organizations in each of the occupations. Various studies have confirmed that a high prevalence of musculoskeletal symptoms is related to low-quality working conditions, poor workstation and tool design, high workload, mental stress, and biomechanical factors when working\textsuperscript{5,12,39}.

In the present study, most workers had worked with poor posture due to prolonged sitting or standing for around 10 to 12 hours per day. Sewing workers had prolonged sitting periods of around 10 to 12 hours per day in which they used both hands and a foot to control clothes and a sewing machine. Most non-sewing and support staff also had prolonged standing periods throughout the day. Sewing machine operators had some repeated or forceful motions such as reaching, stitching, pinching, or pulling, that they performed hundreds of time a day, and each of these motions can cause injuries to muscles and joints because of less time to heal. They also sat in fixed-rigid cushionless chairs without backrests or with very short backrests (about 20 cm) that could not support their backs effectively.

In the subgroup analysis, there was no difference in prevalence of musculoskeletal symptoms between workers sitting in chairs with or without backrests. This may have been due to the fact that the prevalence of musculoskeletal symptoms was quite high amongst these employees, so it is not possible to make a definitive conclusion regarding this at this time.

However, it remains important to use a backrest for work that requires long periods of sitting, and it should be padded with firm cushion to avoid putting high amounts of pressure on nerves or soft tissue and should be adjustable with respect to its height and distance from the center of the seat-pan so that it can accommodate the individual anthropometrics of the worker. Chi-Yuang et al.\textsuperscript{31} found that a chair with a backrest consisting of a lumbar support, which preserved lumbar lordosis, and a thoracic support, which supported the upper back during backward leaning, was very effective in supporting workers’ backs during task performance\textsuperscript{31}. In addition, the seat pan should be padded with a cushion, and it should be adjustable as well.

The RULA ratings in the present study showed very high levels of biomechanical risk for the garment factory workers. Almost 81% of the RULA ratings were at a level indicating that the workstations were a moderate risk needing more investigation and change soon, and 7.5% of the ratings were at the highest level, indicating extreme biomechanical risk and needing investigation and change immediately.

Our study found high prevalence of reported musculoskeletal symptoms in the neck, shoulder, lower, and upper back (72.1, 63.5, 62.3, and 52.7%, respectively) over the last 12 months. These reports reflected the RULA ratings as well (Table 4).

Furthermore, exposure to vibration at workstation and feeling stressed with work were significant risk factors for the discomfort or pain of the neck, shoulder, lower back, and upper back. Many workers felt stressed with work because of the high workload and long working hours, as the majority of the sewing machine operators worked from eight to ten hours per day. Repetitive or monotonous movement was another significant predictor of the likelihood of shoulder and upper back discomfort. Workers performed their tasks using the same motion for most of the work day, and their limb movements were repetitive and fast. Only forceful exertion was significantly associated with lower back symptoms.

Our findings are consistent with previous studies, in which factors such as feeling stressed with work\textsuperscript{9,30,32} and whole body vibration\textsuperscript{35}, were risk factors of musculoskeletal symptoms in the neck. In a systematic review, hand-arm vibration was significantly associated with neck pain\textsuperscript{30}. Our study also indicated that feeling stressed with work (also confirmed by previous studies\textsuperscript{37,38}) was significantly associated with symptoms in the shoulder, upper back, and lower back. Van et al.\textsuperscript{31} clarified the association between shoulder pain and repetitive movement and vibration exposure in their systematic review\textsuperscript{39}. However, we did not detect any specific risk factors for upper back pain.

Besides feeling stressed with work, lower back pain was also related to forceful exertion and vibration in our study. Holmström et al.\textsuperscript{31} indicated that workers with high stress had an approximately three time higher chance of experiencing lower back pain compared with workers with low stress\textsuperscript{40}. Previous studies have shown that lower back pain was related to physical load and frequent lifting\textsuperscript{11} and to frequent manual handling of materials\textsuperscript{41}. These occupational activities caused forceful exertion because they increased muscular effort or placed a high load on muscles or joints.

The duration of exposure was not significantly associated with musculoskeletal symptoms. This may be due to a healthy worker effect. This form of selection bias reduces the likelihood of detecting a significant association between duration of exposure and symptoms in the neck, shoulder upper back, and lower back. As the majority of the workers change
their work because of unsatisfactory working conditions, this results in relatively symptom-free workers in the workplace.43)

In our current study, biomechanical risk factors most likely contributed more to the high prevalence of symptoms than other factors. Participatory ergonomic interventions to reduce biomechanical risk factors have consistently led to the reduction of musculoskeletal symptoms, injuries or injury claims, and sickness absence attributed to musculoskeletal causes.44) In one cohort study, garment workers reported significant reduction in pain severity at all sites (except for the right wrist/hand) after ergonomic interventions including using adjustable chairs.45

In our study, sewing machine operators had the highest 12 months prevalence of neck, lower back, shoulder, and upper back problems. The prevalence of symptoms in each body region in the present study is higher than in previous findings among Chinese industrial workers (15.5–28.0%)22, Malaysian palm plantation workers (7.0–40%)13, Thai sugarcane farmers (26.8–58.7%)15, and Turkish machine operators (23.9–50.5%)16. The high rates of symptoms are likely to relate to constrained postures dictated by both the visual and manual aspects of their tasks, as their chairs and sewing machine desks were in a fixed position. Prolonged static posture and repetitive motion of wrist/hand could also be major contributors to the high prevalence of symptoms in our study, especially since sewing machine operators tend to keep their eyes on the needle with their necks flexed. Lower back pain was likely caused by prolonged sitting, and musculoskeletal symptoms for the shoulder and upper back seemed to be related to upper arm abduction, elevation of the shoulders, or muscle overuse in both regions to control wrist/hand movements while sewing. Li et al. attributed musculoskeletal symptoms in sewing machine operators to poor working posture, repetitive hand and arm movements, and prolonged static muscular load on the neck and shoulders.29,43

We propose that employers should pay attention to workstation design for sewing machine operators. To prevent operators from developing musculoskeletal symptoms because of awkward postures and excessive reaching during task performance, adjustable sewing desk should be provided to operators. The height of the sewing desks should be at the elbow level and easily modified or tilted toward the operators to suit their individual anthropometric characteristics. Tilting of the sewing desk helps operators to improve the visibility of their task and to keep their neck in an upright position. Delleman et al. recommended that sewing machine workstations should have desks adjustable to between 5 and 15 cm above elbow height from a seated posture, that table desks should be sloped (indication: 10°), and that pedals should be positioned as far under the table as considered comfortable.46

Non-sewing workers in Kandal Province also had high prevalences of neck, shoulder, lower back, and upper back pain. These workers had to stand with their necks in flexion and make quick movements with both hands. Notably, this group reported higher prevalences of knee and ankle/foot effects because they stood for up to ten hours per day. Åkesson et al. indicated that pronounced head flexion, constrained neck position, and short periods of trapezius muscular rest combined with low upper arm velocity were the most plausible risk factors for developing neck and shoulder muscle disorders.11 Arien et al. confirmed a relationship between neck pain and the following work-related risk factors: neck flexion, arm force, arm posture, duration of sitting, twisting or bending of the trunk, hand-arm vibration, and workplace design.46

In our study, no employee was rated by the RULA as being at the acceptable lowest-risk level. This is consistent with prior garment industry research.40,47 Biomechanical factors appear to be highly related to the development of musculoskeletal symptoms among garment workers in Kandal Province. Reassuringly, Choobineh et al. found that workstation intervention could reduce the prevalence of symptoms and the RULA scores, as 75% of subjects expressing increased comfort at work.46

To improve the situations identified in the present study, it is recommended that occupational health and safety unit should be established in each garment factory to assist the employers in setting up internal regulation regarding health and safety. Officers from this unit should be trained about ergonomics for the clothing industry, workplace design, and tool and equipment design in their garment factories, and they should work closely with other stakeholders such as the Occupational Safety and Health Department of the Ministry of Labor and Vocational Training, nongovernmental organizations like the International Labor Organization, and local trade union workers to improve the garment factory working condition. In addition, participatory training methodologies and active cooperation between the government, workers, employers, and nongovernmental organizations have made it possible to provide practical training in this type of business in Cambodia.40

Conclusions

The results of this study show both very high levels of reported musculoskeletal symptoms and severe biomechanical risk ratings in garments manufacturing. The SNQ and RULA proved useful as data collection tools in the study. The SNQ body
map helped participants identify body regions with musculoskeletal symptoms easily and quickly, and the RULA was a quick and easy observation method for assessing various body segments during work without inconveniencing the workers. Although the specific clinical mechanisms that cause of musculoskeletal symptoms are still not fully understood, this study provides initial evidence indicating that work environment factors in Cambodian garment factories have an effect on the occurrence of musculoskeletal symptoms. In the context of current Cambodian garment factories, ergonomic countermeasures for prevention and alleviation of musculoskeletal symptoms should be established to minimize or control the biomechanical risks using participatory training methodologies. The control measures can include the following:

1) For engineering control, modifications to sewing desk or workstation have a great potential for improving the posture of the neck and other work-related postures of the upper extremities in operator. Sewing table should be adjustable so that they can be tilted easily towards the operators. Traditional chairs should be replaced by chairs with adjustable seat height and padded backrest to support the lower back. Methods of self-assessment of ergonomic tools should be developed for each type of work.

2) For administrative control, health promotion programs can be introduced in the garment factories, such as provision of short breaks for stretching exercises, which allow the muscle to recover from muscle fatigue and reduce work stress. Self-reporting of musculoskeletal symptoms should be encouraged in the garment factories. Workers should be trained regarding how to use provided work tools and equipment in an appropriate way and trained in techniques for lifting or carrying heavy loads and to use lifting devices when required.

3) For medical management, it is necessary to ensure early identification, evaluation, and treatment of musculoskeletal symptoms.

We also recommend that the Ministry of Labor and Vocational Training should set ergonomic guidelines or policy in its National Occupational Health and Safety Program. Future studies should also be done to further understand relevant risk factors for musculoskeletal disorders among garment workers in Cambodia.

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**References**


