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Ergonomic analysis of postural and musculoskeletal disorders faced by farm women during flower cultivation

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Abstract

In India, floriculture is viewed as highly developing industry. Though the flower cultivation has been in practice in India since times immemorial but the floriculture has flourished in to a viable occupation only in recent years. Earlier flower cultivation was considered as a hobby or great past time of rich people or flower lovers but now it has unwrapped a different perspective in agriculture trade i.e. commercial floriculture which is due to steady increase in demand of flowers. It has also found that there is an intensive involvement of women in this activity which may lead to postural and musculoskeletal disorders due to physical workload. Therefore the present study was conducted with the objective to identify the various postural and musculoskeletal disorders experienced by female workers engaged in flower cultivation. Musculoskeletal Disorders or MSDs are injuries and disorders that affect the human body's movement or musculoskeletal system. A total of 120 female workers were selected as respondents randomly. Therefore, ergonomic analysis of postural and musculoskeletal disorders faced by respondents while performing various activities during flower cultivation were assessed using three subjective scales i.e. Assessment of musculoskeletal problems of respondents (Standardized Nordic Musculoskeletal Questionnaire), Postural discomfort experienced by respondents by using rating of perceived exertion scale Varghese *et al.* (1994) and Postural discomfort experienced by respondents by using Corlett and Bishop Scale (1976). The results revealed that the lower back pain (92.5%) was the main musculoskeletal problem as determined by standardized Nordic musculoskeletal questionnaire. According to Postural discomfort experienced by respondents by using rating of perceived exertion scale Varghese *et al.* (1994) and Corlett and Bishop Scale (1976) respondents reported more pain in lower back and neck respectively. In order to reduce these postural and musculoskeletal disorders remedial measures were also suggested.

Keywords: Musculoskeletal disorders, posture, pain

Introduction

India is the farm country and agriculture is its most important occupation. Agriculture is the backbone of Indian economy. Earlier, wheat and maize used to be the traditional crops but now the scenario has changed. Growing of flowers is an important component of diversification of agricultural cropping pattern. As per information provided by department of Floriculture and Landscaping, Punjab agricultural university, area under floriculture has witnessed impressive increase over the last ten years from 1600 hectares in 2007-08 to 2070 hectares in 2017-18. Marigold is the most commonly grown flower in Punjab. It is an annual flower plant. Flower harvesting is one of the tedious activities and flower plucking is mostly done with the hands. There is an intensive involvement of women in this activity and they do this task with drudgery prone method placing a huge demand on their time and energy (Kaur and Sharma 2014)^[3]. There is hardly any activity in agricultural production where women are not actively involved. Women perform various farm related activities both inside and outside the household. So far, as floriculture is concerned; women participate in almost all activities i.e. from transplanting to harvesting of the flowers. Women adapt unnatural body posture during various flower cultivation activities as a result they face different musculoskeletal discomforts and their physical workload increases due to which the effectiveness of women to work decreases to greater amount. Women suffer from musculoskeletal disorders in various parts of body, especially lower and upper back pain, during different activities in flower cultivation.

Musculoskeletal disorders (MSDs) are injuries or pain in the human musculoskeletal system, including the joints, ligaments, muscles, nerves, tendons, and structures that support limbs,

Neck and back. MSDs can arise from a sudden exertion (e.g., Lifting a heavy object), or they can arise from making the same motions repeatedly repetitive strain, or from repeated exposure to force, vibration, or awkward posture. MSDs can affect many different parts of the body including upper and lower back, neck, shoulders and extremities (arms, legs, feet, and hands). Therefore, the present study was conducted with the objective to identify the various musculoskeletal disorders experienced by female workers engaged in flower cultivation.

Research Methodology

The current study was conducted by a field survey technique with the aim to identify and assess various postural and musculoskeletal disorders experienced by female workers during flower cultivation. For carrying out the field survey, the information regarding the flower cultivators was procured from department of Floriculture and Landscaping, Punjab Agricultural University. The study was carried out in the six marigold fields in Ludhiana district from month June - October. A total of 120 female workers were selected as respondents randomly. Six subjective and objective assessment techniques used to assess the postural and musculoskeletal disorders experienced by respondents which included Corlett and Bishop (1976) [1] Scale for Postural Discomfort, Standardized Nordic Musculoskeletal Questionnaire (Kuorinka *et al.* 1987) [4] and Rating of Perceived Exertion Scale by Varghese *et al.* (1994) [6], Rapid Upper limb Assessment, Rapid Entire Body Assessment and Ovako Working Posture Analysis System. (RULA, REBA and OWAS)

Statistical analysis of data

The data collected was analysed by using following statistical methods:
 -Percentage
 -Mean score: Following formula was used to calculate the mean score:

$$\text{Mean score} = \frac{\sum Sn}{N}$$

Where
 S = Scores given to respondents
 n =Frequency distribution
 N = Total number of respondents

Standard deviation: The formula for calculating standard

deviation is given below:

$$S_x = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}}$$

Where
 n = the number of data points
 \bar{x} = Mean of the values in data sheet
 Xi = Value in data sheet
 - Single proportion z test

$$Z = \frac{p - p_o}{\sqrt{\frac{p_o(1 - p_o)}{n}}}$$

Where
 p = sample proportion
 p_o = population proportion
 n = sample size

Whereas, for postural analysis the respective work sheets were used to calculate the final scores to get action category for each method i.e. RULA, REBA and OWAS.

Research Findings and Discussion

Assessment of musculoskeletal problems of respondents (Standardized Nordic Musculoskeletal Questionnaire)

Standardized Nordic Musculoskeletal Questionnaire was used to determine the musculoskeletal problems and body pain perceived by respondents. The responses collected from respondents were analysed using Z-test (Table 1). Data shows that respondents had trouble in various body parts like lower back, neck, upper back and shoulder during last 12 months and is found to be significant as analysed by z test. Whereas, less pain was observed in knees followed by ankles/feet, hip/thighs, wrist/hands and elbow. Women generally adopt squatting and bending posture while transplanting, hoeing, weeding and harvesting and maintain it for long hours, which cause musculoskeletal problems. As respondents felt pain in different body parts, so there is a need of ergonomic intervention for prevention and management of postural and musculoskeletal discomforts experienced by respondents due to awkward posture adopted by them during flower cultivation. Henry *et al.* (2015) [2] also identified that in planting shoulder and back pain are the most common MSD, although the neck was presumably more exposed to injury

Table 1: Assessment of musculoskeletal problems of respondents (Standardized Nordic Musculoskeletal Questionnaire)

Body parts	I		II		III	
	Percentage (%)	Z Score	Percentage (%)	Z Score	Percentage (%)	Z Score
Low back	92.5	9.311*	28.3	4.747*	70.8	4.564*
Neck	89.2	8.581*	23.3	5.842*	63.3	2.921*
Upper back	81.7	6.938*	13.3	8.033*	47.5	0.548*
Shoulders	68.3	4.017*	6.7	9.494*	28.3	4.747*
Knees	43.3	1.460**	10.8	8.581*	15.0	7.668*
Ankles/feet	34.2	3.469*	8.3	9.129*	7.5	9.311*
Hips/thighs	30.8	4.199*	4.2	10.042*	0.0	0.000*
Wrist/hands	20.0	6.573*	4.2	10.042*	0.0	0.000*
Elbows	17.5	7.120*	0.0	0.000*	3.3	10.224*

Multiple responses
 *Significant ** Non-Significant

Postural discomfort experienced by respondents by using rating of perceived exertion scale Varghese *et al.* (1994)^[6]

It is a 5 point scale ranging from 1 to 5 *viz.* 1 for very mild and 5 for very severe respectively. It shows the rating of perceived exertion felt by respondents in various body parts while doing various flower cultivation activities. Mean scores were calculated and then mean ranks were assigned to calculated mean scores. It is evident from table 2 and figure 1 that respondents felt very severe to mild exertion. When the

workers are forced to work repetitively in awkward body posture they feel severe exertion in various body parts and if they work continuously in the same manner the improper posture could result in permanent bending of some body part. So in order to reduce postural discomforts experienced by respondents it should be ensured that workers should use proper tools and that too of the proper size for performing task

Table 2: Postural discomfort experienced by respondents by using rating of perceived exertion scale Varghese *et al.* (1994)^[6]

Body parts	Mean score	Mean rank
Lower back	4.66	I
Neck	4.61	II
Upper back	4.18	III
Shoulder	3.99	IV
Calf muscles	2.22	V
Ankle/feet	2.18	VI

*Multiple responses

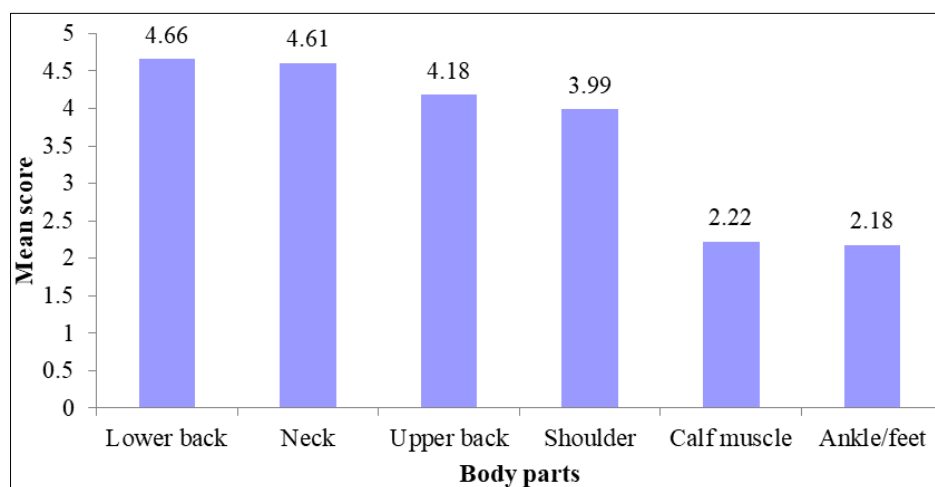


Fig 1: Postural discomfort experienced by respondents by using rating of perceived exertion scale Varghese *et al.* (1994)^[6]

Postural discomfort experienced by respondents (Corlett and Bishop Scale 1976)^[11]

It is a five point scale ranging from 1 to 5 *viz.* 1 for very mild and 5 for very severe respectively. It is used to find out the intensity of pain in different body parts while performing various flower cultivation activities. Mean scores were calculated and then mean ranks were assigned to calculated mean scores. Respondents felt more pain in neck, lower back, upper back and shoulder as they got ranks I, II, III and IV respectively. Whereas, respondents felt low or no pain in calf

muscles and ankle/feet as these got V and VI rank respectively (Table 3 and Fig2). The introduction of frequent breaks is important way to reduce postural discomforts experienced by respondents. (Turner 2004)^[5] Also stated that introduction of small breaks reduces awkwardness, pain and discomfort by reducing muscle and nerve tension. Rather than taking rest to recover from fatigue it is better to have frequent breaks to prevent fatigue. The breaks may be passive or active where the workers can take rest or undertake stretching type exercises respectively

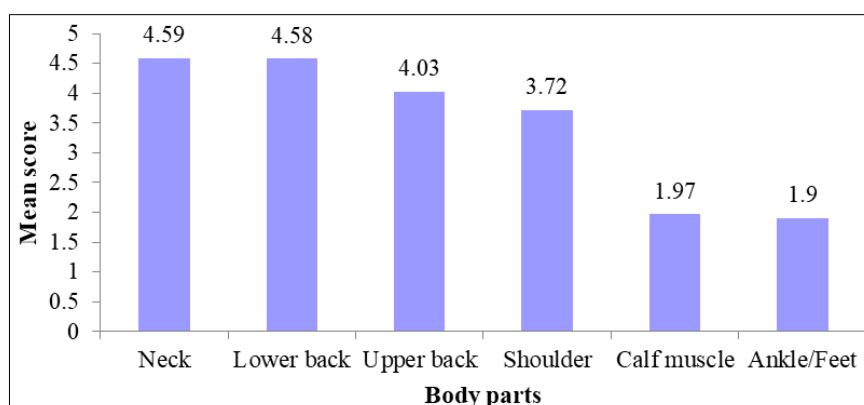


Fig 2: Postural discomfort experienced by respondents (Corlett and Bishop Scale 1976)^[11]

Table 3: Postural discomfort experienced by respondents (Corlett and Bishop Scale 1976)^[1]

Body parts	Mean score	Mean rank
Neck	4.59	I
Lower back	4.58	II
Upper back	4.03	III
Shoulder	3.72	IV
Calf muscles	1.97	V
Ankle/feet	1.90	VI

*Multiple responses

Posture analysis of respondents while performing different activities during flower cultivation using objective assessment techniques

Low cost ergonomic tools i.e. OWAS, RULA and REBA were used to analyse the posture adopted by respondents while performing different flower cultivation activities.

Posture analysis of respondents through low cost techniques

A total of five most awkward and frequently adopted postures were selected for posture analysis of respondents while performing various flower cultivation activities. The selected postures were analysed using low cost posture analysis techniques i.e. OWAS, RULA and REBA and are discussed below from Table 4 to 5.

Analysis of posture I: squatting with stretched arms

Posture I (Table 4) i.e. squatting with stretched arms was

adopted by subjects while plant transplanting. The OWAS action category (Score-3) suggests that corrective measures are needed as soon as possible. The RULA score is 7 with action category Investigate and implement change. The rating of squatting posture with stretched arms done by REBA indicates further investigation and change soon.

Analysis of Posture II: Squatting with side twist

Posture II (Table 5) i.e. squatting with side twist was adopted by subjects while hoeing. The OWAS action category (Score - 3) suggests that corrective measures are needed as soon as possible. The RULA score is 7 with action category Investigate and implement change. The rating of squatting posture with side twist done by REBA indicates further investigation and change soon.

Analysis of Posture III: Squatting

Posture III (Table 6) is a squatting posture which is adopted by subjects while removing of weeds. The OWAS action category (Score-2) suggests that corrective measures are needed in the near future. The RULA score is 4 with action category further Investigation may be needed. The rating of squatting posture done by REBA indicates investigate and implement change. Kaur (2012)^[3] conducted a study on rural and urban homemakers to pick vegetables from the ground level by putting stress on both feet. She also found that squatting posture got OWAS score 2 which is similar to the findings of the present study.

Table 4: Analysis of Posture I: Squatting with stretched arms



OWAS					
Back	Arm	Legs	Load/ Effort	Final score	Action category
2	1	4	1	3	Corrective measures as soon as possible

RULA			
Wrist posture score (A)	Trunk posture score(B)	Neck, Trunk and Leg posture (final score)	Action category
4	7	7	Investigate and implement change

REBA					
Trunk, Neck, Legs	Upper arms, Lower arms, Wrist	Grand score	Final score	Risk level	Action category
5	5	6	7	Medium risk	Further investigation, change soon

Table 5: Analysis of Posture II: Squatting with side twist



Activity: Hoeing

OWAS					
Back	Arm	Legs	Load/Effort	Final score	Action category
2	1	4	1	3	Corrective measures as soon as possible

RULA			
Wrist posture score (A)	Trunk posture score(B)	Neck, Trunk and Leg posture (final score)	Action category
4	7	7	Investigate and implement change

REBA					
Trunk, Neck, Legs	Upper arms, Lower arms, Wrist	Grand score	Final score	Risk level	Action category
5	5	6	7	medium risk	Further investigation, change soon

Table 6: Analysis of Posture III: Squatting



Activity: Removing weeds

OWAS					
Back	Arm	Legs	Load/Effort	Final score	Action category
1	1	4	1	2	Corrective measures in the near future

RULA			
Wrist posture score (A)	Trunk posture score(B)	Neck, Trunk and Leg posture (final score)	Action category
2	3	4	Further investigation, change may be needed

REBA					
Trunk, Neck, Legs	Upper arms, Lower arms, Wrist	Grand score	Final score	Risk level	Action category
3	2	3	4	Medium risk	Investigate and implement change

Table 7: Analysis of Posture IV: Full forward bending



Activity: Flower harvesting

OWAS					
Back	Arm	Legs	Load/Effort	Final score	Action category
2	1	5	1	3	Corrective measures as soon as possible

RULA			
Wrist posture score (A)	Trunk posture score(B)	Neck, Trunk and Leg posture (final score)	Action category
4	6	7	Investigate and implement change

REBA					
Trunk, Neck, Legs	Upper arms, Lower arms, Wrist	Grand score	Final score	Risk level	Action category
7	4	9	11	Very high risk	implement change

Table 8: Analysis of Posture V: Half forward bending with stretched arms



Activity: Flower harvesting

OWAS					
Back	Arm	Legs	Load/Effort	Final score	Action category
2	1	2	1	2	Corrective measures in the near future

RULA			
Wrist posture score (A)	Trunk posture score(B)	Neck, Trunk and Leg posture (final score)	Action category
3	5	6	Further investigation, change soon

REBA					
Trunk, Neck, Legs	Upper arms, Lower arms, Wrist	Grand score	Final score	Risk level	Action category
5	4	5	6	Medium risk	Further investigation, change soon

Analysis of Posture IV: Full forward bending

Posture IV (Table 7) i.e. full forward bending was adopted by subjects while flower harvesting. The OWAS action category (Score - 3) suggests that corrective measures are needed as soon as possible. The RULA score is 7 with action category Investigate and implement change. On the basis of REBA score i.e. 11, this posture was under very high risk where implementation of change is needed.

Analysis of Posture V: Half forward bending with stretched arms

Posture V (Table 8) i.e half forward bending with stretched arms was adopted by subjects while flower harvesting. The OWAS action category (Score-2) suggests that corrective measures are needed in the near future. The RULA score is 6 with action category further investigation and change soon. On the basis of REBA score i.e. 6, this posture was under medium risk where further investigation and change soon is

needed.

Formulation of booklet on remedial measures to reduce postural and musculoskeletal discomforts experienced by respondents

A booklet is formulated in which remedial measures were suggested to reduce postural and musculoskeletal discomforts experienced by female workers engaged in flower cultivation (Annexure-V)

Relaxation methods to reduce postural and musculoskeletal disorders experienced by respondents

Rest breaks

The introduction of frequent breaks is important way to reduce muscle fatigue. Research work suggests that mini breaks of one minute or less are more effective in reducing muscle fatigue and discomfort. Working long hours continuously without any break causes fatigue as well as

safety and health problems. Fatigue impairs an employee’s ability to perform. Appropriate rest breaks are important to the safety and health of employees. A short break after a long period of continuous work provides a chance for employees to relax and recuperate. It helps to improve their performance.

Break ideas

- ❖ To reduce strain take short rests or if necessary close the eyes and cover them with the hands without pressing and breathe deeply eight to ten times.
- ❖ Micro-breaks – between burst of activity rest the hands, neck and shoulders in a relaxed straight posture.
- ❖ Rest-breaks – every 30-60 minutes take a brief 5-minute

For head

1. Tuck your chin onto your chest and gently turn your head from side to side, keeping your chin on your chest. Do this ten times (Fig 3).

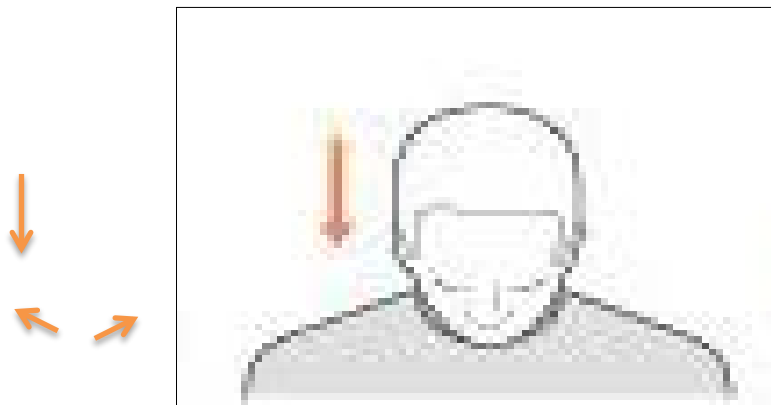


Fig 3: Tuck your chin onto your chest and gently turn your head from side to side, keeping your chin on your chest

2. Turn your head slowly from side to side ten times (Fig 4).

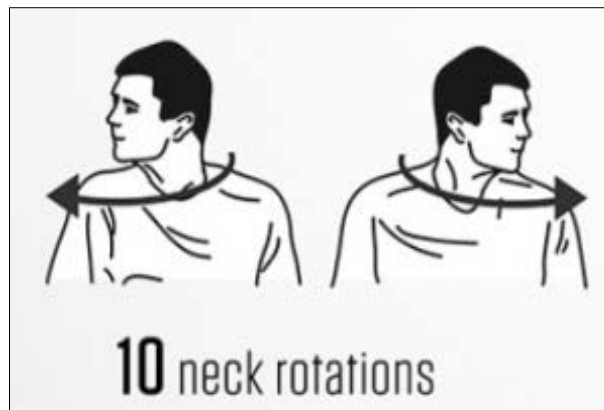


Fig 4: Turn your head slowly from side to side ten times

3. Lock your hand behind your head stretch slowly backward

- Arch your back slightly and gently
- Hold for six to ten seconds and repeat (Fig 5).

- break and engage in another activity.
- ❖ Exercise break- every 1-2 hours do gentle stretching exercise.

Relaxation exercises

For musculoskeletal problems

Women generally adopt squatting and bending posture while sowing, ploughing, weeding and harvesting and maintain it for long hours, which cause musculoskeletal problems in various parts of body. Therefore, some set of relaxing exercises can be helpful for female workers engaged in flower cultivation to reduce musculoskeletal problems which are mentioned below.



Fig 5: Lock your hand behind your head stretch slowly backward

For neck

Turn your neck side to side, up and down, tilt side to side, side stretch and forward stretch. Repeat the set of movements 5 times ().

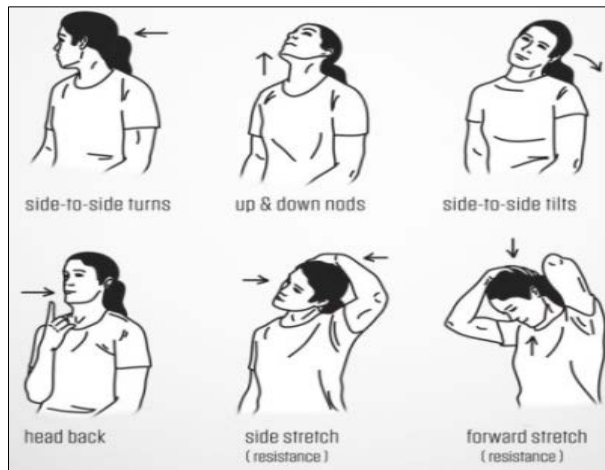


Fig 6: Turn your neck side to side, up and down, tilt side to side, side stretch and forward stretch

For upper back and shoulders

1. Roll the shoulders – raise them, pull them back, then drop them and relax. Repeat in the opposite direction (fig 7).

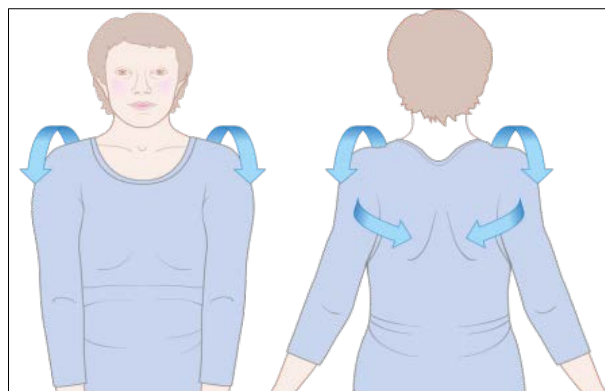


Fig 7: Roll the shoulders – raise them, pull them back, then drop them and relax. Repeat in the opposite direction

2. Reach one arm across the chest, grasping the opposite shoulder.

- With the other arm, gently pull the elbow across the chest and towards the body until you feel a stretch. Hold this position for six to ten seconds (fig 8).

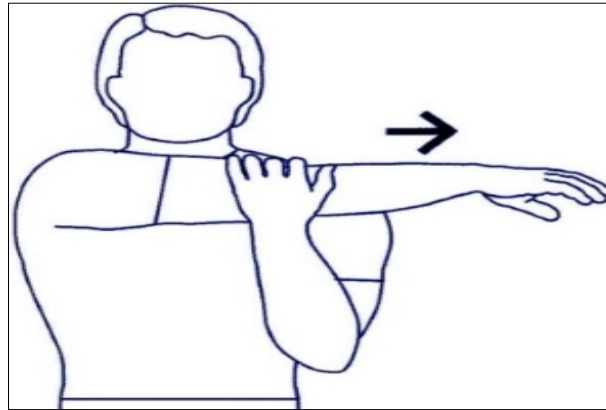


Fig 8: Reach one arm across the chest, grasping the opposite shoulder

Back exercise

1. Stand with your feet shoulder-width apart. Raise your left arm and bend to the right. Hold for 5 seconds (fig 9).
 - Return to the upright posture.
 - Repeat on the left side.
 - Repeat the set of movements 5 times.



Fig 9: Stand with your feet shoulder-width apart. Raise your left arm and bend to the right. Hold for 5 seconds

2. Extend both arms out in front of chest at shoulder height. Do not overextend the elbows.
 - Interlock fingers, palms facing away from the body.
 - Maintaining an upright posture, reach forward with the arms until you feel a stretch in the shoulder/upper back region. Hold for six to ten seconds (fig 10).

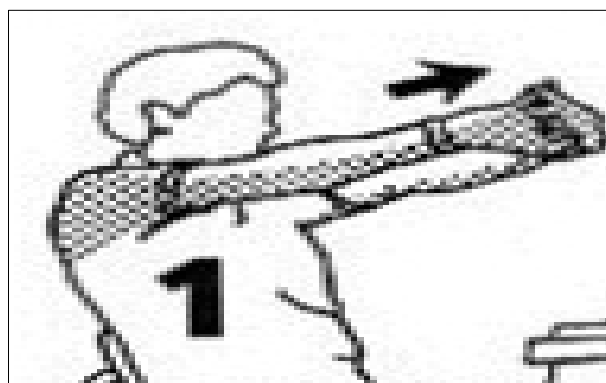


Fig 10: Extend both arms out in front of chest at shoulder height. Do not overextend the elbows

- Raise and stretch arms overhead, keeping arms extended and fingers interlocked. Keep stomach muscles tight to avoid arching the low back. Breathe naturally and hold for ten seconds (fig 11).

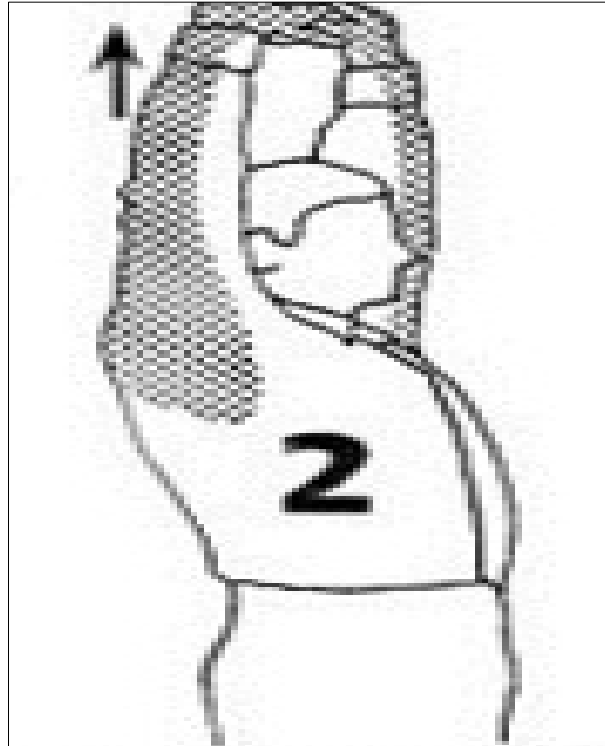


Fig 11: Raise and stretch arms overhead, keeping arms extended and fingers interlocked. Keep stomach muscles tight to avoid arching the low back

For arms and hands

1. Drop your hands to your sides. Shake them out for a few seconds (fig 12).

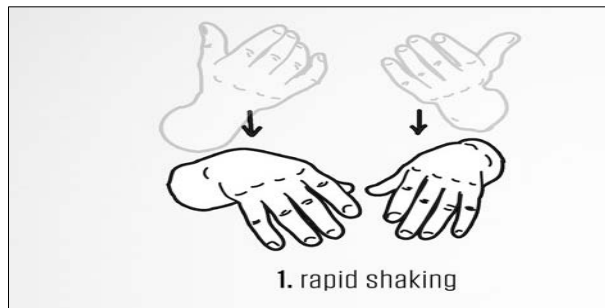


Fig 12: Drop your hands to your sides. Shake them out for a few seconds

2. Straighten one arm in front of you, palm down. Using the hand of the other arm, slowly bend your hand down until you feel a stretch (fig 13).



Fig 13: Straighten one arm in front of you, palm down. Using the hand of the other arm, slowly bend your hand down until you feel a stretch

3. Stretch your arm in front of you with your elbow straight, palm facing away from you downward (fig 14) or upward (fig 15). Then with your other hand pull your fingers backward until you feel the stretch over the front of your forearms. Hold the positions for 30 seconds.



Fig 14: Stretch your arm in front of you with your elbow straight, palm facing away from you downward (fig 14) or upward (fig 15). Then with your other hand pull your fingers backward until you feel the stretch over the front of your forearms. Hold the positions for 30 seconds



Fig 15: Spread out and straighten your fingers. Hold for 5-10 seconds. Relax slowly. Clench your fist tightly for 5-10 seconds. Repeat the set of movements 10 times

4. Spread out and straighten your fingers. Hold for 5-10 seconds. Relax slowly. Clench your fist tightly for 5-10 seconds. Repeat the set of movements 10 times (fig 16)



Fig 16: Spread out and straighten your fingers. Hold for 5-10 seconds. Relax slowly. Clench your fist tightly for 5-10 seconds. Repeat the set of movements 10 times

For legs

1. Hold onto a stable object with your right hand. Use the left hand to pull the right lower leg towards your buttock. Hold for 5 seconds (fig 17).

- Repeat the movements with the right hand and the left leg.
- Repeat the set of movements 5 times.



Fig 17: Hold onto a stable object with your right hand. Use the left hand to pull the right lower leg towards your buttock. Hold for 5 seconds

Conclusion

To summarize it may be concluded that women play an important role in marigold cultivation from transplanting to harvesting. While doing so they maintain unnatural body posture which leads to various postural and musculoskeletal disorders mainly in lower back, neck and upper back region. Seeing all these problems faced by female workers engaged in marigold cultivation, there is a need to develop ergonomic equipments so that female workers can work in comfortable body posture to prevent postural and musculoskeletal disorders

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