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RESEARCH ARTICLE

EFFECT OF INTERMITTENT SITTING ON RANGE OF MOTION OF PROLONGED STANDING LOW BACK PAIN

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ABSTRACT

Background: most persons will experience acute low back pain during their lifetime. The first episode usually occurs between 20 and 40 years of age. **Objectives:** to investigate the effect of intermittent sitting on the lumbar range of motion of prolonged standing low back pain developers. **Methods:** 60 subjects participated in this study. They were randomly distributed into two equal groups; group **I** involved 30 subjects were stood for 15 min. and sit for 5 min. Group **II** involved 30 subjects where stand for 30min and sit 10 min throughout the workday for 8 hours. The study is a one-shot study. BROM (back range of motion device) was used to measure (flexion and extension of lumber ROM). **Results:** There was no substantial change in the stand-to-sit ratio of 3:1 which did not increase the LBP lumbar range of motion produced in response to prolonged standing. **Conclusions:** Extended status of standing in the workplace could result in LBP for workers and possible forms of minimizing sedentary time should be evaluated.

INTRODUCTION

An overwhelming number of individuals will suffer from low back pain at least once in their lifetime. The lifetime prevalence of low back pain is up to 84% (Airaksinen, 2006) (1) and the Pan American Health Organization cited low back pain as one of three occupational problems that should be under surveillance (Choi, 2001) (2).The most interesting phenomenon related to prolonged standing and low back pain is that it affects individuals who, to their own knowledge, have never suffered a back injury or pain that required a visit to a clinician or lost time at work/school. Out of a battery of clinical physical and psychological tests, pain development in standing was only predicted by an Active Hip Abduction Test (Nelson-Wong, 2009) (3). The temporary nature of this production of pain may provide insight into potential mechanisms of pain that predispose some individuals to low back pain while standing. Individuals are graded as pain creators between the 15-45-minute mark of a 2 - hour long standing court. (Marshall, 2011; Nelson-Wong , 2010a) (4,5) and the discomfort dissipates rapidly until the standing has stopped. Transient pain production is due to the mechanical stimulation of the free nerve endings in the lumbar tissues. (Cavanaugh, 1995) (6), while the persistence of pain after the mechanical stimulus is removed is due to inflammation (Cavanaugh, 1995) (6) or chemical insult (Winkelstein, 2004) (7) of the surrounding tissues causing nerves to fire at lower thresholds than they would typically respond.

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Lumbar spine passive tissue strain and contact of the posterior elements of the adjacent vertebrae that occur when the person is standing outside the limits of their lumbar spine passive neutral zone. (8), This can contribute to the firing of nociceptive sensory units in the lumbar tissues, providing a possible explanation for the development of low back pain in certain individuals throughout prolonged standing. When there is no apparent back injury, people may dismiss their low back pain or exhaustion as simply part of their job and not as significant as it goes away once the workday is over. (9). But what are the consequences of 8 hours a day, 6 days a week, of this production of pain for potential risks of chronic low back pain? Using a longitudinal study to track chronic standing pain and non-pain developers over 3 years., Nelson-Wong and Callaghan (2014) found pain developers three times more likely to experience chronic low back pain in the first 24 months, seek medical attention within three years of their involvement, and record several episodes of chronic low back pain. Although the low back pain during standing is temporary in nature, it tends to be a good indicator of potential chronic and persistent low back pain (10). Cumulative mechanical attacks and tissue strains in the low back region can decrease their tolerance over time, resulting in injury or structural changes leading to chronic pain. As a consequence, it is important to note that most people who experience acute pain during their standing periods have never experienced a low back injury, they could be characterized as a pre-clinical group for the development of chronic low back pain in the future. Suggesting that sitting would have a positive effect on alleviating the production of LBP from standing for two reasons. First, lumbar extension (lordotic curve), as seen in the upright position, has been associated with isolated joint positions that raise facet loading, facet contact, and increase the chance of soft-tissue impingement. (Adams and Hutton 1980; Dunlop, Adams, and Hutton 1984; Yang and King 1984), stretching of the facet joint capsule (11) and narrowing of the intervertebral foramen (12,13). Consequently, shifting the spine into flexion, as seen in the sitting, may be a constructive move. Another possible advantage of sitting is the ability to use a broader range of total lumbar spine motion. (14), Improved fan base as opposed to standing. In view of the transition to increased standing in the workplace, this study analyzed how the seated break affects the subjective LBP records and the posture and activity habits of those who are susceptible to LBP development during sustained standing. From all the above, the primary aim of this study was to put a good program in place for our Egyptian workers in companies to save them from being a drain on society. It is also important to investigate the impact of intermittent sitting on subjective LBP development profiles over a prolonged period of standing. The second objective was to characterize posture and movement throughout both standing and sitting exposures. Unfortunately, there is a wide gap in literature concerning the effect of intermittent sitting during prolonged standing on mechanical low back pain developers.

So the current study was attempted to investigate the effect of standing for 30 min. only and sit for 10 min. and for 15 min and sit for 5 min. Throughout the day-to day working time was the solution to the low back pain problem that is caused by the prolonged period of standing and the consequences of productivity

METHODS

Participants: This study was conducted on 60 subjects, 30 subjects that stand for 30min and sit 10 min throughout the workday for 8 hours and 30 subjects that stand for 15 min. and sit for 5 min. They work at least for one year to investigate the effect of intermittent sitting on low back pain developing. Their age from 20 to 35 years old and was randomly assigned to two groups.

Group (I): 30 workers from ABB ARAB factory only males used (they will stand 15 min. and take rest of sitting bouts for 5 min. throughout the workday) by ratio 3:1.

Group (II): 30 workers (males only) from ABB ARAB factory will take bouts of sitting for 10 min. every 30 min. of standing.by ratio 3:1

**I was modified the measurement plan of Kaitlin M. Gallagher to be as the following:

- BROM [back range of motion device] was used to measure (flex. & ext. of lumber spine ROM) for each subject from both groups 4 times:

**Group I: was measured each subject as the following:

1- In the first hour of the workday, at the end of 15 min of standing & at the end of 5 min of sitting.

2- In the last hour of the workday, at the end of 15 min of standing & at the end of 5 min of sitting.

**Group II: was measured each subject as the following:

1- In the first hour of the workday, at the end of 30 min of standing & at the end of 10 min of sitting.

2- In the last hour of the workday, at the end of 30 min of standing & at the end of 10 min of sitting.

Inclusion Criteria

The subjects were screened to ensure that they met the criteria documented in the study which include the following:

- Age from 20 to 35 years old (15).
- Working period from 1 to 5 years.
- All subjects are pain developers
- Normal upper extremity structure (based on general observation of the upper limb).
- Full ROM in all upper limb joints (assessed by asking the patient to complete the expected range of movement of the upper limb as part of screening).
- Adequate strength in upper limb.
- Unimpaired sensation.
- Intact coordination.
- males only

Exclusion Criteria

- not having prior low back injuries that required a visit to a medical doctor or to miss more than three days of work
- the inability to stand for two hours.
- previous lumbar/hip surgery or work in an occupation that required
- prolonged static standing within the last 12 months
- Individuals with any or pervious lower extremity injury
- Severe kyphosis, scoliosis or spinal stenosis
- History of spinal surgery in previous 3 months
- Scheduled for surgery
- History of more than one surgical procedure on the spine
- Cancer
- Rheumatoid Arthritis
- Ankylosing Spondylitis, spondylolisthesis
- Neurological disease other than nerve root involvement at the spinal level.
- Inability to stand and walk without the use of walking aid
- Patients who had LBP for 12 weeks or more that were admitted to the pain clinic and enrolled onto a pain management program for CLBP.

Clinical Assessment

Basic clinical physiotherapy assessment, identical to what was done in a clinical setting. Areas tested included active lumbar and hip range of motion, lumbar segmental mobility evaluation, special intersegmental and general trunk stability measures, and tests for muscle endurance. The lateral bridge ('side support') test was used to assess endurance of the lateral flexors**.** Active Hip Abduction (AHAbd) test: examiner Score Cues for examiner Test Score = 0 (no loss of pelvis frontal plane) Participant smoothly and easily performs the movement. Lower extremities, pelvis, trunk and shoulders remain aligned in the frontal plane.

Test Score = 1(minimal loss of pelvis frontal plane) Participant may demonstrate a slight 'wobble' at initiation of the movement, but quickly regains control. Movement may be performed with noticeable effort or with a slight 'ratcheting' of the moving limb. Test Score = 2 (moderate loss of pelvis frontal plane) Participant has a noticeable 'wobble', tipping of the pelvis, rotation of the shoulders or trunk, hip flexion and/or internal rotation of the abducting limb Movement may be performed overly rapidly, and participant may or may not be able to regain control of the movement once it has been lost. Test Score = 3 (severe loss of pelvis frontal plane) Participant demonstrates the same patterns as in Test Score #2 with greater severity. Participant is unable to regain control of the movement and may have to use their hand or arm on the table in order to maintain balance.

Instrumentation

BROM (back range of motion device) was used to assess range of motion of lumbar and thoracic spine. (16). -BROM was placed on the following anatomical landmarks –T12, L2 and S2 – to allow for calculation of lumbar angles throughout the entire protocol.

Experimental protocol

- Participants completed informed consent. After participants were outfitted with BROM, they entered the experimental protocol. Trials with the participant in upright standing and maximum lumbar extension were recorded for reference postures of the lumbar spine angles.
- Lumbar spine angles (expressed in degrees) were calculated from BROM
- Lumbar spine angles were expressed with respect to maximum lumbar extension.

BROM: The BROM Basic also features two Universal Inclinometers which can be used to measure Flexion and Extension of the spine and range of motion of the extremities. The Universal Inclinometer has two interchangeable bases. The rubber footed base is ideal for measurements of a curved surface such as the spine. Examiner holds the rib cage for positive tracking of rotation and lateral flexion movements. True flexion/extension measurements are made without first making total and pelvic flexion/ extension measurements. The flexion/extension unit is held securely on the patient with Velcro straps eliminating any movement relative to the patient during examination. The flexion/extension unit, a modified inclinometer, eliminates the need for relocation during measurements. The BROM II eliminates the positioning, zeroing and tracking errors associated with stand-alone inclinometers (16).

IMPORTANT: Accurate measurements of the lumbar spine require that all contacts are on the skin (to prevent slippage of the instruments).

FLEXION/EXTENSION MEASUREMENTS: Use the two Universal Inclinometers to make flexion/extension measurements. Measurements with the Universal Inclinometer need to be with the patient in an upright position.

- Palpate and mark S1 and T12. Mark on bare skin when possible. This avoids the marks moving with the patient's clothing.
- Center the two inclinometers over the palpation marks and zero with your finger.
- Have the patient flex forward as far as possible (see figure 2). Note the reading on each inclinometer.
- The BROM II measures the true spine segment flexion between two points. Dual inclinometers measure the spine tangent flexion at the upper measuring point. The BROM has set the standard for measuring lumbar and thoracic flexion/extension, lateral flexion and rotation range of motion measurements
- The Flexion/Extension Unit is easily positioned on the sacrum, eliminating errors due to hip movements during measurements. The unit is secured to the body by hook and loop straps, freeing an examiner's hand for guiding the patient during measurements.
- Repeat flexion protocol for extension having the patient extend back for full
- extension instead of flexing forward. Record the value. The thoracic spine can be measured using the same process but different reference points.

Data Collection

Data will be collected through:

- Personal sheet: Age in years, Sex (male), Height in cm, and Weight in Kg.
- Lumbar flexion & extension: measured by BROM.

Statistical Analysis

Descriptive analysis

In this study it will be used to calculate:

1.Mean, standard deviation SD for the parametric
a. Age b. Height c. Weight
2. Median and Quartile range for the parametric BROM

Inferential statistics

It will be used to study statistical difference within and between groups. For the parametric data (age, height, weight) Mixed design multivariate analysis of Variance (MANOVA) will be conducted within groups.

RESULTS

The purpose of study was to investigate the effect of intermittent sitting on range of motion of prolonged standing low back pain developers. Sixty patients aged from 20 to 35 years were participated in the study. Patients were randomly assigned into two equal groups. Data obtained from the two groups regarding lumbar, flexion, lumbar extension were calculated in the first and last hours of the working day. In group I, measurements were taken after standing for 15 minutes and after sitting for 5 minutes, while in Group II measurements were taken after standing for 30 minutes and after sitting for 10 minutes. The measured variables were statistically analyzed and compared using SPSS for windows version 25 (SPSS, Inc., Chicago, IL) with Alpha level set at 0.05.

Figure 1: BROM

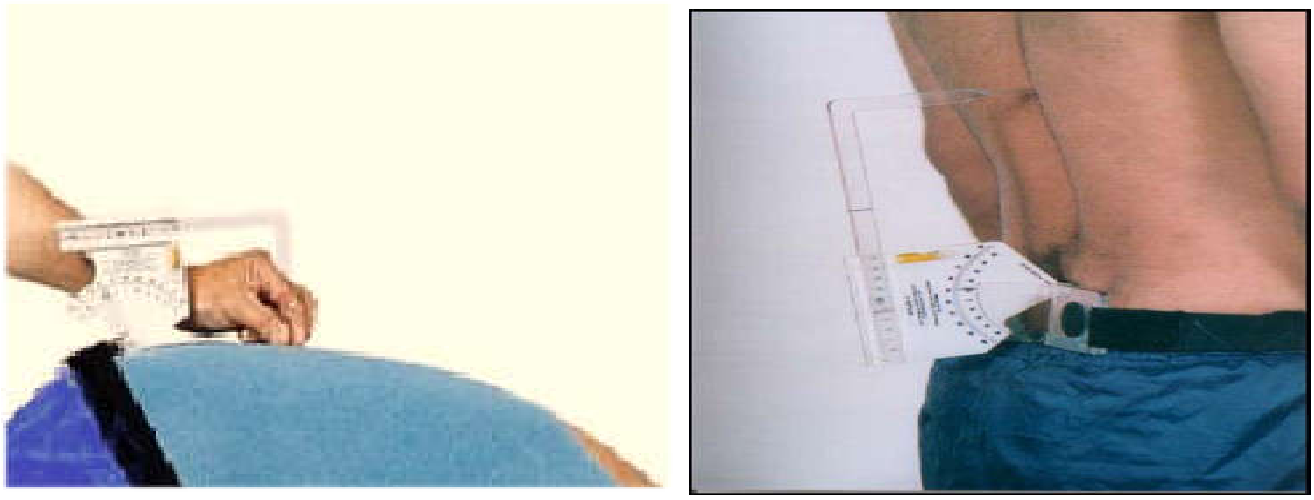

Figure 2. Measurement of lumbar flexion and extension with BROM

Table 1. Baseline Demographic Characteristics of Subjects (N=60) *

Characteristics	Group I (n=30)	Group II (n=30)	F-Value	P Value
Age(years)	29.63±4.33	29.6±4.95	0.001	0.98
Weight (Kg)	74.2±13.36	78.67±19.1	1.11	0.3
Height (m)	170.73±8.64	166.63±17.58	0.813	0.37

Table 2. Clinical Characteristics of Subjects in both Groups for 1^{st} Hour (N=60) *

Characteristics	Group I (n=30)	Group II (n=30)	Mean Difference	95% CI	P Value
L. Flex 1(deg.)	14.27±1.38	15.0±1.83	-0.72	(-1.56, 0.11)	0.09
L. Flex 2(deg.)	15.1±2.16	15.0±2.26	0.1	(-1.04, 1.25)	0.86
L. Ext 1(deg.)	2.61±0.74	2.88±0.81	0.27	(-0.67, 0.14)	0.19
L. Ext 2(deg.)	3.15±0.96	2.75±0.62	0.4	(-0.2, 0.81)	0.06

Table 3. Clinical Characteristics of Subjects in both Groups for the last Hour (N=60) *

Characteristics	Group I (n=30)	Group II (n=30)	Mean Difference	95% CI	P Value
L. Flex 1(deg.)	15.76±1.82	16.52±1.9	-0.76	(-1.72, 0.20)	0.12
L. Flex 2(deg.)	16.73±2.1	16.1±2.22	0.64	(-0.47, 1.74)	0.25
L. Ext 1(deg.)	3.28±0.64	3.48±0.92	0.2	(-0.61, 0.21)	0.33
L. Ext 2(deg.)	4.1±1.1	3.15±0.55	0.91	(0.46, 1.35)	0.0001*

Data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. Shapiro-Wilk test for normality showed that the measured variables were normally distributed (p >0.5).

The baseline demographic characteristics of participants: The baseline demographic characteristics of subjects are shown in table 1. The mean and standard deviation (M±SD) of age were 29.63±4.33 and 29.6±4.95 years for Group I and II, respectively with $F_{(1,58)}$= 0.001 and P=0.98. The (M±SD) of the body weight were 74.2±13.36 and 78.67±19.1 kg for Group I and II, respectively with $F_{(1,58)}$= 1.11 and P=0.3. The M±SD of height were 170.73±8.64 and 166.63±17.58 centimeter for Group I and II, respectively with $F_{(1,58)}$= 0.813and P=0.37. There were no statistically significant differences between the two groups in age, weight or height, (P>0.05).

Results of Mixed design multivariate analysis of Variance (MANOVA): Mixed design multivariate analysis was conducted to assess the difference between participants in the two groups in the amount of change in their scores on the outcome measures. Statistically Significant multivariate effects were found for the main effects of groups, Wilk's A = 0.68, $F_{(10,49)}$ = 2.31, P< 0.026, η2 = 0.32, for time, Wilk's A = 0.63, $F_{(10,49)}$ = 2.86, p < 0.007, η2 = 0.34, as well as for the interaction between groups and time, Wilk's A= 0. 66, F $_{(10,49)}$ = 2.57, p < 0.014, η2 = 0.34.

Results of Mixed design analysis of Variance (ANOVA)between groups in the 1st hour: Follow-up univariate ANOVAs reveal that no statistically significant differences for lumbar flexion after standing, $F_{(1,58)}$ = 3, p= 0.89, η2 = 0.049, for lumbar flexion after sitting, $F_{(1,58)}$ = 0.031 , p= 0.86, η2 = 0.001, for lumbar extension after standing, $F_{(1,58)}$ = 1.78, p= 0.19, η2 = 0.03, for lumbar extension after sitting, $F_{(1,58)}$ = 3.57 , p= 0.06, η2 = 0.058.

Results of Mixed design analysis of Variance (ANOVA) between groups in the last hour: Follow-up univariate ANOVAs reveal that no statistically significant differences for lumbar flexion after standing, $F_{(1,58)}$ = 2,5, p= 0.12, η2 = 0.041, for lumbar flexion after sitting, $F_{(1,58)}$ = 1.33 , p= 0.25, η2 = 0.02, for lumbar extension after standing, $F_{(1,58)}$ = 0.96, p= 0.33, η2 = 0.02, statistically significant difference for lumbar extension after sitting, $F_{(1,58)}$ = 16.63 , p< 0.001, η2 = 0.22.

Clinical Characteristics of Subjects of both groups in the first hour: The clinical characteristics of subjects of both groups in the first hour are shown in table 2. The mean and standard deviation (M±SD) for lumbar flexion outcome after standing were 14.27±1.38, 15.0±1.83 and for lumbar flexion outcome after sitting were15.1±2.16, 15.0±2.26 for group I and group II, respectively. The mean and standard deviation (M±SD) for lumbar extension outcome after standing were 2.61±0.74, 2.88±0.81 and for lumbar extension outcome after sitting were 3.15±0.96, 2.75±0.62 for group I and group II, respectively.

Clinical Characteristics of Subjects of both groups in the last hour: The clinical characteristics of subjects of both groups in the first hour are shown in table 3. The mean and standard deviation (M±SD) for lumbar flexion outcome after standing were 15.76±1.82, 16.52±1.9 and for lumbar flexion outcome after sitting were 16.73±2.1, 16.1±2.22for group I and group II, respectively. The mean and standard deviation (M±SD) for lumbar extension outcome after standing were 3.28±0.64, 3.48±0.92 and for lumbar extension outcome after sitting were 4.1±1.1, 3.15±0.55 for group I and group II, respectively.

DISCUSSION

An intermittent sitting between two bouts of prolonged standing was not enough to improve range of motion of lumbar spine of LBP developers. The characteristics of low back pain developers (LBPD) during standing were statistically significant difference for lumbar extension after sitting as p value (p< 0.001) greater movement of their lumbar spine extension mostly in group I. Even though an increase of 1.3 deg and 1.7 deg was seen with sitting (Table 3) the minimum clinical difference for improvement of LBP has been shown to be greater than 19 mm, thus a change of 20 mm would be necessary for detecting an immediate and significant improvement of pain (17). As a result, a work–rest ratio of 3:1 (stand to sit) was not enough to completely rid the LBP caused by prolonged standing. Other studies have assessed the importance of work–rest ratios as well. In static flexion, a work–rest ratio of 1:1 (i.e. 30 minutes flexion, 30 minutes rest) is optimal for preventing a prolonged neuromuscular disorder, but longer durations between 30 minutes and 60 minutes of work and rest may not be able to prevent a disorder (18). Between poultry inspectors engaged in standing work, a high work-to-rest ratio (60 minutes of work and 15 minutes of rest) resulted in increased low back discomfort. (19). Gerke et al. 2011who tested the loaded sitting position and the recovery side lying position, where the height obtained back as calculated with stadiometry was higher after the load was removed for the first time than in successive repetitions. (20). The difference between recovery from weighted sitting on the side lying positions indicates that creeping due to repeated loading can require additional recovery time for people to completely recover to the condition they were in prior to the mission. (20). We hypothesized that LBPD would stand in a more extended posture since mild flexion is associated with isolated joint positions that have reduced stress on the facet joints, reduced compressive stress on the posterior annulus and improved transport of disc metabolites (21). Recommended standing postures, such as one foot elevated (22) or on a sloped standing surface (23,24), also have a flattened lordosis that adds to the reasoning for our hypothesis that increased extension may be the cause of LBP in standing. The trick may not be a person's pose, but how often they 're shifting around in this pose while standing that counts. While their median postures are similar, people who have little movement in their lumbar spine may bear the negative effects of a more lordotic posture. Altering the thoracic position also influences the low back position and, in this case, can influence how much movement takes place in the lower back while standing. With more thoracic spine extension. In addition to the shift in posture, sitting may also be advantageous due to the increase in mobility allowed by this position as a result of an expanded base of support. Individuals use a larger amount of their overall lumbar spine flexion range of motion when sitting than when standing. (14). Also, in people who report standing for their work, the prevalence of reporting LBP is higher when a person has reported standing in a restricted position for their work versus standing with freedom to sit. (25). During a restricted standing job, people vary their position by around 10% of their total lumbar spine flexion range of motion (14).

In this study, there was not a large difference in lumbar spine flexion range of motion between sitting and standing in LBPD; however, the gross change in posture from standing to sitting may have been enough movement to alter LBP in these participants. Based on this research and other research that focuses on the negative health effects of sedentary behavior, alternative recommendations are proposed for people who cannot tolerate prolonged standing. In agreement with other researchers (26), We want to encourage a reduction in long-term postures and an improvement in workers' influence over their own posture. It is recommended that certain people consider movement every 30 minutes, which is recommended as the average amount of time in a seated position. (27) And incorporating a light-intensity exercise (such as walking combined with short-term standing) to split this sedentary period.

This is in line with research that shows that how a person breaks down their sedentary time is critical to reduce the risk associated with metabolic risk variables, and this is independent of the total sedentary period (28). Employers must always take into account the encouragement of standing and the highly negative discussion of sitting, as this may make a worker feel like they need to work in a certain role, even though it causes them increased discomfort and pain. Those who work in long term positions dismiss their discomfort as a major issue as it goes away after a while, they are unsure whether it is actually related to their working posture and feel that they may be seen to be lazy or not to value their health if they choose to sit down. (9). Emphasis is also advised on encouraging local improvements in the lumbar spine versus whole body movement, such as moving from one leg to another. This may involve alternating between sitting and standing as much as possible, or even replicating movements based on advocated standing aids, such as raising one leg to the floor or standing on a sloping surface.

Conclusion

A standing to intermittent sitting ratio of 3:1 did not allow for complete and lasting recovery of LBP developed in response to prolonged standing. LBPD utilized a limited range of their lumbar spine angle and demonstrated increased lumbar spine extension. This may result in a static lordotic posture that induces a prolonged aggravation of the tissue that does not improve after 5 minutes or 10 minutes of sitting and continues to worsen when a person stands up again.

Implementation

Long exposures to standing workstations could cause LBP in employees. Future studies will examine the ratio of LBP developers to long standing, which still permits movement in the workplace, and advice that encourages the reduction of extended sedentary activities and vulnerability to musculoskeletal injuries and pain.

Recommendation

- This research must be repeated on a larger sample of workers.
- This research must be repeated using different periods of time for stand and sit.

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