**Work-related musculoskeletal disorders of tribal female Sal leaf platemakers: An unperceived issue**

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**Abstract:**

**BACKGROUND:** Industrialization and globalization produce a threat to the traditional livelihood of the indigenous population. A large number of tribal people in Asia are engaged in small-scale forest-based industries. Sal leaf platemaking is a common occupation among most tribal women in the Eastern part of India. However, occupational health problems of the women engaged in this job are hardly reported so far.

**MATERIALS AND METHODS:** This study was carried out on 400 female workers engaged in Sal leaf platemaking units and 100 tribal female homemakers were considered as a referent. Modified Nordic Questionnaire and body part discomfort rating scale were applied for finding reported pain. The working postures were evaluated by rapid entire body assessment, rapid upper limb assessment, and Ovako Working Posture Analysis System (OWAS) methods.

**RESULTS:** The findings emphasize that the Sal leaf platemakers complaints about different musculoskeletal problems. They have to go to the nearby forest (2–3 km far) by foot for 3–4 days per week for collecting the Sal leaves and carry it to their home for making of plates. They spend 4–6 hour daily in making Sal leaf artifacts. The maximum discomforts felt were reported in the lower back, hips, neck, leg, and hand during working hours and also some after the work. The postural analysis shows that most of the posture adopted during Sal leaf platemaking requires corrective measures.

**CONCLUSION:** Postural stress is a causative agent for work-related musculoskeletal disorders. Therefore, to reduce the problems faced by them, some low-cost ergonomic interventions such as working bench, proper work-rest cycle, and back support should be formulated and implemented for the betterment of their daily livings.

**Keywords:**
Ergonomics, musculoskeletal disorder, occupational health, postural analysis, tribal women

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**People** have been dependent and inhabitant of forest since ages provides a great example of symbiosis. India has the largest population of tribal people (8.6% of the total population as per the 2011 census) and a major portion of them are an inhabitant of forest area. Tribal people are greatly dependent on forest for various needs whose livelihood is based on forest products such as fuelwood, fodder and small timber, Sal leaves, Kendu leaves, Sabai grass, Mahua seeds, Bahara, Amalaki, Haritaki, gum, honey, etc. There is strong evidence that, in general, Kharwar tribes and other tribal populations of India were experiencing serious to critical nutritional stress.

Sal leaf platemaking is a common occupation of tribal women in West Bengal, India. They have to go to the nearby forest (2–3 km far) by foot for 3–4 days/week to collect the green Sal leaves. They spend 4–6 hour daily in making Sal leaf artifacts. The task in Sal leaf platemaking units comprises collecting Sal leaves, stitching of leaves and making plates, drying of plates, packaging of the plate, and finalizing the shape of the plate.
with a machine. Apart from this occupational work, the female also performs other household works.

Musculoskeletal disorders (MSDs) are the most important cause of temporary work impairment in the world and together with mental disorders; they account for the majority of permanent disability persons, especially in unorganized workers.[8,9] Work-related MSDs (WRMSDs) are caused by a range of physical, individual, and psychological risk factors.[6,7]

Lower back pain and neck pain are categorized as WRMSDs, which are commonly experienced among workers,[8,9] Back and lower limb disorders occur disproportionately among truck drivers, wore house workers, airplane baggage handlers, construction trades nurses, nursing aides, and other patient-care workers, and operators of cranes and other large vehicles.[10]

A large number of tribal people are employed in brickmaking industries. The incidences of work-related musculoskeletal problems are substantial due to awkward postures and heavy manual material handling (MMH).[11] Similar observations were made by among construction laborers working in the unorganized sector in West Bengal, India.[12]

A study on the MSD among the male handloom weavers showed that they suffered from pain in different body parts. The maximum discomfort felt in the lower back and knee, caused due to adopting awkward sitting postures for a long time, repeated movements of the limbs, altogether put the workers into stress.[13] Many researchers have pointed out the close relationship between working postures and the prevalence of musculoskeletal symptoms.[14,15] Unfortunately, there is a dearth of studies regarding the occupational health problems in the tribal people engaged in different unorganized sectors.

To evaluate the current scenario of the tribal female worker, the present study aims at identification of pain or discomfort felt in different body parts of the tribal female workers according to the activities they are engaged in while making Sal leaf plate and identification of the risk levels of different awkward working posture which will be dealt in the following sections.

**Materials and Methods**

**Subject**

Four hundred adult tribal female workers engaged in Sal leaf platemaking for having at least 2 years of experience were randomly considered as the study participants and 100 tribal females, mainly homemakers, were considered as the referent. Exclusion criteria were those who were suffering from chronic diseases had undergone any surgery within 6 months or not willing to cooperate with the study protocol.

**Physical profile**

Height and weight of individuals were measured by properly calibrated anthropometric rod and digital weighing machine, respectively. From those data, body mass index (BMI) and body surface area were calculated.[16,17]

**Questionnaire assessment**

The modified Nordic Questionnaire[18] was applied to tribal female Sal leaf platemaking workers and homemakers for the assessment of musculoskeletal problems.

**Assessment of discomfort feeling**

10-point body part discomfort scale[19] was used for the measurement of discomfort feeling in different body parts during occupational work.

**Working posture analysis**

Working postures of Sal leaf platemaking workers were evaluated by the Ovako Working Posture Analysis System (OWAS) method,[20] rapid upper limb assessment (RULA) method,[21] and rapid entire body assessment (REBA) method,[22] and accordingly, scoring was done for further investigation.

**Statistical analysis**

The data were expressed as the mean ± standard deviation to evaluate statistical significance for physical characteristics. Differences in the questionnaire responses between the working groups were evaluated using the Chi-square test where P < 0.05 was used as the limit of significance. A hypothesis test for proportions was to analyze the tendency of deviation of the outcome.[22]

The study was conducted following the Helsinki Declaration. Prior to the experiment, written consent was obtained from the participants and the study protocol was approved by the Department of Physiology, University of Kalyani.

**Results**

Table 1 represents the physical parameters of Group 1 (i.e., the tribal Sal leaf platemaking female workers) and Group 2 (i.e., the tribal homemakers). As observed from the following table, we can conclude that most of the female workers belong to the middle-age group and that the Sal leaf platemaking workers had comparatively lower BMI to that of referent homemakers.

The following Table 2 represents the reported pain/discomfort felt by the Sal leaf platemaking workers and the referent group during the work and post the
Table 1: Physical characteristics of tribal female Sal leaf platemaking workers and homemakers

|                      | Sal leaf platemaking workers (n=400) | Homemakers (n=100) |
|----------------------|------------------------------------|---------------------|
| Age (years)          | 39.41±11.88 (18-70)                | 40.81±12.54 (19-66) |
| Height (cm)          | 151.26±6.01 (134.0-180.3)          | 152.20±5.73 (139.7-167.0) |
| Weight (kg)          | 43.13±7.35 (26-69)                 | 45.28±8.26 (26-70)  |
| BMI (kg/m²)          | 18.82±2.98 (11.57-29.70)           | 19.53±3.30 (11.57-27.33) |
| BSA (m²)             | 1.39±0.12 (1.09-1.87)              | 1.43±0.13 (1.12-1.80) |
| Work experience (years) | 28.73±11.65 (8-60)               | 23.82±12.58 (2-49)  |

Values: Mean±SD (figures in the parenthesis indicate the range). BMI=Body mass index, BSA=Body surface area, SD=Standard deviation

Table 2: Discomfort/pain feeling at different times of day

| Times of discomfort | Group 1 (n=400) | Group 2 (n=100) | χ² | P |
|---------------------|-----------------|-----------------|----|---|
| During work         | 190 (47.5)      | 38 (38)         | 0.03 | 0.86 |
| Just after work     | 290 (72.5)      | 58 (58)         | 1.50 | 0.22 |
| During sleep        | 280 (70)        | 55 (55)         | 0.05 | 0.82 |
| During 24 h after work | 210 (52.5)  | 40 (40)         | 0.04 | 0.84 |

Values: Number of responses (figure in the parenthesis indicate the percentage).

Table 3: Responses of discomfort/pain in different body parts among tribal female Sal leaf platemaking (i.e., Group 1) and homemakers (i.e., Group 2)

| Body parts       | Group 1 (n=400) | Group 2 (n=100) | χ² | P |
|------------------|-----------------|-----------------|----|---|
| Head             | 70 (17.5)       | 11 (11)         | 2.03 | 0.1542 |
| Eye              | 30 (7.5)        | 3 (3)           | 1.95 | 0.1626 |
| Neck             | 301 (75.25)     | 61 (61)         | 7.43 | 0.0064* |
| Shoulder         | 178 (44.5)      | 33 (33)         | 4.03 | 0.0447* |
| Upper arm        | 110 (27.5)      | 20 (20)         | 1.97 | 0.1604 |
| Lower arm        | 200 (50)        | 38 (38)         | 4.15 | 0.0416* |
| Elbow            | 174 (43.5)      | 32 (32)         | 3.91 | 0.048* |
| Wrist            | 241 (60.25)     | 48 (48)         | 4.43 | 0.0353* |
| Finger           | 39 (9.75)       | 6 (6)           | 0.95 | 0.5023 |
| Upper back       | 269 (67.25)     | 55 (55)         | 4.74 | 0.0295* |
| Lower back       | 341 (85.25)     | 71 (71)         | 10.24 | 0.0014* |
| Hip/buttock      | 321 (80.25)     | 67 (67)         | 7.35 | 0.0067* |
| Knee             | 326 (81.5)      | 70 (70)         | 5.74 | 0.0166* |
| Ankles           | 197 (49.25)     | 37 (37)         | 4.34 | 0.0372* |
| Calf             | 175 (43.75)     | 36 (36)         | 1.67 | 0.1963 |
| Thigh            | 205 (51.25)     | 40 (40)         | 3.61 | 0.09 |

Values: Number of responses (figure in the parenthesis indicate the percentage). *Significant, P<0.05

Figure 1 represents the prevalence of pain among the female workers and the counter referent group for the previous 7 days which demarcated the extensiveness of pain at the neck, lower back, hip, and knee.

Association of the feeling of pain or the absence of feeling of pain between platemaking workers and homemakers on the basis of their pain prevalence for the past 1 year is given in Table 4. From the statistical analysis by means of the Chi-square test, it is clear that maximum discomfort responses were significantly higher in the neck, wrist, upper and lower back, hip, knee, and ankles of Sal leaf platemakers. This discomfort may be attributed to continuous forward bending, moving, and awkward sitting posture exposed for a prolonged time.

Table 5 depicts the significant association between the MSD complaints of the Sal leaf platemaking female workers with the BMI at regions such as the neck, shoulder, wrist, lower back, and hip. A value <18.5 kg/m² signifies that the subjects are suffering from chronic energy deficiency (The World Health Organization, 1998 Guidelines[24]), as has been indicated.

The postural stress among the female Sal leaf plate workers due to varied adopting postures while working had been depicted in Table 6. This risk level was measured by OWAS, REBA, and RULA standard methods. This assessment had shown that most of the Sal leaf platemaking workers experience some strain and were at greater risk of developing postural deformities for which actions need to be implemented in the near future.

Discussions

In India, the importance of women in tribal society is unique than in any other social group. The tribal females work in the agricultural field during the agricultural season as a daily laborer. They perform different heavy work such as cutting of crops, harvesting, collecting crops from land to home, and threshing. Their involvement has also been found in various other sectors.

In this cohort study, we have considered tribal female workers engaged in the Sal leaf platemaking activity...
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for their livelihood of different districts of West Bengal, India. Initial investigation showed that they have to go to the nearby forest for collecting Sal leaves that too for 3–4 days/week and carry it back to their home and finally uses it for ultimate product formation, i.e., Sal plate. These plates are purchased by the trader.

The questionnaire study showed that most of the tribal females who are engaged in the Sal leaf platemaking job suffered from discomfort and pain feeling in different body parts that may be considered as a pro indicator for the MSD. The most complaint about discomfort was raised in the hip, wrist, neck, and lower back. The main causation of this malaise may be due to the awkward sitting posture for a prolonged time without taking proper rest and improper work-rest cycle. Some characteristics of such activity had revealed that there exist repetitive movements, sustained posture, and incorrect work position which may promote MSD.

From the postural analysis, it was evident that most of the postures adopted during the Sal leaf platemaking activities needed change immediately. On the other hand, the amount and quality of forwarding bent work postures influence the comprehensive force on the vertical discs and

Table 4: Responses of discomfort/pain in different body parts among tribal female Sal leaf platemaking (i.e., Group 1) and homemakers (i.e., Group 2) on the basis of their pain prevalence for the past 1 year

| Body parts   | Group 1 (n=400) | Group 2 (n=100) | \( \chi^2 \) | \( P \) |
|--------------|----------------|----------------|-----------|------|
| Head         | 70 (17.5)      | 14 (14)        | 0.47      | 0.493|
| Eye          | 25 (6.25)      | 6 (6)          | 0.02      | 0.8875|
| Neck         | 260 (65)       | 46 (46)        | 11.38     | 0.0007*|
| Shoulder     | 165 (41.25)    | 32 (32)        | 2.49      | 0.1146|
| Upper arm    | 73 (18.25)     | 13 (13)        | 1.2       | 0.2733|
| Lower arm    | 180 (45)       | 40 (40)        | 0.62      | 0.431 |
| Elbow        | 130 (32.5)     | 25 (25)        | 1.77      | 0.1834|
| Wrist        | 227 (56.75)    | 45 (45)        | 3.99      | 0.0458*|
| Finger       | 29 (7.25)      | 6 (6)          | 0.05      | 0.8231|
| Upper back   | 255 (63.75)    | 52 (52)        | 4.18      | 0.0409*|
| Lower back   | 300 (75)       | 62 (62)        | 6.13      | 0.0133*|
| Hip/buttock  | 270 (67.5)     | 56 (56)        | 4.17      | 0.0411*|
| Knee         | 246 (61.5)     | 50 (50)        | 3.92      | 0.0477*|
| Ankles       | 175 (43.75)    | 32 (32)        | 4.08      | 0.0434*|
| Calf         | 135 (33.75)    | 27 (27)        | 1.37      | 0.2418|
| Thigh        | 185 (46.25)    | 39 (39)        | 1.42      | 0.2334|

Values: Number of responses (figure in the parenthesis indicate the percentage). *Significant, \( P<0.05 \)

Table 5: The relationship between the complaint regarding musculoskeletal disorders and body mass index

| MSD complaints | BMI (kg/m\(^2\)) | Yes | No | \( \chi^2 \) | Interpretation |
|----------------|------------------|-----|----|--------------|---------------|
| Head           | <18.5            | 40  | 360| 1.27         | NS            |
|                | >18.5            | 30  | 370|              |               |
| Neck           | <18.5            | 129 | 271| 4.26         | S*            |
|                | >18.5            | 158 | 242|              |               |
| Shoulder       | <18.5            | 103 | 297| 5.27         | S*            |
|                | >18.5            | 75  | 325|              |               |
| Upper arm      | <18.5            | 61  | 339| 1.28         | NS            |
|                | >18.5            | 49  | 351|              |               |
| Lower arm      | <18.5            | 110 | 290| 2.15         | NS            |
|                | >18.5            | 91  | 309|              |               |
| Wrist          | <18.5            | 134 | 266| 4.34         | S*            |
|                | >18.5            | 106 | 294|              |               |
| Upper back     | <18.5            | 137 | 263| 0.28         | NS            |
|                | >18.5            | 129 | 271|              |               |
| Lower back     | <18.5            | 191 | 209| 8.18         | S*            |
|                | >18.5            | 150 | 250|              |               |
| Hip            | <18.5            | 144 | 256| 5.33         | S*            |
|                | >18.5            | 157 | 243| 0.52         | NS            |
|                 |                   | 168 | 232|              |               |

*\( P<0.05 \). MSD=Musculoskeletal disorder, BMI=Body mass index, S=Significant, NS=Nonsignificant
### Table 6: Analysis of working posture of tribal Sal leaf platemaking workers

| Working posture | Stick diagram | Activity | Scores   | Action category                  | Maximum discomfort body part - Low back, BPD core (BPD scale range 0-10) |
|-----------------|---------------|----------|----------|----------------------------------|-----------------------------------------------------------------------|
| Making leaf plate |               | Making leaf plate | OWAS - 2 | Some strain, near future         | 7                                                                     |
|                 |               |           | REBA - 8 | High                             | Investigate and implement change                                      |
|                 |               |           | RULA - 7 |                                  |                                                                        |
|                 |               | Making leaf plate | OWAS - 2 | Some strain, near future         | 7                                                                     |
|                 |               |           | REBA - 9 | High                             | Investigate and implement change                                      |
|                 |               |           | RULA - 7 |                                  |                                                                        |
|                 |               | Making leaf plate | OWAS - 2 | Some strain, near future         | 8                                                                     |
|                 |               |           | REBA - 8 | High                             | Investigate and implement change                                      |
|                 |               |           | RULA - 7 |                                  |                                                                        |
|                 |               | Making leaf plate | OWAS - 2 | Some strain, near future         | 9                                                                     |
|                 |               |           | REBA - 9 | High                             | Investigate and implement change                                      |
|                 |               |           | RULA - 7 |                                  |                                                                        |
|                 |               | Making leaf plate | OWAS - 2 | Some strain, near future         | 9                                                                     |
|                 |               |           | REBA - 9 | High                             | Investigate and implement change                                      |
|                 |               |           | RULA - 7 |                                  |                                                                        |

Contd...
erector spine muscles as evident by a study. Another pronounced recent study on work-related musculoskeletal problems among traditional and Jacquard handloom weavers had concluded that due to the prolonged awkward working posture, they also do complaints of body discomfort and pain which is a clear indicator for the development of musculoskeletal problems.

The present study depicted that the health condition of the Sal leaf platemakers was compromised to a greater extent and it needs sooner implementation measures. Some low-cost ergonomic interventions such as working bench, intermittent breaks, and back support may reduce the problem faced by the female workers to a greater extent for the betterment of life.

**Conclusion**

Since tribal women are suffering from poor economic conditions and malnutrition, they earn their livelihood.
They are indeed hard working. Apart from household duty, they are involved in different strenuous works to run the family. Sal leaf platemaking tribal women workers were suffering from various work-related discomfort in their body parts, mainly MSD, because of their continuous awkward working posture due to in-proper work station and working environment. Majorly discomforts were observed in the lower back, neck, wrist, hips/buttock, and knees. Improper work schedule as well as poor working time and nonadjustable work station imparts a negative impact on them. Working posture analysis score showed that some of the postures adopted during Sal leaf platemaking required corrective maneuver. Therefore, it can be recommended to implement some low-cost ergonomic intervention such as working bench, intermittent breaks and back support will improve the quality of life of them.

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Conflicts of interest
There are no conflicts of interest.

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