

**Impact of Prolonged Sitting Posture on Prevalence of Musculo-Skeletal Disorders
among College-going Female Students in Bengaluru City**

K. Ambika Devi ¹ and B. Loganayaki ²

ABSTRACT

Young female students attending lectures in college experience musculoskeletal pains owing to strenuous academic activities, adopting poor seated postures over prolonged duration in a mismatched ergonomic environment. This can lead to incidence of work related Musculo skeletal Disorders (MSDs) that are progressive and impedes regular routines of students. The situation deteriorates during the university examination period as they are forced to sit for extended hours in designated seat without fidgeting. Cross-sectional study was conducted in Higher Educational Institutes of Bengaluru during the period of university semester examinations (USE) to estimate the prevalence of MSDs among college going females. Adapted version of Nordic Musculoskeletal Questionnaire was administered among 150 college going female students (random sampling) aged between 17-22years. Pain experienced in different anatomical parts prior to and after the USE were collected and compared. MSDs were prevalent in 74% of the sample. Significant proportion of 2nd years (44%), from Sciences programs (50%), Undergraduates (49.3%), and Karnataka natives (51.3%) indicated MSD symptoms. Study projected significant differences between BMI and MSDs developed in sample. Musculoskeletal pain was registered in neck (46%), in shoulder (40%), upper forearm (38%), Upper back (46%) and Lower back (48%) by the sample. More than one fifth of sample developed pain in their waist, buttocks, elbows, lower arm, wrist, hands and lower body parts. Manifestations of pain were significantly different in all body parts before and after USE ($p < 0.05$). Study draws attention to prevalence of MSDs owing to prolonged sitting posture amongst female youth. Reducing static work durations, providing ergonomic work spaces are vital for female student's health that has a long way to go.

Key words: Musculoskeletal discomforts, Occupational health, Ergonomics, College going students, Static Sitting Postures.

Introduction

World Health Organisation (WHO) defines Musculoskeletal disorders(MSDs) as disorders of body muscles, joints, tendons, ligaments, peripheral nerves, vascular system and framework that reinforces extremities, spine and neck, not directly resulting from an acute and immediate effect, but installing gradually and chronically. ^{1, 2, 3, 4} They cover slight and passing discomforts or pain, to irreversible and incapacitating injuries. Musculoskeletal complaints include pain and stiffness in various body regions like neck, shoulder, lower back and wrist. ⁴

1. Ph. D., Research Scholar, Department of Resource Management, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu - 641043. **Email:** mccambika@gmail.com, Mobile- 8904030060
2. Assistant Professor (SG), Department of Resource Management, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu- 641043. **Email:** loganayaki_rm@avinuty.ac.in

Corresponding Address: Ph.D Research Scholar, Department of Resource Management, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu- 641043. **Email:** mccambika@gmail.com, Mobile- 8904030060

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The incidence of MSDs among college students spans between 32.9% - 89.3%, globally.^{5,6} Musculoskeletal conditions (MSCs) have been ranked nationwide as the second largest determinant of disability by Global Burden of Disease.^{7,3} Universally, the foremost genesis of disability is lumbar pain (43%).^{8,9}

MSDs are omnipresent occupational injuries, ubiquitous throughout lifespan. Both physical, organizational, cognitive variables can contribute to the possibilities of MSDs among college-going youth. Physical hazards include distorted posture, repetitive movements, strenuous activity, mechanical strain on body tissues, frigid working conditions, ergonomically mismatched furniture and work station.^{10, 11, 5} Poor organizational characteristics in work atmosphere and structure comprises of monotonous work, time pressure, high work load, complex tasks, career concerns, lack of peer support, work schedule, fatigue and psychosocial parameters.^{12, 13} University students undergo academic stress and previous research reports linkage with MSDs. Psychosocial demands exceed the defense mechanism causing stress that increases the muscle tension.⁹

College-going students spend at least one third of a day in universities immersed in various tasks adopting varied postures like standing, sitting, bending. But, the most predominant posture is the sitting posture (80%) for writing, reading, listening to lectures and browsing. Their bouts of sitting last to 40-50 minutes during class lectures. With technology infiltration in educational institutions, there is obsessive use of electronic devices like computer and smart phones, inducing a sedentary lifestyle.¹⁴ Students are transfixed in static sitting postures for long durations using information technology for knowledge gaining, social interaction, for entertainment and online shopping.⁸ Static posture exerts muscular overloading compared to dynamic postures predisposing to MSDs.¹⁵

Student's learning assessment is an integral part of any Indian university curriculum. During the assessment, they partake in written examinations conducted for a time span of 3-hours. In addition to the stress of good performance, students are exposed to long period of static sitting posture without fidgeting—a mandatory requirement to avoid malpractices. The mandatory posture over time is fatiguing as the muscles employed for sustaining the body in a static sitting position need to function overtime. Persistent exertion or elongated static posture/ loading is notable among students getting ready for exams. This prolonged immobility, coupled with an ensuing reduction in blood flow, induces muscle tension and elevates the risk of musculoskeletal impairments.⁴ Human body constantly adapts by adopting different postures like slanting or cross-legged sitting posture. This behaviour imposes slumped sitting posture wherein there is an increased strain in ligaments and disks inducing pain in lower back.¹⁶ Ultimately, these ailments are progressive and inflammatory that can trigger recurring pain and impede regular routines of the students.⁴

Research by Morais et al. (2019),¹¹ have pointed that in women, occurrence of musculoskeletal pain (MSP) associated with MSD is higher.⁶ Ohlendorf et al. (2020), in their studies contend that females had severe and longer symptoms than male counterparts.^{15, 6} There is paucity of data with respect to students attending regular arts and science colleges. Hence, the investigation was undertaken to quantify the prevalence of Musculoskeletal Disorders (MSDs) in college-going female students in cosmopolitan city of Bengaluru.

Objectives of the study

1. Estimate prevalence of MSDs in college-going female students.
2. Detect manifestations of MSDs after prolonged static sitting posture.

Methodology

The study was executed in two Arts and Science Women's Colleges in Central Bengaluru upon approval from the management authorities of these colleges. The investigation was carried out in conjunction with university's semester examinations (USE). Participation of students was voluntary. A thorough explanation of the study's objectives and the content of questionnaire were conveyed to volunteers.

Sample size and sampling method: A sample of 150 college-going female students was selected using random sampling method.

Inclusion criteria: Female students who have completed a minimum 3 months of academic life in the selected colleges were considered. Undergraduates and post graduate college goers in range of 17-22 years were selected. Students with dominant right hand.

Exclusion Criteria: Male candidates, Students aged <17 and >22 years were excluded. Students with previous history of any surgical procedures and physical disabilities were exempted. Pupils with preferred left hand were not included.

Study Instrument: An amended version of Nordic Musculoskeletal Questionnaire (NMQ) was employed. Standardized NMQ is a simple instrument with global validation. It features questions that are tailored to identify musculoskeletal pain in the neck, shoulders, back, and extremities¹⁰. A pilot study was conducted on 30 samples (20% of total sample) to confirm the reliability and validity of the questionnaire.

Demographic Study: The modified NMQ used for the study comprised of 3 sections. Questions on categorical variables like age in years, nativity, course of study, year of study, and dietary habits were put forth in first section.

Anthropometric Indices: The next part of the questionnaire included anthropometrics. Anthropometric measurements of height and weight to calculate the BMI was taken following SOPs. Heights (in cms) and weights (in Kg) of subjects were recorded with minimal clothing, and barefooted using SECA 213 stadiometer and digital weighing scale. BMI (kg/m^2) was calculated and subjects were classified as per WHO Asia Pacific classification. The classifications are <18.5 kg/m^2 (underweight), 18.5-22.9 kg/m^2 (Normal), $\geq 23\text{kg/m}^2$ (Overweight) and $\geq 30\text{kg/m}^2$ (Obese).¹⁷

Assessment of Musculoskeletal Symptoms: The final section of the tool enlisted structured questions with Likert Scale to detect MSD symptoms in 16 specific body parts. These parts were demarcated in body map image that was illustrated in the Questionnaire as a guideline for students. The research instrument was administered to the candidates after they had completed the 3-hour university semester examinations (USE). The students were asked to indicate the pain felt in different body parts before and after the USE. A 5-point Likert scale was used to rate each body part pain ranging from 0-4 (0- No pain, 1- Mild pain, 2-Moderate pain, 3-Higher pain and 4-Extreme pain). Reliability test was done and Cronbach alpha calculated was 0.86.

Data Collection: Questionnaire was administered after the 3 hour of USE in the forenoon sessions, for a period of 6 weeks in the year 2024 (March - May months). USEs were conducted in classrooms that had fixed wooden seating arrangements and students were transfixed in their seats as per the examination rules. Informed consent from the subjects were taken and then asked to fill the questionnaire. The information given by students were retrieved and counter checked for discrepancies. Errors noticed were further asked to be rectified by the volunteers.

Statistical analysis: Data was compiled and analysed using MS Excel, Microsoft Office Professional Plus, 2016. Confidence level of 95 percent was taken into account for statistical computations. Statistical significance was established at $p < 0.05$. Chi Square test was employed to confirm associations between categorical variables. Z-test was applied to compare if there was significant difference between the levels of musculoskeletal pains before and after the 3- hour examination in different body parts.

Results and Discussion

The consolidated data is analysed and discussed further. It was observed that during the university examination students were involved in reading, writing, arithmetic and sketching. During the entire duration of 3-hours university semester examination (USE), subjects were seated on wooden benches.

Table-1 gives demographics and work related attributes of the students attending colleges in a cosmopolitan city of Bengaluru. The average age of the subjects is 19.5 years. The data subjected for statistical test using Chi Square indicates the difference in the courses undertaken by sample, year of student pursuing the course and programs between the age groups was significant at 5% level. The findings are in line with that of Behera et al. (2020),⁷ wherein 58% of students had developed musculoskeletal pain in year of joining the course, and 87% experienced MSP in later years of the course.

This may be attributed to increased workload in later years of college education. It may be noticed that there is a reduction in MSDs among the 3rd years and Post Graduates, as they are involved in variety of tasks that they explore in college life.

Table -1: Demographic and Work Related Attributes of the Sample

Variables		Subjects experiencing MSDs		Age Group (in Years)								χ ² Test
				17-18yrs (N=30)		19-20yrs (N=79)		21-22yrs (N=41)		TOTAL		
				No.	%	No.	%	No.	%	No.	%	
Course (N=111)	Sciences	75	50.0	3	2	31	20.7	41	27.3	75	50.0	79.9
	Humanities	10	6.7	21	14	19	12.7	0	0	40	26.7	
	Commerce	26	17.3	6	4	29	19.3	0	0	35	23.3	
Year of Study	1 st Year	17	11.3	25	16.7	1	0.7	16	10.6	42	28.0	89.8
	2 nd Year	66	44.0	5	3.3	45	30.0	24	16.0	74	49.3	
	3 rd Year	28	18.7	0	0	33	22.0	1	0.7	34	22.7	
Program	Under Graduate	74	49.3	30	20.0	79	52.7	1	0.7	110	73.3	144.0 2
	Post Graduate	37	24.7	0	0	0	0	40	26.6	40	26.7	
Ethnicity	Karnataka	77	51.3	21	14	51	34.0	26	17.3	98	65.3	0.28*
	Non Karnataka	34	22.7	9	6.0	28	18.7	15	10.0	52	34.7	

* Significant at 95%

The computed $\chi^2 = 0.27$ showed no significant difference in the age and ethnicity of the students. Students travel across different regions in pursuit of higher education. They have to acclimatize to new location, climatic variations, cultural differences, food habits etc. Mismatch of furniture owing to different body sizes can cause unhealthy postural shifts leading to MSDs.¹⁸

To summarise, the demographic data indicates that most samples who developed MSDs were students enrolled in Science courses (50%), subjects who are in 2nd year of their collegiate education (44%), samples from under-graduate programs (49.3%) and those who were Karnataka natives (51.3%). The higher percentage of MSDs in these categories can be attributed to prolonged work hours with increased work load of course, academic stress, exposure to mismatched furniture and workstations for longer time frames. Nationality, academic level, fatigue and exertion without breaks are factors that are significantly related to development of MSDs.¹⁹

Table -2: Anthropometric Indices and Dietary habits

Anthropometric Indices	Vegetarian (34.7%)		Non Vegetarian (65.3%)		Z Score
	Mean (N=52)	SD	Mean (N=98)	SD	
Height	160.1	4.1	158.9	5	1.49
Weight	49.8	3.2	54.1	4.9	0.1
BMI	19.4	0.7	21.4	1.47	11.24*

* Significant at 95%

Table-2 compares the mean and standard deviation of anthropometric variables with the dietary habits of the sample. The anthropometric variables of height and weight did not show significant difference between vegetarians and the non vegetarians. (Z score=1.49 for height and 0.1* for weight) The computed Z value indicated that the difference in BMI between the vegetarians and non vegetarians were significant (Z score= 11.24*). A longitudinal study conducted in Australian young women has indicated BMI in vegetarians were less compared to non vegetarians. Similar results were

found by investigations done in younger adult cohort in Nepal, where vegetarians had a lower BMI in comparison to non vegetarians.²⁰

Table -3: BMI Classification and MSDs among students

BMI Classification	Students who experienced MSDs		Students did not experience MSDs		Total		χ^2 Test
	No.	%	No.	%	No.	%	
Under weight (<18.5 kg/m ²)	4	2.667	12	8	16	10.67	27.9
Normal (18.5-22.9 kg/m ²)	82	54.67	28	18.67	110	73.33	
Over weight (≥ 23 kg/m ²)	24	16	0	0	24	16	

* Significant at 95%

The BMI classification and predisposition of MSDs among the sample have been reported in Table-3. The study points out that the BMI categorization and MSDs developed among the subjects was significant ($\chi^2=27.9$). Noticeable fact is that that all the students who were over-weight (16%) had manifested MSDs. Profound academic stress can result in weight surge and thus escalate BMI.⁵ BMI is an independent triggering factor for MSDs and suggests that there is a positive association existing between variables.⁴

MSDs Impacted in Body Parts owing to Prolonged Sitting: The data on musculoskeletal pain manifested in various anatomical parts were segregated into Upper body parts, Mid-body parts and Lower body parts. Comparison of musculoskeletal pain developed due to prolonged sitting in static posture after 3-hour of University Semester examination (USE) is projected in Figure-1.

Fig.- 1: Comparison of musculoskeletal discomforts in upper body parts owing to prolonged sitting

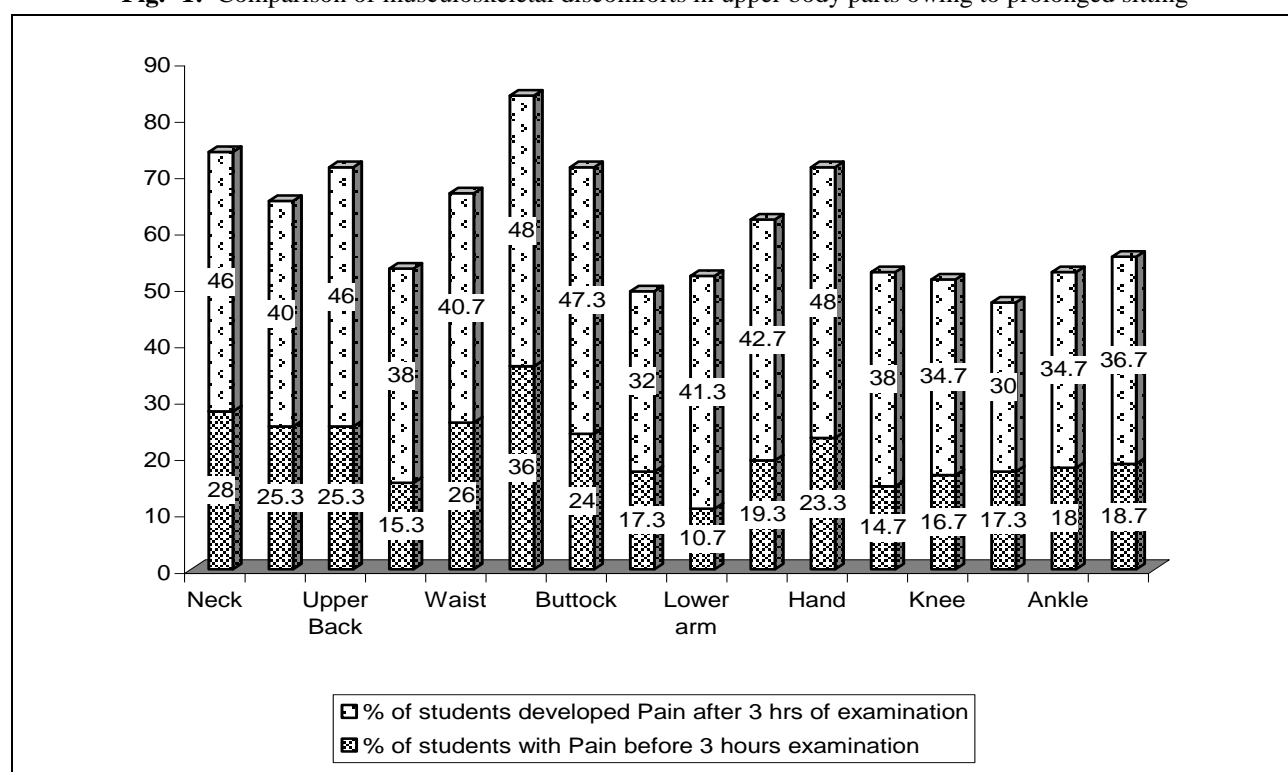


Table 4: Comparison of Musculoskeletal Pain in Upper body parts before and after 3 hour USE

Upper Body Parts	Students with pain before the 3-hour USE		Students manifested pain after 3-hour USE		'Z' test
	No.	%	No.	%	
Pain in Neck	42	28	69	46	7.6*
Pain in Shoulder	38	25.3	60	40	7.36*
Pain in Upper back	38	25.3	69	46	7.7*
Pain in Upper Fore arm	23	15.3	57	38	6.2*

*Significant at 95%

Table-4 presents the findings on the comparison of pain felt in upper body parts of the students after 3 hour examination in higher educational institutes. There were manifestations of pain in upper body parts and Z-test showed significant difference ($p < 0.05$) before versus after prolonged sitting in the university examinations.

The findings reveal that, of the students who manifested pain after activity, 61 – 63 percent reported mild pain in neck and upper back. Moderate pain was experienced by 35 percent students in the neck and 29 percent in upper back. Severe pains were observed in 15 – 18 percent in neck and upper back. Mild pain was reported in Upper forearm. Extremely severe pain in the neck, Shoulder and Upper back were observed in 8-13 percent students. Uninterrupted sitting posture has twice as much strain on intervertebral discs as that of standing and in turn strains the neck causing pain in this anatomical part. The repetitiveness and inert nature of the task done on mismatched furniture causes pain in the shoulder and upper forearm.²¹

Table 5: Comparison of Musculoskeletal Pain in Mid body parts before and after 3-hour University Examination

Mid Body Part	Students with Pain before the 3-hour USE		Students Manifested Pain after 3-Hr USE		Z Score
	No.	%	No.	%	
Waist	39	26	61	40.7	4.3*
Lower back	54	36	72	48	4.4*
Buttock	36	24	71	47.3	8.2*
Elbow	26	17.3	48	32	6.3*
Lower arm	16	10.7	62	41.3	7.3*
Wrist	29	19.3	64	42.7	7.8*
Hand	35	23.3	72	48	7.8*

*Significant at 95%

It was observed that the prevalence of mild pain was reported in mid body parts like lower back, buttocks, waist, wrist and hand. Table- 5 shows that nearly half (48%) of the students experienced pain in lower back (Figure-2.). The rate of pain before the activity was ranging between 0.1-0.7 which increased to 1.8 after the 3 hour activity. The statistical analysis using Z-test showed significant difference for all the mid body parts. Similar results observed by Morais et al.,¹¹ reported 54.5% of undergraduates had pain in lumbar region of the spine.

The prolonged sitting posture triggers musculoskeletal complaints due to problems posed by alterations in body parts. These alterations include: torso contraction, abdominal enlargement, tilting of midriff, widening of pelvis, extended upper dorsal slouching, shift in angular orientation of elbow, frontal limb stretch due to flexion of knees.²² Also, University examinations are rigorous in nature and students have to complete the task within stipulated time limits. They perform the tasks faster triggering inappropriate postures resulting in muscular tension.

Fig.- 2: Severity of musculoskeletal pain in mid body parts after the 3 hours USE

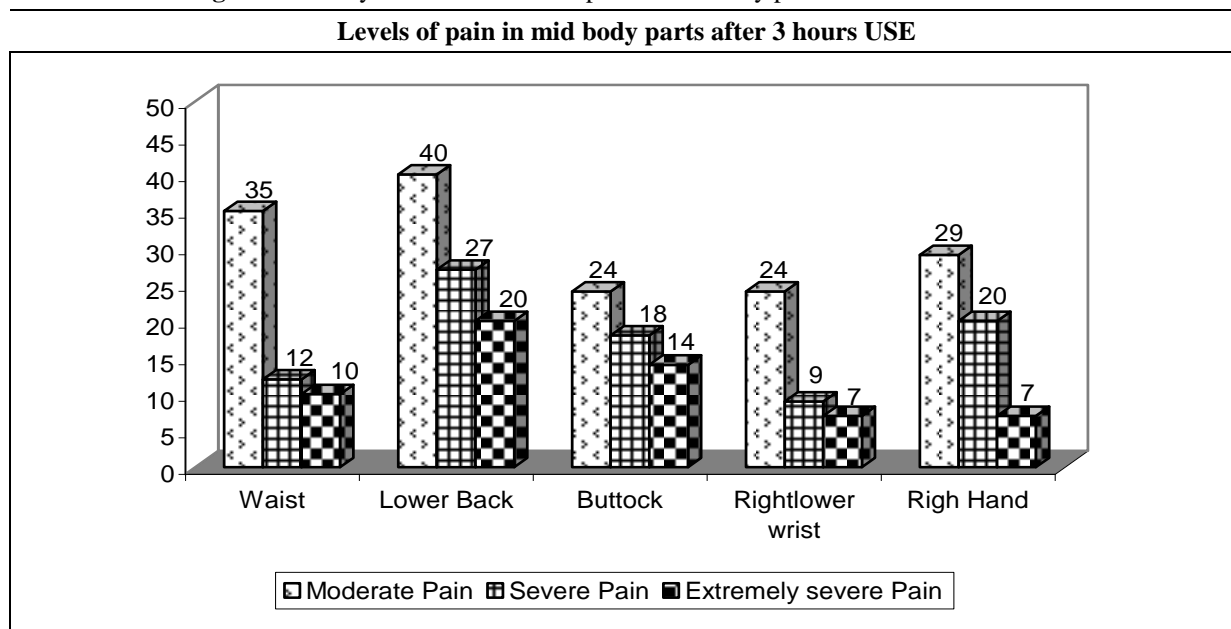


Table-6: Musculoskeletal Pain in Lower body parts before and after 3 hour USE

Lower Body parts	Mean rate of pain		Students who manifested pain after 3 hour USE		Z score
	Before USE	After USE	No.	%	
Thigh	0.2	1	57	38	6.4*
Knee	0.2	1	52	34.6	6.3*
Calf	0.2	0.8	45	30	5.7*
Ankle	0.2	1	52	34.7	6.07*
Foot	0.2	1	55	36.7	7.06*

*Significant at 95%

The diagnosis of MSDs revealed that there was a prevalence of the nosological entity in all the Lower body parts (Table 6). Students mostly sit on hard wooden benches or metal chairs. The high surface pressure results in compression of blood vessels in tissue and cause discomforts.²³ The levels of pains expressed ranged between 0.8-1 of mild pain after 3 hour of USE. They shake and move their legs involuntarily while working, reducing the severity of pains in lower body parts. Significant difference in the Z-score statistic for all the lower body parts was evident. Static posture and ergonomic mismatches are the contributors to the pains in the lower body parts.

Conclusion

The study on health of the college going students in Bengaluru city demonstrated prevalence of MSDs among majority of the participants. Difference in the specific body part pain was significant due to prolonged static sitting posture during university examination period. Reducing the static work period for USE by atleast 30 minutes must be considered by the educational authorities to lower the severity of pains. Examinations can be conducted in two sessions with a short break in between to reduce the inertness of the task. University examinations may be scheduled with alternating shorter and longer time slots for minor and major study modules. The prognosis of MSDs in early stages is considered to be good. Provision of ergonomic work station for students is the key in reducing body discomforts at an early stage. Musculo skeletal disorders may evolve over passage of time and hence it is important for prevention at the very onset. Musculoskeletal health of female youth has a long way to go and hence specific stance has to be taken to prevent MSDs.

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