

Investigating the Relationship Between Serum Vitamin D Deficiency and Musculoskeletal Disorders in Garment Industry Workers: A Cross-Sectional Theoretical Study on Occupational Health Challenges

Suvarthy Dey¹, Tathagata Roy Chowdhury^{2*}

¹MBBS, MPH (Occupation and environmental health; major: Occupational health and safety); Msc in biomedicine (on course)

²Assistant Professor, Department of Computer Science and Engineering, Techno Engineering College Banipur, India

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***Corresponding author:** Tathagata Roy Chowdhury, Assistant Professor, Department of Computer Science and Engineering, Techno Engineering College Banipur, India

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ABSTRACT

Musculoskeletal disorders (MSDs) significantly impact garment workers' health, contributing to absenteeism, reduced productivity, and economic loss. This cross-sectional study investigates the relationship between serum Vitamin D levels and the prevalence of MSDs in garment workers from Bangladesh. A total of 168 participants, aged 18 to 47, were recruited from various sections within garment factories. Serum Vitamin D levels were measured using the ELISA method, and MSDs were assessed based on body discomfort and pain severity. Among the respondents, 86.3% had sufficient Vitamin D levels, while 35.1% reported experiencing MSDs, primarily in the lower back and knee joints. A significant correlation was found between insufficient Vitamin D levels and the occurrence of MSDs ($p < 0.05$), suggesting that adequate Vitamin D intake could reduce the risk of developing MSDs. The findings highlight the potential for targeted health interventions to improve workers' well-being and productivity.

Keywords: Musculoskeletal disorders (MSDs), Serum Vitamin D levels, Garment workers, Bangladesh, Cross-sectional study, Occupational health, Ergonomics, Work-related fatigue, Standing posture, Sewing section workers, Body Mass Index (BMI), Pain assessment, ELISA method, Workplace hazards, Nutritional deficiency, Female workforce, Occupational diseases, MSD prevalence, Vitamin D deficiency, Chronic pain.

INTRODUCTION

Musculoskeletal disorders (MSDs) are injuries or pain in the musculoskeletal system which affects the human body's movement. The MSDs includes pain in the joints, ligaments, muscles, nerves, tendons, and structures that support limbs, neck and back. When a person is exposed to MSDs risk factors, they begin to fatigue. When fatigue spread out in their body's recovery system, they start to develop musculoskeletal imbalance. So, when fatigue continues to increase and musculoskeletal imbalance persists, that ultimately leads to progress of musculoskeletal disorders. (Musculoskeletal disorders program; 24.3.2016)

Musculoskeletal disorder is the second most common reason for visits to physician ^[1]. It also a major cause of activity limitation and work absence throughout the world ^[2]. It was recorded in a previous study that, those who works in standing position for a long time specially the female workers having more experience in both subjective and physical fatigability ^[3]

There are many causes of MSDs and occupational hazard is one of them. There are many working area where workers have to maintain the same posture over a prolong period of time and often several years. Even sometimes natural postures like standing can lead to MSDs like low back pain. But postures which are unnatural like twisting or tension in the upper or lower body are typically contributors to the development of MSDs because of the unnatural biomechanical load of these postures. (Musculoskeletal disorders and workplace factors; 24.3.2016)

In 1997, the Centers for Disease Control and Prevention's (CDC) National Institute for Occupational Safety and Health (NIOSH) released a review statement for work-related MSDs. According to that statement, some work conditions like routine lifting of heavy objects, daily exposure to whole body vibration, work with the neck in chronic flexion position, or performing repetitive forceful tasks has reported positive evidence for relationships between work conditions and developing MSDs of the neck, shoulder, elbow, hand and wrist, and back ^[4].

On the other hand, a study has showed that, vitamin D plays a central role in the musculoskeletal system. Vitamin D is a fat soluble vitamin, which produce endogenously in our body in exposure to sun-light and is well known for multiple functions in bone biology, autoimmune diseases, cell growth, inflammation or neuromuscular and other immune functions. It has been proven in many studies that, vitamin D deficiency causes many diseases. In cases of vitamin D deficiency, there has found a strong negative impact on bone health like, rickets, osteomalacia, osteopenia, primary and secondary osteoporosis and musculoskeletal pain ^[5].

Vitamin D has immunomodulatory activities. Deficiency of vitamin D might be associated with diseases of immune dysregulation, which can be manifested by excessive daytime sleepiness, fatigue, tiredness, non-specific musculoskeletal pain ^[6].

Again, a study showed, the prevalence of low vitamin D is high in patients who present with fatigue and stable chronic medical conditions. After normalization of vitamin D levels with ergocalciferol therapy significantly improves the severity of their fatigue symptoms. In that study, the prevalence of low vitamin D was 77.2% in patients who presented with fatigue. After normalization of vitamin D levels fatigue symptom scores improved significantly ($P < 0.001$) in all five subscale categories of fatigue ^[7].

On the contrary, A cross-sectional and interventional study was carried out in two phase in which, complaints of unexplained pain in upper and lower limbs were noted among senior executives of some companies who worked long hours in air-conditioned offices and in spite of living in a city with a tropical climate, were barely exposed to sunlight. In the first phase of that study, after assessing other causes and serum vitamin D3 level, the result has revealed that, the prevalence of vitamin D deficiency is lower (25%) in those who give history of regular exercise in open air than in others (46.2%) and vitamin D deficiency is higher (47%) in those whose workday started earlier than in those whose workday started later (12%). In the second phase of that study, significant improvements were seen in unexplained pain in upper and lower limbs and serum D3 values after 3months sun exposure, oral therapy and dietary modifications^[8].

Bangladesh is a developing and highly populated country of 147610 km² with a population of nearly 160 million. Garment manufacturing is the biggest industrial sector of Bangladesh. The total number of garment workers is 1.6 million, among which 80% are women and most of them almost 70% or 80% workers are young girls. They are very hard working and their life is full of struggle. They mostly seen in the Dhaka city, coming from different areas of the country. They work from 8 am. to 8 pm during which they are not getting chance to come in sun-light exposure. So, there is a chance of Vitamin D deficiency which may be a cause of MSDs among the garments workers. (Life of a garments worker in Bangladesh, 2017)

The health and well-being of working people and their families are greatly influenced by the quality of their work environments, which is a direct result from exposures to physical hazards on the job and risks associated with the organizational context, or indirectly through the impact of work on health behaviors. (Sorensan G., et al. 2004)

The proposed study is an attempt to find out whether there is any association between statuses of vitamin D and development of musculo-skeletal disorders among Bangladeshi garments workers.

Background

Vitamin D is the latest trend in the news at the moment. Recently the NHS in the UK announced that increasing vitamin D intake, especially in the winter months can help prevent millions of colds and flu cases and possible save lives. (Add vitamin D to food to prevent colds and flu; 2017)

A recent studies find out that, in places where sunshine is not common, the people of that places are suffering from some underlying health conditions such as cancer, diabetes, high blood pressure, poor semen quality, depression, osteoporosis, fatigue, depression etc. There seems to be no limit to the illnesses that vitamin D can affect. Even though knowledge connecting low levels of vitamin D with severe health issues is available, people are still getting far too little of the vital vitamins. (We are not getting enough Vitamin D; 2014)

Vitamin D is sometimes called the “sunshine vitamin” because it’s produced in your skin in response to sunlight. Our body produces vitamin D naturally when it’s directly exposed to sunlight. Vitamin D has several important functions such as absorption of calcium, phosphorus, and facilitating normal immune-system function. Getting a sufficient amount of vitamin D is important for normal growth and development of bones and teeth, and improved resistance against certain disease. (Benefits of Vitamin D; the sun shine Vitamin; 2017)

Vitamin D refers to a group of fat-soluble vitamin which plays an important role for increasing intestinal absorption of some micro-nutrients such as calcium, magnesium, phosphate and multiple other biological effects. In humans, the most important compounds in this group are vitamin D₃ (also known as cholecalciferol) and vitamin D₂(ergocalciferol)^[9].

Vitamin D isn't found in many foods, the major natural source of the vitamin is synthesis of cholecalciferol in the skin from cholesterol through a chemical reaction that is dependent on sun exposure specifically UVB radiation. Vitamin D from the diet or skin synthesis is biologically inactive; a reaction process name hydroxylation which is also known as enzymatic conversion is needed and for these whole activation process liver and kidney is compulsory. Cholecalciferol is converted in the liver to 25-hydroxycholecalciferol and ergocalciferol is converted to 25-hydroxyergocalciferol. These two vitamin D metabolites also called as 25-hydroxyvitamin D or 25(OH)D. These 25(OH)D are measured in serum to determine a person's vitamin D status. Calcifediol is further hydroxylated by the kidneys to form calcitriol, which is the biologically active form of vitamin D and also known as 1,25-dihydroxycholecalciferol^[10].

Vitamin D: Sources

Sun exposure

Sunlight is considered as the main source of vitamin D for human population. (HolickMF.; 2007). Irradiation of ultraviolet (UV) B of wavelength of 290–320 nanometers enters in skin and converts cutaneous 7-dehydrocholesterol to pre-vitamin D₃, which in turn becomes vitamin D₃. UV radiation exposure and vitamin D synthesis may be affected by season, day duration, cloud, smog, skin melanin content, and sunscreen.(Dietary reference Intakes for Calcium and Vitamin D; 2010). Gloomy environment can reduce 50% of UV energy and 60% reduced by greenhouse gases^[11]. UV radiation cannot cross transparent glass, so sunshine entering through window cannot produce vitamin D(Holick MF 2005). Developing general guidelines for UV radiation and sun exposure in maintaining adequate vitamin D levels is sometimes very difficult. Researchers suggest that sun exposure for approximately 5–30 minutes in peak day time for minimum twice a week to the body surface without using any sunscreen is usually sufficient for vitamin D synthesis^[12].

Individuals and women who generally wear long robes and cover head for either religious or occupation purposes limit themselves to sun exposure to obtain adequate vitamin D.

Food

Vitamin D is available only in small number of natural foods. The Cod liver oil (400-1000 IU/ml), salmon fish (600-1000 IU) and tuna fish (236 IU) are the best sources of vitamin D. Vitamin D is also available in beef liver, milk (100 IU/ml), cheese(100IU/ml) and egg yolks (20 IU/ml) is very little amounts. Variable amounts of vitamin D₂are also provide in some mushrooms (1600 IU) .

Dietary supplements

Some supplements and fortified foods may provide the two forms of Vitamin D; D₂ (ergocalciferol) and D₃ (cholecalciferol). Vitamin D₂ is manufactured by the UV irradiation of ergosterol in yeast, and vitamin D₃ is manufactured by the irradiation of 7-dehydrocholesterol from lanolin and the chemical conversion of cholesterol.

So the researchers should take an attempt to find out whether there is any association between development of fatigability and statuses of vitamin D among Bangladeshi garments workers.

Problem Statement

Bangladesh is a densely populated country and recently has promoted as middle income country. Most of populations (especially in Dhaka city) are garments worker and they work from morning 8.00am to 8.00pm of evening. Whenever they do the overtime duty they work till 9.00pm to 10.00pm at night. That's why the garments workers don't get enough opportunity for sun exposure and vitamin D deficiency is now the evidence of lifestyle disorder in population. Most of the garments workers are suffering from fatigue ability specially musculoskeletal disorders which may be an outcome of vitamin D deficiency.

Justification

In Bangladesh, approximately 4million of total population are working in readymade garments sector of which 80% are female. (BGME report; September, 2018) Studies reported that, most of them suffers from some sorts of fatigability specially due to musculoskeletal disorders such as low back pain, knee joint pain, ankle joint pain, pain in the muscles of lower limbs etc. which reducing their working capacity ultimately great loss of productivity.

Scientists discovered that deficiency of serum vitamin D might be the cause of muscular weakness and muscle pain among adults. In human body, around 90% vitamin D generally derived from sunlight and rest from dietary intake. Both physical and environmental factors may affect individual's exposure to sun light and thus limit the ability of production of vitamin D endogenously within their body. Deficiency of vitamin D is now a days been identified as the evidence of life style disorder in the urban population even after abundant sunlight. They fail to expose themselves to sunlight due to long working time, lack of physical activities and exercises. Researchers suggest that sun exposure for approximately 5-30 minutes in peak day time for minimum twice a week to body surface without using any sunscreen is usually sufficient for vitamin D synthesis. Individuals and women who wear long robes and cover head or either religious or occupational purpose limit themselves to sun exposure to obtain adequate vitamin D.

As it is observed that the garments worker in Bangladesh have to work more than 12hours long time in indoor area which is devoid of sun exposure may develop the vitamin D deficiency and also may responsible for develop fatigability among them. So occupational health scientists should look after this issue to investigate the association between vitamin D deficiency and developing musculoskeletal problems among the garments workers.

OBJECTIVES

General Objectives:

- To estimate the status of serum Vitamin D level and determine Musculoskeletal Disorders among the Garments workers.

List of Variables:

Socio-economic Demography:

- Age
- Sex
- Educational level
- Family History of MSD
- Living area
- Income

Work-Related Factors:

- Type of work
- Working posture
- Working Hour
- Pervious work history

Pain related:

- Site of pain
- Type of pain
- Duration of pain
- Aggravating factors of pain
- Relieving factors of pain
- Functional disabilities due to pain

Sun exposure

- Time and frequency of sun exposure
- Body surface that exposed to sun
- Lunch time activities

Food Habit:

- Milk
- Yogurt

- Egg
- Tuna Fish

Affected sites of musculoskeletal disorders:

- Discomfort in neck
- Discomfort in shoulder joint
- Discomfort in lower part of back
- Discomfort in Hip joint
- Discomfort in knee joint
- Discomfort in inter-phalangeal joint (Both upper & lower limbs)

Biochemical parameters of subject

- Serum Vitamin D
- Serum to measure rheumatoid factors antibody

Literature Review:

Bangladesh is a developing country. Once upon a time her economic development was fully depended on agriculture. Now Bangladesh is one of the world's leading clothing exporters, and there are about 4500 garments factories in which approximately 3.6million people are working.

Like other developing countries, Bangladesh is facing some occupational health problems in garments industries which is relating to communicable diseases, malnutrition, deficiency diseases and causing sufferings for the workers which is an important cause for absenteeism and is a major concern among owners of the factories and policy makers.

Different steps have been taken to improve the both workplace conditions and health of the workers. But still, the conditions of the garment factories are unsafe and workers are at risk of developing different illnesses like respiratory problem, eye problem, muscle pain, headache, work related stress, low back pain, fatigability etc.

The garments workers have to perform only one function or movement for a long period of time or day after day. The workers may have experience due to long hours sitting or standing any of the following: muscle fatigue, dizziness and body tiredness, numbness in fingers, numbness in thighs, difficulty moving finger, stiff joints, or back pain and the most frequently affected areas of the body are the arms and the back. Working in both sitting and standing position may need more mobility large degree of freedom. Meanwhile when the standing worker spent a long period of time in standing position throughout their working hours, they may feel discomfort and experienced muscle fatigue at the end of workday and in the long terms, they will potentially experience occupational injuries. It

is well known that prolonged standing has been linked to the onset of work-related musculoskeletal disorders associated with lower back pain among industrial workers.

One study has found that increased discomfort and whole body fatigue associated with prolonged standing causes localized muscle fatigue and commonly represented as foot and lower leg swelling. On the other hand duration of the working hours is another trigger to increase the MSD related health problems of the standing workers. According to A. Magora (1972), workers perform jobs in standing position for more than 4 hours each day, they will potentially exposed to WMSD (Work related musculoskeletal disorder) associated with lower back pain. On the other hand one recent study reported that around 50 percent of healthy respondents reported discomfort in the lower back, even though exposed after 2 hours of continuous standing.

We know that, the main source of Vitamin D is sunlight. Bangladesh has a tropical monsoon climate characterized by wide seasonal variations in rainfall, high temperatures, and high humidity. Regional climatic differences in this flat country are minor. Three seasons are generally recognized: a hot, muggy summer from March to June; a hot, humid and rainy monsoon season from June to November; and a warm-hot, dry winter from December to February. In general, maximum summer temperatures range between 38 and 41 °C (100.4 and 105.8 °F). April is the hottest month in most parts of the country. January is the coolest month, when the average temperature for most of the country is 16–20 °C (61–68 °F) during the day. (Geographical location of Bangladesh.; 2011)

So, Bangladesh gets enough sun exposure by which normal vitamin D level can be maintain. But the garments workers have to work from morning to evening and don't get enough opportunity of sun exposure. According to a study, about 90% of garments workers are suffering from fatigability specially fatigability. Standing and female workers are the most vulnerable group.

Bangladesh is a developing country. Once up on a time her economic development was fully depended on agriculture. Although Bangladesh is not developed in industry, but now her economic has started to depend on industry and it has been enriched in Garment industries in the recent past years. In the field of Industrialization garment industry is a promising step. It has given the opportunity of employment to millions of unemployed, especially innumerable uneducated women of the country. It is making significant contribution in the field of our export income. For these Garments industries Bangladesh has got recognition as a middle income country in the world.

METHODOLOGY

Sampling technique

Simple random sampling technique will be adopted. All the available subjects during the data collection period who will be fulfilled the study selection criteria will be included in the study.

Data collection instrument

- A semi-structured questionnaire and checklist using the selected variables according to the specific objectives.
- Checklist
- Blood collection tools (disposable syringe with needle, hand gloves, tourniquet, skin sterilizer, cotton, banded)
- Biochemical reagents.

Data collection technique:

- **SOCIO-DEMOGRAPHIC AND HEALTH-STATUS ASSESSMENT**

At the time of enrollment, trained research assistants will administer a pretested socio-demographic and pain relating questionnaire of each participating subject. Socio-demographic variables including age, household size, education of parents or caregiver, income, employment of the head of the households and housing condition will be recorded.

- **DETERMINATION OF PAIN**

Site, time and frequency of pain will be obtained along with family history of similar pain and the pain relieving methods using questionnaire.

Pain severity will be evaluated using Visual Analog Scale{VAS}, a linear scale where a score from 0 to 10 is marked according to the severity of pain. Respondents will be asked to mark the severity of pain they experienced during the last attack.

- **DETERMINATION OF SUN EXPOSURE**

Sun exposure history will be taken by interview whether the study participants stay outside especially when the sunlight is maximum (generally 10 am. to 4 pm). Participants will also be asked to record their primary activities during this specific time. Physical activity will be evaluated using questionnaire regarding type, frequency, and duration of each exercise. Sun exposure will assessed using questionnaire regarding the duration of exposure and the percentage of the body surface exposed.

- **BLOOD SAMPLE COLLECTION**

Venous blood will be collected in the morning taking by trained phlebotomist. Sample will be taken in the red-top tube for serum separator. Then the tubes will be kept in cold box and will send it to the reference laboratory within 4 h where Serum Vitamin D will be measured.

Collection OF Biological Sample:

According to the Bangladesh Medical Research Council ethical guide line and permission will obtain from Bangladesh University of Health Sciences. After discussion with the respondents about the objectives and mode of data collection, will assure all the aseptic precaution and will also ensure all sorts of treatment if any complication arises during the process of biological sample collection and then taking prior written consent from the respondent of biological sample (venous blood) will be collected by following procedures:

- Blood pressure of the respondent will be check

- Will clean the desired skin area over the vein (anterior part of Elbow joint; from median cubital vein situated superficially over cubital fossa below superior radio-ulnar joint) with a liquid sterilizer (Hexisol)
- Will tie an elastic band (Tourniquet) around arm so the vein fills quickly with blood
- Will insert a small needle into the vein
- Will collect blood in a sterile 5cc syringe vial attached to the needle
- Will cover the puncture site with gauze and an adhesive bandage to stop any bleeding
- Will send the collected blood sample to a lab to measure serum Vitamin D level and RF antibody
- Every measurement will be ready for any emergency like bleeding, fainting etc.

Data analysis

After collection, all the data will be checked and edited. Then data will be entered into computer with the help of software SPSS. Frequencies and rates along with means and standard deviations of almost all the variables will be measured. Association will also be statistically checked by appropriate test of significance.

Data collection method.

- Socio-demographic and profession related information will be collected by face to face interview.
- Data will be collected by structured and semi structured questionnaire.
- Questionnaire will be translated into local language to make more flexible to collect specific and precise data.

Ethical Consideration

- **Written consent :**
 - Approval from ethical review committee of the Bangladesh University of Health Science (BUHS).
 - Permission will be taken from Factory authority.
 - Privacy and confidentiality of the respondents will be maintained strictly.
- **Verbal consent :**
 - Consent form will be translated into local language.
 - Verbal consent will be taken from each respondent before the interview

DISCUSSION

Musculoskeletal disorder is a type of disease which affects the locomotor system – such as, muscles, bones, joints and associated tissues such as tendons and ligaments. Musculoskeletal disorders are one of the leading contributors to disability worldwide, with low back pain being the single leading cause of disability globally. Now-a-days,

musculoskeletal disorders are not just conditions of older age – they are prevalent across the life-course. (WHO, 2019) Recently in many study, it has found that, a major number of the garments workers are suffering from MSD. This study was a cross sectional study conducted among 168 garments workers to find out the level of serum vitamin D and the status of MSDs among the garments workers in Bangladesh. Data was collected from those who were willing to give blood from serum Vitamin D analysis along with questioner from 168 working employees. Due to unavailability of respondents and time constraints, only 168 workers were interviewed. Questionnaire was translated into Bengali language and explained them. 20 minutes orientation has been given to share the purpose of study and then started to fill up the questionnaire. A semi- structured interview questionnaire was used to find out the status of MSDs among the garments workers. MSD disorders are taken as pain. Vitamin D measured from serum by ELISA method.

The aim of this study is to determine the serum Vitamin D level and status of musculoskeletal disorders among the garment workers in Bangladesh. Two garment industries were selected for recruiting this study almost more than one third 64.9% belonged to age 18-27 year with mean age 27.42 ± 7.484 years. It was reported that over the past quarter century, women have joined the labor market specially in garments sector is increasing in numbers day by day. (World development report 2012). In 2004, there were 3480 factories that employed 1.8 million workers of which 1.5 million were women, which also reflected in this study where females were predominant (Female 64.3% & Male 35.7%). Here, among the respondents most of them were completed (45.2%) primary school education and 41.1% participants had completed secondary school certificate which also co-relate with a study done by Sultana S, 2017. At the same time, more than half (61.3%) participants were unmarried and about more than two third (80.4%) participants belongs to nuclear family. These findings match with a study findings done by Rahman, HM & Siddiqui, SA 2015 where 58% participants were unmarried and 76% respondents belongs to nuclear family. Among the participants in this study, 79.2% participant's working experience belonged to 2-5 years, 20.8% participant's had work experience more than 5 years where mean work experience is 4.52 ± 2.153 years. This findings reflects with the study done by Antle DM 2013 where 73.4% participants had more than 4 years work experience. Moreover from this current study found that, 61.3% respondents monthly income BDT 5000-10000 TK with mean income 7376.88 ± 6.302 tk which also corresponds with the study finding KironMI, 2015 where 58.9% participants monthly were 6000-10000 TK BDT.

In this study it was recorded that, 10.1% respondents were from cutting section, 64.3% participant were working in swing section, 13.1% participant's was from finishing section and 12.5% participant's was from ironing section. Among 168 participants about two third 67.3% participants work was in standing posture and 32.7% participant's work was sitting posture. Both these finding related s with the result of a study done by Ferdous KJ, 2014 where 66% respondents worked at swing section and 69.6% participants worked in standing position. About two third 62.5% participants of this study had previous work experience and 37.5% participants had no work experience. This result also relates with the findings of Ferdous KJ, 2014, where 60% participants had previous work experience. It was also recorded that, more than half of respondents 63.4% had history of previous history of same profession

which reflects of a findings of a study done by Rahman HM, 2016 (52% had previous work experience of same profession). Among the participants, one third participants 61.3% had normal body weight, 10.1% participants had less than normal body weight and 28.6% respondents had healthy BMI with mean BMI 22.75 ± 3.535 kg/m². This BMI findings also corresponds with the findings of a study done by Mukund A, 2014 where 64% participants had normal BMI.

In this study, it was observed that, the respondents who were sufferings from MSD, 43% had family history of MSDs of whom 18.6% had both insufficient Vitamin D level and positive family history and 37.5% had no MSDs in spite of having insufficient Vitamin D level and negative family history. On the other hand, 81.4% had MSDs although they had sufficient level of vitamin D but had positive family history. At the same time, 94.4% respondents had no MSD though they had positive family history but they had sufficient level of Vitamin D. According to statistics I found that if serum vitamin D increases 1 unit, number of MSD can be decreased in one person per four persons.

CONCLUSION

Respondents were mostly female and within the age group of 18-27 years. Among them MSD was found at different site of the body where the percentage of MSD was higher the female workers than the male workers. Among the respondents who worked in standing position was reported higher percentage of MSD in different area of body than the respondents who worked in sitting position. I found that if serum vitamin D increases 1 unit, number of MSD can be decreased in one person per four persons. Besides this, Statistically MSD has strong association with Vitamin D over family history of MSD. At the same time, it has also come to known that, MSD has association with both working posture and work experience.

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