ADDIS ABABA UNIVERSITY
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Magnitude of work related musculoskeletal disorders, ergonomic risk practice and their perceptions among medical laboratory professionals working in Bahirdar, North west Ethiopia

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This is to certify that the thesis prepared by **Mekuriaw Temeche,** entitled:

Magnitude of work related musculoskeletal disorders, ergonomic risk practices and their perceptions among Medical laboratory professionals in Bahirdar, Ethiopia and submitted in partial fulfillment of the requirements for Master of Science degree in Clinical Laboratory Sciences (Clinical Laboratory Management and Quality Assurance) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abbreviations/ Acronyms

AAU	Addis Ababa University
AORs	Adjusted Odd Ratio
APHI	Amhara Public Health Institute
ART	Antiretroviral Treatment
BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
COR	Crude Odd Ratio
DC	Data Collectors
EC	Ethiopian Calendar
ETB	Ethiopian Birr
FDRE	Federal Democratic Republic of Ethiopia
GC	Gregorian calendar
HC	Health Centers
HFs	Health facilities
ILP	International Labor Organization
MLPs	Medical laboratory professionals
MOLSA	Ministry of Labor and Social Affairs
MSc	Master of science
MSDs	Musculoskeletal Disorders
NIOSH	National Institute for Occupational Safety and Health
NMQ	Nordic Musculoskeletal Questionnaire
OHS	Occupational Health and Safety
PI	Principal Investigators
SPSS	Statistical Package for Social Sciences
TV	Television
USA	United States of America
WHO	World Health Organization
WMSDs	Work Related Musculoskeletal Disorders

Abstract

Background: Ergonomics is fitting a workplace to the user's needs to increase efficiency and productivity. Advancements in technology, nature of the work, limited awareness, and poor ergonomic workstation collectively exposed medical laboratories to work related musculoskeletal disorders (WMSDs). Even though such evidences are available in most part of the world, there is no detailed and latest information in Ethiopia. Thus, this study aimed to assess the magnitude of WMSDs, ergonomic risk practice and their perceptions among medical laboratories of Bahirdar, Ethiopia from Feb1, 2021 to June 30, 2021.

Methods: Cross-sectional study design was employed among 238 medical laboratory professionals (MLPs) and Nordic Musculoskeletal Questionnaire was administered in addition to questionnaires about socio-demographic characteristics, pain and discomfort, and ergonomic risk practice, one to one interview, and direct observational checklist. On daily basis data accuracy, clarity, and completeness were checked. Data was entered into EpiData 3.1 then exported and analyzed using SPSS version 25. Logistic regression analysis was used to estimate the 95% CI (AOR) at a cut off value of $p<0.05$ for statistically significant tests.

Results: A total of 238 MLPs were participated in the study. The magnitude of WMSDs over the past 12 months was 48.7%. The most affected body parts were lower back (20.6%) and wrists (16.4%). The magnitude of WMSDs among Public owned hospitals were highest (56.4%). The number of laboratory staffs who works for >5 days and ≥ 40 hours per week were 129 (54.2%) and 140(58.8%) respectively. 67.6% MLPs never heard about ergonomics. The general mean score of workstations was 2.28.

Conclusion: The current findings revealed high magnitude of work related musculoskeletal disorders (WMSDs) that strongly need applying preventive action before body symptoms developed. Improving and renovating workplace design and enhancing awareness of MLPs were necessary measures to control ergonomic risk factors.

Key words: Ergonomics, musculoskeletal disorders, risk practice

1. Introduction

Background

In the beginning of 18th century, Musculoskeletal disorders (MSDs) were recognized as having occupational etiologic factors (1). In the world, humans face physical limitations and the prominent cause is MSDs. The Global Burden of Disease (GBD) study reported that the second most common cause of disability in the world was MSDs (2). Nowadays in-developed countries, the main cause of occupational injury and disability are work related musculoskeletal disorders (WMSDs). Also in developing countries, due to lack of effective programs to prevent injuries and eliminate poor working conditions there is a high magnitude of MSDs (3). Furthermore, WMSDs negatively affect workers' quality of life, productive capacity, absenteeism pattern, and disabilities (2).

MSDs are injuries of the muscles, nerves, tendons, joints, cartilage, and spinal discs. WMSDs are musculoskeletal disorders when intensified by working environment and conditions (4). It also affects organizations and society. Beyond that, it costs by adversely affecting the quality and usefulness of works (3). The main risk factors for MSDs development among MLPs are ill-structured job, poor posture at work, poor workstation design, prolonged working time, and repetitive movements (5).

With no consideration of the type of work activity, in occupationally active population the occurrence of WMSDs related with psychosocial problems, organizational behaviors, sociodemographic factors may be influenced (6). Prolonged exposure to ergonomic risk factors can also cause damage to a worker's body and leads to WMSDs. Medical laboratory workstations are confined that enforce the professionals to work in seated or standing position for a longer working hours which is one of risk factor to WMSDs (2). Without proper functioning of ergonomics in work place environment and tasks of medical laboratories, the goal of health institution cannot be achieved hence the efficiency of employees decreased (5).

Medical laboratory technicians have high magnitude of WMSDs and the major affected areas were neck, shoulder, elbow, and hand pain (7). Routine activities that performed in medical laboratory departments such as pipetting, microscopy, micromanipulation, and working with biosafety cabinets or cryostats, and non-standardized work place designs exposed MLPs to

WMSDs (3, 8). The magnitude of WMSDs among medical laboratory professionals (MLPs) ranged from 40 to 60% (9). Managers' should emphasize good ergonomic design and safe working environment because physical efforts continue to cause serious damage to workers' health (4, 10).

A study conducted in Riyadh, Saudi Arabia shows the 12 months prevalence of WMSDs in any region of the body was 82%. Lower back pain (61%) was the most one (2). On the same concept, The prevalence of WMSDs among registered nurses of Harare, Zimbabwe was in 12 month study was 82.1%. the most affected body part is the back (84.3%) (11).

There is increased risk of WMSDs among healthcare workers (HCWs) and prevalence rate in Nigeria, which ranged from 26% to 69% likewise, because of the presence of ergonomic risk factors, the prevalence of MSDs in MLPs is high (8, 12). Much loss to the industry in terms of money, time, and productivity happens when sustained physical work injures the workers body (10).

In Ethiopia, there is shortage of healthcare professionals' particularly medical laboratory professional's (13); because of this, there might be high work load and it will leads WMSDs but to the best of our knowledge there is no documented evidence to indicate the magnitude of WMSDs and ergonomic risk factors. Hence, it is necessary to assess WMSDs and ergonomic risk factors in medical laboratory department of health institutions to suggest possible solutions. Therefore, the study is planned to determine the magnitude of WMSDs, ergonomic risk practice and their perceptions among MLPs working at Bahirdar city, Ethiopia.

Statement of the Problem

Every human being at least once faces a serious problem that related with MSDs (14). WMSDs were one on reducing the productivity and quality of workers' life (15). Moreover, many working populations exposed to morbidity because of WMSDs. Globally, almost 20%–30% of people live with a musculoskeletal condition (2). The study from global statistics estimated that two million people die annually due to work-related injuries or illnesses, while annually the number of work related new cases were 160 million (16). United Nation (UN) reported work-related deaths by geographical regions as follows Africa accounts for 11.8%, America 10.9%, Asia 65.0%, Europe 11.7%, and Oceania 0.6% (14). An observational report by European Union shows the prevalence of MSDs among European workers was 22.8% and the main muscular pains were in shoulders, neck and limbs (17).

With regard to cost, WMSDs are the most expensive form of work related disability, attributing to about 40% of all costs toward the treatment of work-related injuries (15). In 2012, USA overall workers compensation and associated private costs were $250 billion; and Australia were costs an estimated of $55.1 billion due to musculoskeletal conditions and arthritis (11) on the same year, Germany also costs 38 billion Euros for WMSDs (15).

Lower middle-income countries such as Ethiopia has limited health budget to solve life treating health conditions. In Ethiopia, the prevalence of musculoskeletal disorders among working population varies from 35% to 74.5% (18). According to the study that conducted in Addis Ababa public health laboratories in 2012, poor ergonomic design of workstations was the main factor for the report of WMSDs. More over the study strongly associates WMSDs complaint with poor ergonomic workstations. Among the complaints of WMSDs ankle/feet (21.7%) and knees (20.8%) were the major ones (19). Broadly, in Ethiopia, there is little evidence on the WMSDs and ergonomic risk factors in medical laboratory department of health institutions.

Despite of this, to the best of our knowledge on searching the literatures, there was no updated and detailed study, which includes the research idea "WMSDs, ergonomic risk practices and perceptions among MLPs in Ethiopia. Therefore, this study aimed to assess the magnitude of WMSDs, ergonomic risk practice and their perceptions among MLPs working in Bahirdar, Ethiopia." Thus, can fill the gap and used as recent information for further study.

Significance of the study

There are different researches studied in the health sectors on department of medical laboratory about ergonomic risk practices and WMSDs in the world particularly in developed nations (20) In the contrary, in Ethiopia the only study was conducted in Addis Abeba, which was focusing mainly on ergonomic prevalence. Thus, we believe more comprehensive study should be conducted. Hence, we design this study by including the above concepts and contain additional idea about the perceptions of MLPs, magnitude of WMSDs and ergonomic risk practice in Bahirdar.

Understanding ergonomic risk factor that influence WMSDs among MLPs will help to develop efficient and effective guidelines, and strategies to manage ergonomic risk factors, which cause WMSDs. Assessment of perception of MLPs about WMSDs and ergonomic risk practices will help to know their status and consequently to plan the next improving measures.

The study will be an alarm for clinicians to give attention about WMSDs, consequently the musculoskeletal injuries and disorders aggravated by work among MLPs were decreased and managed that improves patient satisfaction by giving quality laboratory service. Additionally, the resource that wasted because of WMSDs will be saved.

Therefore, this study provides an essential input to aware MLPs about ergonomic risk practices and WMSDs. It gives valuable information for medical laboratory managers, programmers, public and private health institution owners and hospital chief executive officers, and nongovernmental organizations to prevent and control ergonomic risk practices as well WMSDs by renovating, planning work conditions and practices of medical laboratory service. Moreover, this study provides significant contribution for further detail study.

2. Literature Review

Work related musculoskeletal disorders

Occurrence of musculoskeletal pain has no age limitation because obesity, psychological problems, sitting too much, exhausting exercise and smoking is risk factor in child hood and adolescence (21). In addition, the major relevant issue to the occurrence of MSDs are the working posture of workers, handling of materials, movements performed repeatedly, static work and work related disorders. WMSDs mostly affect neck/shoulder and low back of the body (22).

One of the most prevalent health issues that faced the worlds' working population is WMSDs. It is directly associated with more absenteeism or disability when compared with other diseases (8). WMSDs are a reason for prominent pain and disability that results a significant burden on millions of people in both developed and developing countries. Majorly worker function, performance and productivity are impacted (19). MSDs are also related with disease for instance sickle cell anemia patients has a prevalence of MSDs ranging from 37 to 50% (23), among Parkinson's disease patients, the prevalence of MSDs is 58.9% (24), and among dialysis patients, the prevalence of MSDs is 76.4% (25).

The number of people who are affected by work related physical disorder is 150 million which is four times larger than 20 years ago (26). According to WHO report, in industrialized countries 70% of the population experiences nonspecific lower back pain in their life time (27). In any given time, nearly 30% of adult population of USA has been complaining of joint pain, swelling, or limitations (28). The prevalence of back injuries in U.S covers up to 50% of musculoskeletal disorders (29). MSDs are also responsible for the loss of 29.00% all working time in United States and 13.10% of government budget for relief of MSDs in Iran (3). On the other hand, a study that investigates 2000 selected patient records in Sweden founds that a percentage of patients that lay between 13 and 35%, did not receive a MSDs diagnosis. Even though there are symptoms of MSDs (30). WMSDs was one of the most common disorders among health care workers which accounts 60% of reported occupational injuries (31).

There was a cross sectional study conducted among 269 laboratory workers who work on research laboratory in Saudi Arabia. The study order musculoskeletal symptoms on increasing order as follows, shoulders (33.5%), low back (27.5%), upper back (26.5%), followed by neck

(23.0%) (32). The main obstacles in occupational health is WMSDs that causes decreased efficiency and effectiveness, decreased work output and the quality of health of the worker becomes poorer (6).

An increased musculoskeletal injury risk results because of a laboratory workplace environment requires repetitive motion, fine task precision, static, sustained and awkward postures (8). Furthermore, WMSDs can be worsening by repeated, forceful, or prolonged work activities with inadequate recovery (2). In addition, there was poor awareness of ergonomics and knowledge of gains of its right among MLPs (5).

In developing nations, there is lack of fruitful programs to prevent disorders and remove poor working conditions (3). Even though the concept of ergonomics in developing nations is quite new in healthcare, there are some studies (5). A study conducted about work posture and prevalence of MSDs documented about the prevalence of MSDs among medical technicians' were 73.3% and the majorly affected body parts were trunk, knees, neck and ankles/feet (33). An article conducted in India about WMSDs among MLPs order the event of pain as follows lower back (61%), neck (46%), shoulders (45%), upper back (44%), wrists/hands (34%), ankles/feet (29%), knees (28%), hips/thighs (17%), and elbows (10%) (2). According to another study conducted in India, Bangalore by Joseph B et al, WMSDs are prevalent and estimated to be 68.3% (31).

The study from Singapore shows that the prevalence of MSDs among medical technologists was 96% and the most commonly affected body parts were shoulder, neck and lower back (9). A study from India, Mumbai showed a strong association between WMSDs problems with poor ergonomics at workstation. The main WMSDs complaints are pain (87%), fatigue (41%), and stiffness (40%). The major pains were back pain (53%), neck (39%), wrist (21%), shoulder (21%), heel (14%) & knee (10%) respectively (34). A study carried on Nigerian hospital workers about pattern of WMSDs, analyzed information and the most affected to the least were as the following: low back (61.1%) neck (43.4%), shoulder (32.1%), upper back (31.5%), hips (30.6%), hand (26.5%), and elbow (12.7%) (35).

A cross sectional study from Nigeria shows that the WMSDs distribution among health workers as follows; Doctors (60.7%), Laboratory professionals (71.4%), Nurses (78.2%), Physiotherapist

(83.3%) and Technicians/Scientist health attendants (100%). Common musculoskeletal disorders among the health workers are pain at the lower back (50.5%), shoulder (25.2%), neck (21.0%), ankle feet (20.5%) and knee (20.5%) (12). Another study conducted in Nigeria about WMSDs complaints among healthcare professionals showed the major affected area were low back pain (71.6%), followed by shoulder (46.8%) and necks (42.2%) (36). Medical laboratory technicians have high prevalence of WMSDs and the major areas that experience were neck, shoulder, elbow and hand (7).

Ergonomic risk practices

According to the definition of international ergonomics association (IEA), ergonomics is a science that deals the compatibility among human anatomical, anthropometric, physiological and biomechanical characteristics and the static and dynamic parameters of physical work (22). Hazards in the healthcare workers classified into physical, biological, mechanical, ergonomic, chemical and psychosocial (37). One of the key inputs to minimize work related damage is ergonomics (5). WMSDs is a concern of health workers because the work situation has unwholesome work environment, understaffing, excessive workload, lack of appropriate and needed work equipment, excessive patient manual handling, and working long hours in sitting and standing (38).

One of the pertinent causes for increased risk of WMSDs development among MLPs is lack of application of ergonomic principle (5). Above all, to get effective and efficient result, health and safety MLPs at the work environment should be given utmost concern because 60-70% of decisions related to admission of patients to hospital, prescriptions of medication and discharges need participation of medical laboratories (37).

A study from India, Mumbai showed a strong association between WMSDs problems with poor ergonomics at workstation (34). A work setting causes workplace risk factors for MSDs such as shoulder and backache, joint pain and muscles fatigue, this suffering mainly lies on health care professionals comprising MLPs (26). There are limited studies about ergonomic hazards that ultimately lead to musculoskeletal problems. Differently, routine laboratory examination needs procedures such as pipetting, working at microscopes,

operating microtomes and using cell counters requires repetitive motion, which is risky (39).

Perception about MSDs and ergonomic risk practice among MLPS

MSDs cause severe physical impairment and pain that alter the psychosocial status of the affected personnels (2). A study from Southern India on public health facilities found a high prevalence of WMSDs and limited awareness of hazards. Consequently which may create an obstacle for implementation of ergonomic control measures (40). Specifically, in developing nations ergonomics education may be absent specifically, in MLP continues professional development program. Above all there is no policy of ergonomics that results no opportunity for both public and private diagnostic laboratories to get in-service trainings (2). Furthermore, the growth of the life expectancy and sedentary life style has a major role for a development of MSDs in developing nations (6).

When work environment lacks necessary inputs consequently not only individuals also companies and the society are affected (22). Application of the principles of ergonomics in timely and right manner at work places promotes the health, efficiency, and well-being of the workers (5). Beyond that, ergonomically adjusted environment results well bigness of an individual's, helps the companies and the community by boosting the quality and productivity gains (22).

When compared with rehabilitation, golden solution to occurrence of WMSDs on workers, employers and society, is applying preventive measures by detecting potentially harmful ergonomic work situations (6). The other essential two basic measures to decrease pain and discomfort, to improve work motivation and moral satisfaction of MLPs, are applying ergonomic modifications and engineering control on the workplace (41).

2.1 Conceptual Framework

Different literatures used to make the conceptual framework about the association of dependent variables and independent variables. Different factors could affect musculoskeletal disorder at work place. The first factors were sociodemographic factors like age, sex, marital status;

educational status, work experience, and monthly salary. The Second factors were psychological, individual and behavioral such as (BMI, job stress, job satisfaction, physical exercise, smoking) and perceptions about ergonomics (education and training) indirectly associated with MSDs (19, 42).

Thirdly, the ergonomic risk practice factors such as Employment status, Laboratory section, Main workstation status, overtime work, Second job , previous diagnosis of bond disease, regular housework, time spent carrying children younger than age 5 year, amount of rest between tasks, average number of hours standing per day, average number of hours sitting per day, availability of light, types of health facility were directly affect the dependent variable that is WMSDs. Ergonomic risk practice factors were very important because it directly affect WMSDs or indirectly via other factors. The detail list of independent variables and its association to WMSDs are shown on figure1 (19, 42).

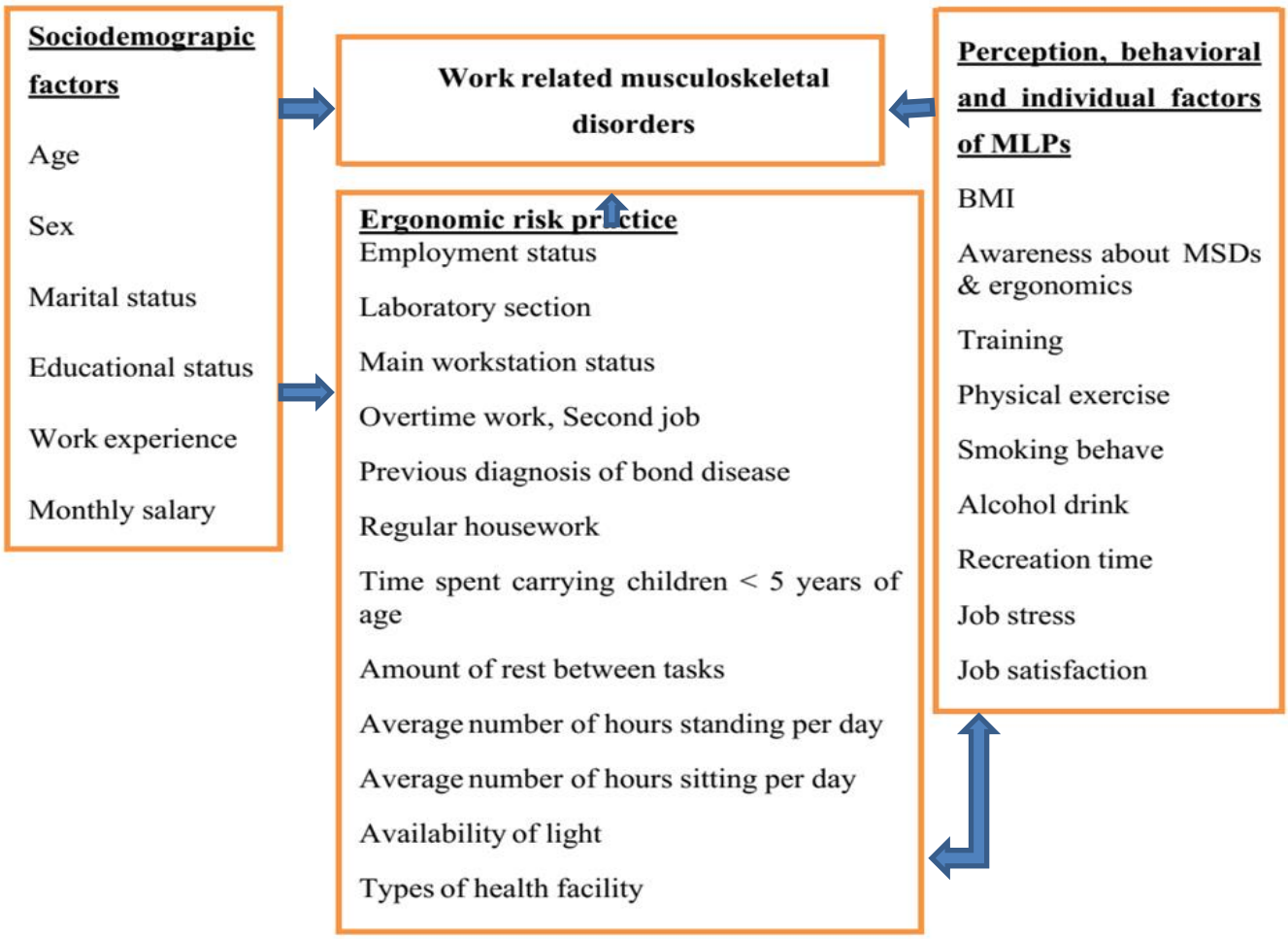


Figure1. Conceptual framework of WMSDs reviewed from different literatures.

3. Objectives

General objective

The general objective of this study was to assess the magnitude of work related musculoskeletal disorders, ergonomic risk practice and their perceptions among medical laboratory professionals working in Bahirdar health facilities, Ethiopia from February 1, 2020 to June 30, 2021.

Specific objectives

To determine the magnitude of work related musculoskeletal disorders among medical laboratory professionals in Bahirdar.

To assess the level of ergonomic risk practices among medical laboratory professionals in Bahirdar.

To assess the perception of musculoskeletal and ergonomic risk practice disorders among medical laboratory professionals in Bahirdar.

4. Hypothesis

Ho: there is no significant association between the occurrence of WMSDs and ergonomic risk practice as well as perceptions among medical laboratory professionals in Bahirdar.

5. Materials and methods

Study area

Bahirdar is a City which is sit of Amhara National Regional State located at about 565 km northwest of Addis Ababa (the capital city of Ethiopia) (43). It has an average elevation of 1801 m above sea level. According to the Central Statistical Authority (CSA), the population of the city was projected to be 214, 691 in 2020 (44).

The city had three government owned hospitals namely Tibebe-Gion Specialized Hospital which established under Bahirdar university, college of medicine and health science for teaching and learning, research and innovations, community service and health care provisions with a capacity of giving 2000 clients per day and have over 500 beds (45). Felege Hiwot specialized comprehensive hospital, which is the largest tertiary level referral hospital in the region (with more than 400 beds) and one of the largest health services giving in the country, that serve more than 7 million people (46, 47). Addis Alem hospital and four private owned hospitals namely Gamby teaching hospital, Adinas general hospital, Afilas general hospital and Dream care general hospital in addition ten government owned health centers namely Han H/C, Shmbit H/C, Dagmawi Minilik H/C, Abaymado H/C, Bahirdar H/C, Meshenti H/C, Zenzelma H/C, Tisabay H/C, Zegie H/C. Ten private owned clinics also included in the study.

Furthermore, the city had Amhara public health institute (APHI) that accredited by the Ethiopian National Accreditation Office (ENAO) in all laboratory test since 2018 in accordance with the ISO 15189:2012 standard (48). According to health and health indicators of Amhara regional state health bureau, the number of medical laboratory professionals in the city is 264.

Study design and period

Cross-sectional study design was conducted to assess the magnitude of WMSDs, ergonomic risk practice and their perceptions among medical laboratory professionals of Bahirdar, Ethiopia by incorporating the quantitative and direct observational techniques from February 1, 2020 to June 30, 2021.

Population

Source population

The source of population for this study was all MLPs who were working in Bahirdar health institutions and health professionals working in those health institutions.

Study Population

The study population was all MLPs who are working in the health facility of Bahirdar during the study period that fulfill the inclusion criteria.

Inclusion and exclusion criteria

Inclusion criteria

Medical laboratory professionals who are engaged in the laboratory diagnosis of government and private health facilities as well as who have fixed working hours had been included.

Exclusion criteria

Medical laboratory professionals working less than one year of medical laboratory work experience and those who were working at the government and private health facilities which managed at once and excluded in the next founding health facilities.

Study variables

Dependent variable

Magnitude of work related musculoskeletal disorders

Independent variables

Socio-demographic variables:- age, sex, marital status, educational status, monthly salaries and service year.

Ergonomic risk practices:- Employment status, laboratory section, main workstation, overtime work, second job, regular house work, time spent carrying children younger than 5 years, amount of rest between tasks, average amount of hour standing and seating per day, total break excluding lunch time, availability of light, and type of health facility.

Perception of MSDs and ergonomic risk practice among MLPs:- awareness of ergonomics, and trainings about ergonomics.

Behavioral and personal factors:- BMI, physical exercise, smoking behavior, alcohol drinking, and recreation activities.

Psychosocial factors:- job satisfaction and job stress.

Sample size calculation and sampling method

Sample size

All medical laboratory professionals who were working in health facilities of Bahirdar that fulfills the inclusions criteria were taken as a study subjects. Thus, no need of sample size calculation for determination of the study variables. Accordingly, all the two hundred thirty eight (238) MLPs working in health facilities in Bahirdar city were included in the study.

Totally 27 health facilities medical laboratory departments were assessed. One hundred fifty six workstations that laboratory staffs were on work during data collection moment were selected purposively. 156 workstations that includes sitting bench, standing bench, computer, microscopic, chair, pipette, micromanipulation workstations. Ergonomic measurements alone cannot measure ergonomic issues. The suitability and ways of adjustment of each workstation assessment along with skill of each MLPs makes possible a full observation of the condition (49). Twenty-seven (17.3%) workstations were evaluated for each component of workstations except computer workstations 11(7.5%) and micromanipulation 10(6.4%). One to one interview was performed with all (27) medical laboratory managers of government and private owned health facilities.

Sampling Method

The health facilities were selected purposively by taking all the health facilities having laboratory service during the study period. Census sampling technique employed for those MLPs who actively engaged in the laboratory diagnosis of government and private owned health facilities as well as and who had fixed working hours.

Data collection procedure

The questionnaires, checklists and interviews totally, data collection tools were interrelated to assess the magnitude about association of WMSDs and ergonomic risk practices and perceptions of among MLPs. The type of questionnaires were socio-demographic characteristics, pain and discomfort, Nordic Musculoskeletal questionnaire which is Nordic measurement, that divides human body into nine body regions, which may affect by WMSDs, institutional factors, and workplace factors (50). A data collected using direct observational checklist to determine the condition of standing bench, sitting bench, computer, pipetting, microscope, chair, and

micromanipulation workstation. One to one interviews using semi-structured questions with all medical laboratory managers were carried out. A data collection tools were pretested in Debretabor specialized comprehensive hospital.

Data was collected by using pre-tested English questionnaire by considering of all MLPs had diploma and above educational level, so that can have a good and well understand the English version of the assessment tool. Moreover, tools like Paper, pencil, a folding ruler, and a camera was used for workplace observations and for identification of ergonomic hazards (29). To calculate BMI of medical laboratory professionals' weight and height was measured using portable digital weight machine and potable steel height measuring tape respectively.

Data Quality Assurance

Preanalytical data quality assurance

The data quality was assured before, during and after the data collection. Before data collection, the questionnaires were pre tested in Debre Tabor comprehensive specialized hospital to evaluate its clearness and applicability according to the objective of the study. Based on the result of pre-test, some modifications on the questionnaires were made. Each questionnaire was given different identification number. One experienced medical laboratory expert who had a second degree were used as supervisor and a trainer for three medical laboratory professional data collectors and PI. Two days' intensive training was given for three data collectors on each objective of the study. The principal investigator and the supervisor were responsible for co-ordination and supervision of the overall quantitative and direct observational techniques data collection process.

In medical laboratory workplace, there were different parameters all needed and measurable parameters such as length and width of workstations were assessed by standard ruler and converted in to meter.

Analytical data quality assurance

A supervisor and investigator evaluated the collected data including completeness, accuracy, and clarity on a daily basis. Missed questions and variables during the first visit were filled by given the questionnaires and reinterviewing the participants.

Post analytical data quality assurance

After the data collection, the collected data was rechecked for its completeness and consistency by the supervisor and principal investigator. The completeness of the questionnaire and its clarity was mainly rechecking by principal investigator.

Nordic musculoskeletal questionnaire had an anatomical diagram of nine body regions like neck, shoulder, upper and lower back, hands/wrists, arms, knee, thighs and feet to make easy for study participants on correctly identifying the presence of musculoskeletal symptoms.

Data analysis and interpretation of quantitative data

The data was edited, coded, and double entered into SPSS version 25 software program for cleaning and analysis. Odds ratio with 95% confidence interval was used to measure the association between the independent variables with the dependent variable. Results were summarized in texts, frequency tables and graphs.

The association between report of WMSDs and respondents' sociodemographic and ergonomics risk practice data were checked by using the binary logistic regression analysis. In addition, chi-square assumption was checked. For statistically significant tests and to count in the last logistic model the cut off value was $P < 0.25$.

In the two variables (bivariate) analysis, the crude OR (COR) of reports of WMSDs was estimated by covariates; all covariates were categorical. It is clear that the effect of confounding variable(s) does not take into account by COR. Furthermore, to clear confounders and to check for interactions, multiple logistic regression analysis was used to estimate the adjusted OR at a cut off value of $p < 0.05$ for statistically significance using Hosmer and Lemeshow goodness of fit test.

Data analysis and interpretation of qualitative data

Medical laboratories Workstation

Standard ruler was used to measure the selected workstation. The measured values (centimeters) were converted into suitable units (meter). At the selected workstation, direct observational data was recorded while medical laboratory personnels were at work. Each workstation was evaluated using assessment checklist (29). The collected data were summarized in texts, and frequency tables.

If the workstations had the item (presence of contact stressor, presence of lower back support of chairs, etc.) when assessed, then it was score "1" (representing "yes"). While, if the workstation had not the required item when assessed, then it was score ("0" representing "no"). Suboptimal conditions and risk of injury represented by "no" answers. The sum of all item score gives total score of workstation. The sum of all item scores was dividing the total score of workstation. The total score of each workstation was divided by the number of items checked; the final score was expressed as a percentage (19).

Categorizing of medical laboratory workstations

Workstations of medical laboratories was categorized according to the following components: the standard height of standing bench is 0.91m, the standard height of sitting bench is 0.76m, laboratory chairs, microscopes (in bacteriology, hematology, parasitology, and urine analysis), pipettes, micromanipulation (of vials, forceps, cap openers, and tube holders), miscellaneous (i.e., platforms, storage space, storage closets, bins, and racks), and computer workstation (19, 51).

Operational definitions

Availability of Lighting: - It is the presence of visible light that allow workers to move in the work place easily and appropriately to perform their responsibility more effective and efficiently.

Body mass index: weight in kilograms divided by the square of the height in meters (kg)/ $(m)^2$. The measurement of weight and height were measured using the portable measuring tape and digital balance, respectively and classified into underweight= BMI <18.50, Normal range= BMI b/n 18.50-24.99, overweight = BMI b/n 25.00-29.99, and Obese= BMI ≥30.00 (52).

Ergonomics is a science that deals with adjusting wide variety of working conditions and job demands that can affect worker's comfort and health to the capability of the working population (53).

Ergonomic risk practice is a condition related to work activity and ergonomics that created deliberately or not which might contribute to results against the principle of ergonomics. Consequently, that may increase the probability of harm to the health and wellbeing of MLPs. The prominent ergonomic risk practices are repetition, awkward posture, vibration, static loading, forceful exertion, extreme temperature etc. (54).

Job satisfaction: the generic job satisfaction scale was used to classify a score as no (10 - 31) and yes (32 -50) (42).

Job stress: Work place stress scale used as measurement score as no (lower than or equal 15) and yes (16 to 40) (55).

Repetitive work within less than 30 second: - when workers exposed too repeatedly for a task that repeat itself every 30 second in the same direction.

Systemic illnesses: - a disease that affects the whole body not specifically one organ example diabetes, chronic renal failure, gout.

Work load: - the number of patients served in a day by one professional is greater than 35, it considered as loaded (56).

Work related musculoskeletal disorders are conditions when the immediate working environment intensifies injuries of muscles, nerves, tendons, joints, cartilage, and spinal discs for at least 2 to 3 days during the last 12 months on any body parts. These symptoms often come along at the work and go away at the time of rest and symptoms continue after work ends. These symptoms often appear at work that disappears during rest and symptom continues after work ends (4, 42, 57).

Ethical considerations

The study was conducted after ethical clearance was obtained from department research and ethical review committee of Addis Abeba University, college of health science with a protocol number of DRERC/618/21/MLS and a reference number of MLS/085/21. An official permission letter was delivered to the respective health facilities of Bahirdar by Amhara public health institution.

Formal letter for cooperation was obtained from Amhara public health institution to government and private owned health facilities of Bahirdar. The facility administration was informed about the general objective and significance of the study through an official letter. During data collection, oral consent was obtained from study participants by explaining the aim of the study and their rights. All results were kept confidential; their name or other personal identifier identified the participants; rather appropriate coding system was used.

Dissemination of the result

The findings of the research will be submitted to Addis Ababa University, college of Health science, department of medical laboratory, Bahirdar city health administration bureau, for

hospitals whom participate on the research and other responsible bodies. It was available in the library to serve as a reference material for students, researchers, experts or policy makers for intervention. The result will be presented on different seminars, meetings and workshops. Furthermore, it will publish on peer-reviewed reputable journal.

6. Results

6.1 Socio-demographic characteristics of the study variables of participants

Two hundred sixty four MLPs expected to participate in the study, 238 were included in the analysis making with a response rate of 90%. Majority of study participants (58.4%) were from government owned health facility (Table 2). One hundred forty seven (61.8%) were males and the age of MLPs ranges from 20 to 58 years and the mean age was 30.81years with SD of ±5.704 years additionally, 197(82.8%) participants were in an age range of 20 to 35 years.

Most of the respondents, 135(56.7%) and 116(48.7%) were single and first-degree holders respectively. The mean work experience was 7.77(SD=4.982) and 153(64.3%) professionals had a work experience of greater than 5 years in their medical laboratory work place. 145(53.4%) of the laboratory personnels had a monthly income of between 4501-7501 ETB with mean of 6008.63(SD=2025.214) (Table 1).

Table 1. Demographics characteristics of MLPs working in Bahirdar, Ethiopia, 2021(n=238).

Variables	Category	Frequency	%
Sex	Male	147	59.7
	Female	91	38.2
Age in years	20-35	197	82.8
	36-60	41	17.2
Marital status	Single	135	56.7
	Married	97	40.8
	Divorced	6	2.5
Educational status	College diploma	96	40.3
	First degree	116	48.7
	Second degree	26	10.9

Table 1. (Continued)

Work experience	<5 years	85	35.7
	5-15 years	137	57.6
	>15 years	16	6.7
Monthly income in Ethiopian birr	<4501	58	24.4
	4501-7501	127	53.4
	>7501	53	22.3

Profile of health facilities

Status of health facilities and the number of MLPs in each type of health facilities were clearly indicated in (Table 2).

Table 2. Characteristics of health facilities.

Variables	Category	Frequency	%
Status of health facilities	Public hospital	03	9.7
	Public health center	10	34.5
	Private hospital	04	13.8
	Private clinic	10	34.5
	Other	02	6.9
Number of MLPs in each health facilities	Public hospital	111	46.6
	Public health center	30	12.6
	Private hospital	38	15.9
	Private clinic	31	13.0
	Others	28	11.7

Report of work related musculoskeletal disorders

Magnitude distribution of WMSDs among body parts of medical laboratory professionals

Over the past 12 months, about half 116(48.7%) of clinical laboratory staffs reported WMSDs at least one of the nine body parts, they reported 274 pain and discomforts, and the most affected body parts were the lower back 49 (20.6%), the wrists 39 (16.4%), lower back 33 (13.9%), neck 31(13.0%) and the least was elbows, hip and shoulders had equal magnitude of 23(9.7%) (Figure 2).

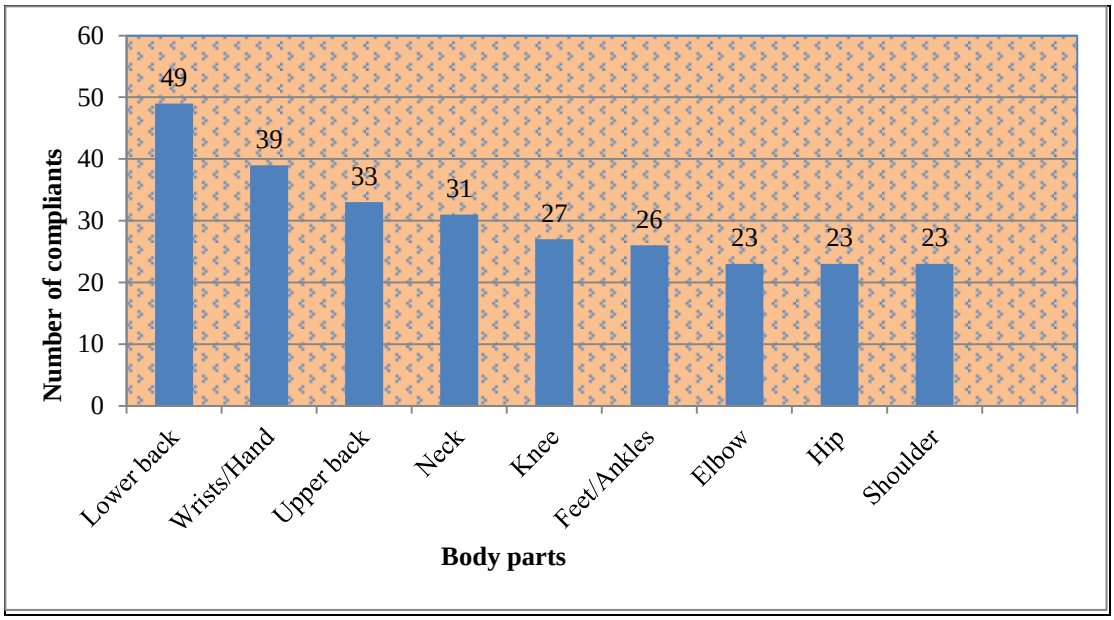


Figure 2. Number of body complaints among MLPs working in Bahirdar, Ethiopia, 2021.

Frequency of pain and discomfort within medical laboratory professionals

One hundred one (42.4%) of participants took medication because of WMSDs. The most affected was wrist 18(7.6%) and ankles 16 (6.7%). The cause of the disorder that judged by the respondents were repetitive work 83(34.9%) and awkward posture 26(10.9%). Of those who had disorders 83(38.4%) suffers a pain 2 to 3 times per week. Thirty-nine (16.4%) got medication because of the disorders. Among those 25(10.5%) took 265 sick leave days that range from 2 to 90 days with mean of 10.6 days (SD= 17.543) with a year (Table 3).

Table 3. Pain and discomfort among MLPs working in Bahirdar, Ethiopia, 2021.

Variables	Category	Frequency	(%)
WMSDs within a year(n=238)	Yes	116	48.7
	No	122	51.3
Likely cause of the pain(n=114)	Repetition	82	34.5
	Awkward posture	26	10.9
	Vibration	5	2.1
	Static loading	1	0.4
	Forceful exertion	2	0.8

Table 3. (Continued)

Medication for pain(n=116)	Yes	39	16.6
	No	77	32.3
Frequency of pain per week(n=109)	1-2	75	31.5
	>2	34	14.3
sick leave(n=106)	Yes	25	10.5
	No	91	38.1

Magnitude distribution of WMSDs and types of health facility

MLPs who are working in government owned hospitals report the highest annual magnitude of WMSDs 62(56.9%) followed by private hospitals 18(15.5%). Low back pain was highest among MLPs who work on public hospital 28(57.2%) followed by private hospital 8(16.3%) (Table 4).

Table 4. Musculoskeletal complaints of MLPs working in Bahirdar, Ethiopia, 2021.

Type of Musculoskeletal complaint	Ownership of health facilities				
	Gov't owned hospital	Gov't owned HC	Private hospital	Private clinic	Others
	N (%)	N (%)	N (%)	N (%)	N (%)
WMSDs(yes)	62(56.9)	16(17.8)	18(15.5)	15(12.9)	5(4.2)
Neck pain	15(4.8)	5(16.1)	5(16.1)	4(3.4)	2(1.7)
Shoulder pain	12(51.2)	5(2.2)	2(8.7)	3(13)	1(4.3)
Elbow/forearm pain	14 (60.9)	4(17.4)	2(8.7)	3(13)	0(0.0)
Wrist/hand pain	18(46.2)	6(15.4)	5(12.8)	9(23.1)	1(2.6)
Upper back pain	19(59.4)	7(21.9)	2(6.3)	3(9.4)	2(6.3)
Lower back pain	28(57.2)	7(14.3)	8(16.3)	5(10.2)	1(2.0)
Hip/thigh pain	10(43.5)	8(34.8)	3(13.0)	1(4.3)	1(4.3)
Knees/leg pain	11(40.7)	4(14.8)	4(14.8)	6(22.2)	2(8.7)
Ankle pain	11(42.3)	6(23.0)	1(3.8)	6(23.0)	2(7.7)

"Others" represents MLPs working in APHI and Blood bank branch of Bahirdar

6.2 Perception, behavioral and individual factors of medical laboratory professionals

Individual Characteristics of the medical laboratory professionals

Most professionals 221(92.9%) had normal BMI (18.5-24.9kg/m^2) with the mean of 19.4 (SD=0.260). More than half (64.3%) professional staffs has no a habit of doing physical exercise whereas 85(35.7%) had an experience, of those 51(21.4%) doing physical exercise two times per week. 15(6.3%) , 8(3.4%), 12(5.0%) laboratory staffs had medical history of systemic illness, symptoms related to WMSDs before engaged in this job, and were diagnosed for bone disease respectively.

The recreation time of 127(53.4%) laboratory staffs were spent on watching television and 41(17.2%) reading books. None of respondents has smoking behavior, whereas 48(20.2%) of respondents consume alcohol twice per week. Moreover 216(90.8%) of participants had job stress and more than half of 141(59.2%) were not satisfied with their job (Table 5).

Table 5. Individual characteristics of MLPs in Bahirdar, Ethiopia, 2021.

Variables	Category	N	(%)
Body mass index	Underweight	16	6.7
	Healthy	221	92.9
	Overweight	1	0.4
Regular physical exercise	None	153	64.3
	Two times per week	51	21.4
	≥ 3 times per week	34	14.3
Medical history of systemic illness	Yes	15	6.3
	No	223	93.7
Symptoms related to WMSDs before engaged in this job	Yes	8	3.4
	No	230	96.6
Alcohol drinking behavior	Yes	48	20.2
	No	190	79.8
Diagnosis of bone disease	Yes	12	5.0
	No	226	95.0
Type of Recreation	Watching television	127	53.4
	Reading books	41	17.2
	Doing home activities	70	29.4

Table 5. (continued)

Ergonomics	Yes	77	32.4
	No	161	67.6
Job stress	<=15	216	90.8
	16-35	22	9.8
Job satisfaction	10-31	97	40.8
	32-50	141	59.2

6.3 Ergonomic risk practices

Working situations medical laboratory professionals

The mean of weekly working days were 5.72(SD=1.019) and the mean of weekly working hours were 47.64(SD=10.42). Specifically, more than half of medical laboratory staffs 129(54.2%), and 140(58.8%) worked for more than five days and 41 hours per week respectively. Furthermore, there was no working breaks other than lunchtime on regular laboratory work for one hundred forty (58.8%) medical laboratory professionals. Among the rest 66(27.7%) took a break of less than 15 minutes.

More than half(58.0%) and half(50.4%) respondents did highly loaded work sometimes and repetitive movements within <30 seconds respectively. One hundred thirty two (55.5%) of MLPs had overtime work. Of those 82(34.5%) were on the work for 1 to 15 hours weekly and they 36(15.1%) had a work break of 4 to 16 minutes. 66 (27.7%) laboratory personnels had second job, among them 45(18.9%) use 1-5 hours daily. Many laboratory professionals 118(49.8%) spent 1 to 4 hours on housework and 76(31.6%) were take care of children under five years from 1 to 4 hours daily (Table 6).

Table 6. Work situations of MLPs working in HFs of Bahirdar, Ethiopia, 2021.

Variables	Category	Frequency(n=238)	(%)
Working days in week	≤5	109	45.8
	>5	129	54.2
Working hours in week	<40	98	41.2
	≥40	140	58.8
Presence of working breaks excluding lunch time	No	140	58.8
	≤ 15 minutes	66	27.7

	>15 minutes	32	13.4

Table 6. (continued)

Doing high loaded work	never	14	5.9
	sometimes	138	58.0
	always	86	36.1
Repetitive movement within < 30 seconds	never	31	13.0
	sometimes	120	50.4
	always	87	36.6
Number of hours in overtime work per week	No	106	44.5
	1-15	82	34.5
	16-30	41	17.2
	31-45	9	3.8
Rest between overtime work	No	76	31.9
	4-16	36	15.1
	17-28	12	5.0
	29-40	5	2.3
	>40	3	1.3
Hours spent in second job per day	No	172	72.2
	1-5	45	18.9
	6-10	18	7.6
	>10	3	1.3
Number of hours in housework	No	50	21.0
	1-4	118	49.8
	5-8	65	27.3
	9-12	5	2.1
Number of hours carrying children <5	No	126	52.9
	1-4	76	31.6
	5-8	33	13.9
	9-12	3	1.3

Characteristics of work environment among medical laboratory personnels

The study showed almost all 230(96.6%) of MLPs were permanently employed. 123(51.7%) respondents were working on public hospitals. Among MLPs 55(23.1%) were assigned on Parasitology and urinalysis section, 41(17.2%) Hematology, 36(15.1%) Clinical chemistry, and 62(26.1%) had miscellaneous. With regard to workstations, professionals that work on seating bench were 42(17.6%), computer 53(22.3%), standing bench 34(14.3%), microscope 29(12.2%). 130(54.6%) laboratory staff served 12 to 82 customer in a day. 150(63%) of MLPs were setting on the workplace for 4 to 6 hours daily and 126(52.9%) were standing 4-6 hours. As judged subjectively by laboratory staffs 176(81.5%) reported there was available light on the workplace (Table 7).

Table 7. Workplace characteristics of MLPs working in HFs of Bahirdar, Ethiopia, 2021.

Variables	Category	Frequency	(%)
Employment status	Contract	8	3.4
	Permanent	230	96.6
Status of health facility	Public hospital	123	51.7
	Public health center	30	12.6
	Private hospital	38	16.0
	Private clinic	32	13.4
	Others	15	6.3
Section of laboratory dept.	Clinical chemistry	36	15.1
	Hematology	41	17.2
	Bacteriology	20	8.4
	Parasitology and urinalysis	55	23.1
	ART laboratory	8	3.4
	Blood bank	16	6.7
	Miscellaneous	62	26.1
Workstations of MLPs	Standing bench	34	14.3
	Seating bench	42	17.6
	Laboratory chairs	28	11.8
	Microscope	29	12.2
	Pipettes	28	11.8

	Micromanipulation	11	4.6
	Computer	53	22.3
	Miscellaneous	13	5.5
Number of customers	1-35	13	13.9
	36-70	71	29.8
	71-105	88	37.0
	>105	46	19.3
Average sitting time, h/d	1-3	63	26.5
	4-6	150	63.0
	7-9	25	10.5
Average standing time, h/d	1-3	102	42.9
	4-6	126	52.9
	7-9	10	4.2
Availability of light	yes	196	82.4
	no	42	17.6

6.4 Logistic regression analysis of study variables

Bivariate analysis of sociodemographic characteristics of participants revealed marital status, monthly salary and work experience of participants significantly associated with WMSDs. Laboratory personnels that got a monthly salary of greater than 4500ETB had little risk of experiencing WMSDs than those who earned less (OR, 2.451;95% CI, 1.108-5.420). The more experienced laboratory staffs i.e. > 5 years had lesser experience WMSDs than those who had < 5 years of work experience (OR, 0.063; 95% CI, 0.013-0.2975). Age (OR, 0.147; 95% CI, 0.062-0.347) and Sex (OR, 0.975; 95% CI, 0.578-1.645) did not fit with the model of Hosmer and Lemeshow test (Table 8).

Different Individual characteristics of study participants were analyzed among them reading books as a recreation was greater than two times more likely to develop a risk of WMSDs (OR, 2.451; 95% CI, 1.108-5.420). Regular physical exercise had an association with report of WMSDs (OR, 1.399; 95% CI, 0.821-2.381) at a significant value of 0.217. Type of recreation, diagnosis of bone disease, job stress and job satisfaction had no an association with reports of WMSDs (Table 8).

Ergonomic risk practice like repetitive movement of medical laboratory works within 30 seconds and doing of high workload had significantly associated with WMSDs. On the other hand, there was no association between variables hours for caring children younger than 5 years and report of WMSDs. The association of report of WMSDs and overtime work, regular housework, rest between regular laboratory tasks, and secondary work did not fit with the Hosmer and Lemeshow test model (Table 8).

The medical laboratory work place also analyzed on the current study. Many laboratory sections had a negative association with reports of the outcome variable. MLPs working in sections of laboratory like Hematology, Parasitology & urinalysis, ART and miscellaneous, and were found lower risk of WMSDs. Whereas there was significant association between number of customers serviced in a day, average standing time, and average sitting time, with WMSDs. There was no a significant association between status of health facility, and main workstation. The association of report of WMSDs and availability of light did not fit with the Hosmer and Lemeshow test model (Table 8).

To minimize confounders adjusted odds ratio was necessary. To analyze well, only variables with $p<0.25$ in the bivariate analysis were calculated in the multiple logistic regression analysis. Work tincture and section of laboratory had a significant association with WMSDs after analyzed using multivariate analysis.

Laboratory personnels whose work experience greater than ranged from 5-15 years (AOR, 0.325; 95% CI,(0.156-0.678) and ≥15 years (AOR, 0.05 ;95%CI, (0.009-0.336) with significance value of 0.003 and 0.002 respectively, which had less chance of developing WMSDs. Sections of laboratory such as bacteriology and parasitology and urinalysis had AOR of (AOR, 0.215; 95% CI, (0.055- 0.834) and (AOR, 0.166; 95% CI, (0.057- 0.478) respectively that implies MLPs who served in listed sections had less risk of WMSDs.

Marital status, monthly salary, type of recreation, regular physical exercise, repetitive movement within < 30 seconds, number of customers serviced in a day, average sitting and standing time had no significant association with work related musculoskeletal disorders (Table 8).

Table 8. Logistic regression analysis factors among MLPs in Bahirdar, Ethiopia, 2021.

		WMDS			P		P
Variable	**Category**	**Yes**	**No**	**COR (95% CI)**	**value**	**AOR(95% CI)**	**value**
Marital status	Widowed	5	1	1		1	
	Single	72	63	4.247 (0.483-37.325)	0.192	1.167(0.594-2.291)	0.614
	Married	38	59	7.763(0.873-69.047)	0.066	0.141(0.013-1.523)	0.107
Monthly salary	<4501	32	21	1		1	
in ETB	4501-7501	59	62	0.873(0.467-1.633)	0.671	1.204(0.566-2.560)	0.630
	>7501	25	33	0.497(0.233-1.060)	0.070	1.172(0.424-3.245)	0.759
Work experience	<5 years	14	2	1		1	
	5-15 years	76	61	0.354(0.200-0.626)	0.000	0.325(0.156-0.678)	**0.003***
	>15 years	26	59	0.063(0.013-0.297)	0.000	0.056(0.009-0.336)	**0.002***
Type of	Home activities	41	29	1		1	
recreation	Watching TV	60	67	1.579(0.876-2.847)	0.129	1.146(0.574-2.288)	0.700
	Reading books	15	26	2.451(1.108-5.420)	0.027	2.348(0.957-5.760)	0.062
Regular physical	No	70	83	1		1	
exercise	Yes	46	39	1.399(0.821-2.381)	0.217	0.550(0.292-1.037)	0.065
Repetitive	Never	12	19	1		1	
movement	sometimes	54	66	0.467(0.202-1.081)	0.075	0.980(0.397-2.418)	0.965
within < 30	always	50	37	0.772(0.344-1.730)	0.530	1.020(0.385-2.702)	0.969
seconds							
Laboratory	Cl. Chemistry	10	26	1		1	
section	Hematology	20	21	0.256(0.081-0.813)	0.021	0.463(0.157-1.369)	0.164
	Bacteriology	12	8	0.641(0.129-3.196)	0.587	0.215(0.055-0.834)	**0.026***
	Parasitology &	32	23	0.445(0.172-1.155)	0.096	0.166(0.057-0.478)	**0.001***
	urinalysis	4	4	0.385(0.159-0.930)	0.034	0.689(0.111-4.279)	0.689
	ART laboratory	7	9	0.641(0.184-2.232)	0.485	0.537(0.129-2.243)	0.394
	Blood bank	30	32	0.220(0.088-0.548)	0.001	0.402(0.143 -1.125)	0.083
	Miscellaneous						
Number of	1-35	14	19	1		1	
customers	36-70	40	31	0.571(0.248-1.316)	0.188	0.402(0.145-1.118)	0.081

Serviced in a day	71-105	41	47	0.845(0.377-1.894)	0.682	0.626(0.232-1.685)	0.354
	>105	21	25	0.877(0.356-2.161)	0.776	0.434(0.144-1.308)	0.138
Average	1-3	49	53	1		1	
standing time,	4-6	59	67	0.231(0.047-1.142)	0.072	1.356(0.638-2.882)	0.429
h/d	7-9	8	2	1.050(0.622-1.771)	0.855	0.346(0.052-2.300)	0.272
Average sitting	1-3	34	29	1		1	
time, h/d	4-6	73	77	1.237(0.686-2.231)	0.480	1.091(0.468-2.540)	0.840
	7-9	9	16	2.084(0.802-5.417)	0.132	2.291(0.609-8.619)	0.220

Abbreviations: ETB Ethiopian Birr, CI confidence interval, COR crude odds ratio, AOR adjusted odds ratio, 1= reference, and "*" represents statistically significance of variables.

Results of qualitative data

Perception of medical laboratory professionals about ergonomics risk practices

Awareness and commitment of medical laboratory staffs and managers

Seventy-seven (32.4%) participants reported they heard about ergonomics, and the source of information was regular education 30(12.6%) and training 26(10.9%) (Table 5). All who had awareness about ergonomics believe the necessity to applying the principle of ergonomics. Twenty-six (10.9%) respondents reported they exposed to biological and chemical risk majorly.

Laboratory managers i.e. 15 out of 27 reported did not heard about ergonomics. The others (12 out of 25) know little about ergonomics, their source of information was from formal education (50%) and training. They reported the importance of ergonomics to grow productivity of the health facility and to keep the professionals health. Nevertheless, eight managers reported there was no interventional measures took place on the work place, four of the 12 declared that there was training about the concept. Ten (37%) managers reported that the duty of applying the principle of ergonomics should be responsibility of MLPs and managers.

Table 9. Awareness of ergonomics by type of HFs of Bahirdar, Ethiopia, 2021.

Do you heard about ergonomics?	Gov't owned hospital	Gov't owned HC	Private hospital	Private clinic	Others
Yes	45(58.4%)	10(13.0%)	9(11.7%)	10(13.0%)	3(3.0%)
No	78(48.4%)	20(12.4%)	29(18.0%)	22(13.7%)	12(7.5%)

Ergonomics workstations evaluations among laboratory managers

The association of ergonomic hazards and WMSDs may be understated by making a good setup of workplace for workers (6). Observational method was applied to evaluate the workstation. The following parameters were used to analyze this workstation. Evenness of workstation, amount of workspace, suitability of design of tools and equipments, working height adjustment, working chair adjustment, the possibility to sit and rest, repetition of sustained work when twisting of the back, neck and hand, availability of light and repetition of similar movements.

Among twenty-seven MLPs that participated in the study 24(88.9%) were on sustained work while their back was mildly flexed forward. 22(81.5%) of study participants were perform their repeated work in uncomfortable hand positions. 26(96.3%) study participants were work on sustained work when their arm reaches forward without support. Furthermore, 25(92.6%) study participants work similar work movements repeatedly.

The observation showed that 16(59.3%) of working surface area was evenly arranged well. 16(59.3%) of working space was too limited for work movements. The force needed to complete the task depends on significantly on proper design of tools and equipments. The other fact that worsens the working space was 18 (66.7%) tools and equipments design was not suitable. The working height of only 14(51.9%) tables was correctly fit with the workers body condition. 19(70.4%) of professionals had a possibility to sit and rest.

General evaluation of ergonomic workstations

To determine the final score, the numbers of ergonomic workstations evaluated were 156. The mean score of less than 2.00 was scored by 54 (34.6%) workstations. That clearly indicates poor ergonomic condition. Hence, the overall mean score was 2.28; no workstation got a good status. A mean score greater than 4.00 implies good ergonomic situation (Table 10).

Table 10. Mean score evaluation of medical laboratory workstations.

Scores	1	2	3	4	5	Total Workstations	
Workstations	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)[a]	Mean score[b]
Standing bench	7(25.9)	14(37.0)	6(22.2)	NA	NA	27(17.3)	1.96
Seating bench	6(22.2)	12(44.4)	9(33.3)	NA	NA	27(17.3)	2.11
Laboratory chairs	6(22.2)	11(40.7)	10(37)	NA	NA	27(17.3)	2.15
Microscopes	5(18.5)	15(55.5)	5(18.5)	2(7.4)	NA	27(17.3)	2.15
Pipettes	11(40.7)	12(44.4)	4(14.8)	NA	NA	27(17.3)	1.74
Computer	NA	4(36.4)	6(54.5)	2(18.2)	NA	11(7.5)	3.09
Micromanipulation	NA	4(40)	4(40)	2(20)	NA	10(6.4)	2.8
Total	35(23.9)	68(46.6)	40(31.5)	4(2.7)	NA	156(100)	2.28

NA, not applicable, n=238

[b]poor ergonomic conditions=2.00 or lower, good ergonomic conditions=4.00 or higher.

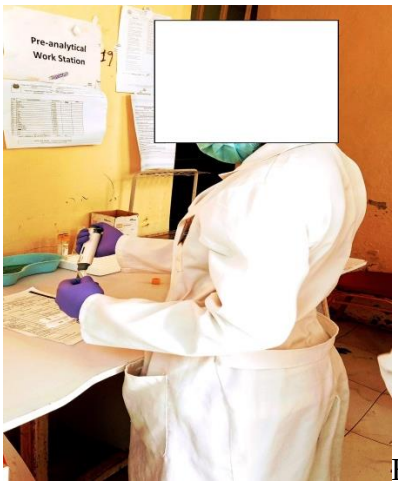
[a]n= 156 respondents worked in health facilities of Bahirdar.

Standing and Sitting Workstations

A total of 27 standing benches were assessed among them none of them had anti-fatigue matting, all laboratory benches were fixed, the height of 16(59%) laboratory benches fitted with workers, 17(62.9%) benches had ample leg room, 5(18.5%) benches has contact stressor, 25 (92.6%) workstations had no rounded padded edges to reduce contact stress and 24(88.8%) MLPs had necessary materials around their arm's reach averagely expected within 11 inches. Twenty-seven seating benches were observed. Forty of them (51.9%) had cut outs usable for seated workers. Figure 3 shows some of standing and sitting workstations in some health facility laboratories.

Computer workstation

Totally 27 health facility workstations were assessed. 11(40.7%) health facilities has computer workstations among them 7(63.6%) were private health facilities. 8(72.7%) computer workstations had adjustable seats and back support , all computer work stations has ample leg room , only 3(27.2%) seats had foot rest provided, 3(27.2%) computer monitors are out of arm distance, 3(27.2%) computer workstation tables are not at recommended height. 6(22.2%) workstations had a computer monitor at an arm distance. Nineteen (70.4%) workstations had not ample room to accommodate a keyboard and a computer mouse to make employees to rest their side and forearms parallel to the floor. None of them had glare screens on the monitors.

A. 

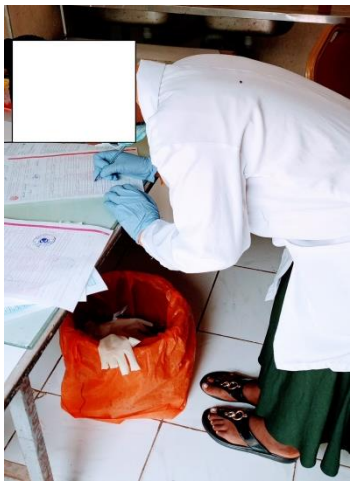
B, 
C. 

Figure 3. MLPs in standing and sitting workstations of HFs of Bahirdar, Ethiopia, 2021.

A, awkward arm and neck position. **B**, unfitted sitting bench, no hand and back support. **C**, awkward posture of the whole body and compromised knee clearance.

A.  **B.**  **C.** 

Figure 4 Microscopic and computer workstation in some HFs of Bahirdar, Ethiopia, 2021.

A, no support for hand and unadjusted chair in computer workstation, **B**, no backrest, and unadjusted chair in microscopic workstation **C,** unsupported back and awkward position of back in chemistry workstation.

Microscope workstation

Among clinical laboratory professionals who were on microscopy workstation, five out of 27 had rounded chair. 23 (85%) laboratory professionals has excessive neck flexion (>25 degree), no contact stressor between sharp edges and the forearms on microscopy workstation, 13 (48%) microscopies are pulled out to the end of the workbench to make the work easier**,** none of the workstations had armrests or padding, 16 (59%) workstations had sufficient leg room and professionals rest their feet on laboratory stool as a support. **Figure 4** shows microscopic workstation.

Chair workstation

Totally 27 laboratory chairs were assessed; the number of chairs which had adjustable height and backrests was 15(55.6%). A chair with footrest support was 20(70.0%). In addition, chairs that had adjustable armrests that may be removed if they made an obstacle were 21(77.8%).

Pipette workstations

The other workstation assessed was pipette. The numbers of pipette workstations were 27. Almost all workstations 26(95%) were used routine pipetting by single manual pipette. 14 MLPs were observed on work for more than two hours per day**.** One health facility uses multichannel pipettes and works more than 4 hours a day. Five (18.5%) laboratory professionals worked in neutral position with relaxed arm, wrist and shoulder.

Micromanipulation

Eighty eight percent of the time (7 of 8 times) workstations were performed micromanipulations like decapping and capping tubes easily.

7. Discussion

WMSDs and ergonomic risk factors in medical laboratory department of health institutions were source of negative effect on workers' quality of life, capacity of productivity, pattern of absenteeism, and disabilities on body parts (2). The current study tried to assess the magnitude of work related musculoskeletal disorders, ergonomic risk practice and their perceptions among MLPs working in Bahirdar health facilities, Ethiopia.

This study revealed the magnitude of WMSDs within the past 12 months were (48.7%) in line with studies conducted in Addis Abeba (49.4%) among MLPs (11), and study among adults in Ethiopia 35% to 74.5% (18). Rebelliously, the magnitude of the study finding is greater than the study done among MLPs in Nigeria (34.5%) (8, 12), MLPs in India (18%) (58) and WMSDs in industry workers of Iran 36% (33). The results of the investigation had lower magnitude than two studies in India 66.9% (38) and 100% (59), another study in Saudi Arabia (82%) (2). The variation could be because of disparity in demographic difference and study setting.

The specific body parts which were affect more were lower back 49(20.6%), wrists/hands 39(16.4%) and upper back 33(13.9%). This study was lower than two studies of Saudi Arabia among laboratory workers were lower back (61%), upper back (44%) and also wrists/hands (34%) and the second study with a magnitude of shoulders (33.5%), low back (27.5%), upper back (26.5%), and neck (23.0%) respectively (2, 32). The pain magnitude from India were back pain (53%), neck (39%), wrist (21%), shoulder (21%), heel (14%) & knee (10%) (34). Among office workers of Nigerian hospital were low back (61.1%) neck (43.4%), shoulder (32.1%), upper back (31.5%), hips (30.6%), hand (26.5%), and elbow (12.7%) (35). A possible explanation regarding the disagreement of studies might be due to sociodemographic variation and study setting.

In the current study, lower back pain had high magnitude 49(20.6%). Which is comparative with studies done in Nigeria healthcare workers (36), general surgeons of India (60), a review from Brazil (6) and medical practitioners of Saudi Arabia (61). On the other hand, this study findings was lower than a study done in Nigeria among health workers (12). A possible explanation of the agreement between the studies may be due the nature of the procedure that the work needs or material design used by these health workers.

Laboratory personnel whose work experience ranged from 6 to 10 years (AOR,0.363; 95% CI,(0.181-0.726) and ≥16 years (AOR, 0.083;95%CI, (0.008-0.842) with significance value of 0.004 and 0.035 respectively, had less chance of developing WMSDs when compared with work experience of 1 to 5 years. Younger professionals that had the work experience of 1 and 5 years were more exposed to WMSDs which supported by studies from India and Australia (8, 15, 58). This result is also consistent with study done in Saudi Arabia (2). On the contrary, a study from the same country indicated that medical practitioners with work tincture of 6-10 years had twice as likely as study participants with 1-5 years of experiences to develop WMSDs (61).

Insubordinately, a study done by Agrawal *et al*. reported duration of employment had no association with occurrence of WMSDs (58). On the other side, a study conducted among Iranian health workers reported no association between problems of WMSDs and work experience (62). In other words, WMSDs may meaningfully relate with medical laboratory professionals work experience, lack of training, lack of systematic working habit. In addition, this may be because less experienced personnels may participate in work that is more technical, little experience to handle bad ergonomic conditions and exposed to high workload. As a result, a new direction of outlook could be necessary to solve the occurrence of WMSDs at early age and stages of career.

One of the major factors in WMSDs was sections of medical laboratory departments. This study found an association between some sections of laboratory and WMSDs. Laboratory staffs that were in sections like bacteriology (AOR, 0.218; 95% CI, (0.065- 0.727), and parasitology and urinalysis (AOR, 0.384; 95% CI, (0.152- 0.974) had lesser risk of WMSDs. The possible explanation for lower risk of WMSDs in bacteriology department may be presence of low workloads and incase of parasitology and urinalysis due to presence of work shifts. This research was generally coincides with similar findings in Addis Abeba (19). The reason for the agreement might be due to sociodemographic similarities and evaluation tools used.

Based on the current study, awareness about ergonomics had less likely association with WMSDs. Among 238 MLPs, 77(32.4%) heard about ergonomics. Which is comparable with study in Nigeria (25.5%) (5). Even though, there was no updated study on the local context. Ergonomic awareness of this study participants was greater than a two studies conducted in

Ethiopia, the first among MLPs 15.4% (19) and the second within industry workers (42). The difference might be due to variation on study setting and years.

Nevertheless, ergonomics is new to the healthcare (5), regular education and training was the major source of an information. But the worse result was half of interviewed, 15(55.6%) laboratory managers reported they had no any idea about ergonomics, which is supported by previous study findings in Ethiopia (19). To get the very benefit of ergonomics, laboratory managers had no basic knowledge that leads poor application (5). Likewise, awareness of ergonomics at the work place among majority of participants did not known (39). The possible explanation may be due to poor in-house training about ergonomics (5). Moreover, weakness of peer teaching and orientation after taking training. We understand that the best scheme for preventing WMSDs were strengthen trainings about ergonomics (63).

The major relevant issue to the occurrence of MSDs are the working posture of workers, handling of materials, movements performed repeatedly, static work and work related disorders. WMSDs mostly affect neck/shoulder and low back of the body (22). When the work environment was in poor ergonomic design, which leads to awkward postures and work activities that consequently leads to biomechanical stresses on joints, muscles, and tendons (63). When the result of evaluation of ergonomic workstations is 2.00 or lower, it is represent as poor ergonomic conditions and if the evaluated result is 4.00 or higher, it represented as good ergonomic conditions. In our study, the mean score of the workstations were 2.28 that show poor ergonomic condition and a comparable study of Iran reported a mean score of 2.21(64). It is contrasting with a study from Ethiopia with a mean score of 1.95 (19). The deviation from Haile et al. study could be due to set up of laboratories and production of ergonomically well designed materials currently.

We have a chance to see its magnitude in line with standing and sitting workstations. Accordingly, the study revealed that many conditions of standing and sitting workstations were poor with a mean score of 1.96 and 2.11 respectively. There was no anti fatigue matting in any workstation, 11(40.7%) height of benches were not adjusted, 81.5% of benches had no contact stressor, 13(48.1%) seated benches had no cut out and all benches had fixed height and no supportive shoes used. It is comparable with a study by Haile *et al* in terms of percentage of

rounded edge of contact stressor, easiness of reaching materials on laboratory benches (19). Likewise a study conducted in India, reported prolonged standing, inappropriate height of tables had no an association with WMSDs (58). The reason for the comparability of the study may be due to similarity of sociodemographic factors.

In this study, the number of chairs with lumbar support and adjustability features was eight (72.7%). The number of workstations without foot support was eight (72.7%). The Workstations without enough space to hold monitor and mouse was 19(70.4%) that have consequently uncomfortable hand position. All workstations had no antiglares screens, which is in comparison with the study in Ethiopia reported as the laboratory chairs with adjustment feature was 43.8% (19), whereas in Indian study chairs with adjustability feature was 51.6%, workstations that had no foot support were 66.7%, laboratory computers with an antiglare screens was 25.0%. (58). The difference might be created because of advancements in furnitures technologies in near feature, limited awareness about the importance of the materials, the necessity of the product may be decreased, example antiglare screens because of improvements on buildings.

The magnitude of sufficient legroom in the workplace was 16(59%). In contrast, the study in India exposed 11.1% participants on microscope workspace had no enough leg and space which directly leads to enhance exposure of awkward posture. (58). Use of microscope at awkward posture for long period of time associated with WMSDs (65) and 23(85%) of MLPs has excessive neck flexion that significantly associated with WMSDs (61). On microscopy workstation, there was no contact stressor between sharp edges and the forearm that creates WMSDs of hand and wrists (66). The probable explanatory difference may be awareness variation and workplace design difference.

To reduce the occurrence of musculoskeletal disorders having ergonomic requirements of chairs have been very much important (58). In the present study, fifty (55.6%) chairs had adjustable height and backrests, 20(70%) had foot support and 21(77.8%) had removable adjustable armrests, which is contrast with a study from Addis Abeba resulted with (20.0%) had adjustable height and backrests, 12(60.0%) had footrest support and 5(25.0%) had had removable adjustable armrests (19), the differences may be due to technological advancement, increment of awareness of MLPs and the buying power of health facilities.

In the present study, 22(81.5%) MLPs working in pipette workstation did not worked in relaxed shoulder and neutral position of arms and wrists. Which is supported by similar previous study findings in Ethiopia that reported 86.6% of MLPs did not work in neutral position of arms and wrists and with relaxed shoulder (19). This might be due to poor awareness of ergonomics and knowledge of gains of its right among MLPs (5). Moreover, there are limited studies about ergonomic hazards that ultimately lead to musculoskeletal problems (39). The study from India concluded that the percentage of participants with WMSD that were work on pipette in awkward posture was 6.7% (58). The difference might be due to awareness about neutral position of body, the ability to provide ergonomic workstation and work setup.

8. Strengths and limitations of the study

Strength of the Study

This study attempts to covers all laboratory tasks and laboratory professionals. Trained medical laboratory professionals and clinical laboratory experts respectively did data collection and supervision, which consequently increase data reliability. To assure the quality of data, tools of data collection was pretesting in one of tertiary hospital in Amhara region.

Limitation of the Study

Due to different factors, this study had some limitations and reader should consider them while inferring our finding: it was limited by cross sectional nature of the study design. The study demanded a 12-month period recall about the magnitude of musculoskeletal disorders, which might be lead to under or over estimation on the magnitude of WMSDs. Few study participants answer questionnaires partially. The same is true for related studies, it might be difficult to distinguish between WMSDs and musculoskeletal disorders of other causes for MLPs.

9. Conclusion and recommendations

Conclusion

The finding of this study confirms, about half of the study participants, 116(48.7%) MLPs suffered from WMSDs and majority was from public hospitals. Among them, 42.4% of MLPs took medication. Of the nine body regions lower back, wrist/hand and upper back pain was the mainly affected. MLPs reported the foremost causes of WMSDs were doing the same laboratory tasks repeatedly within short period of time and awkward posture. The choice of the recreation type for 70.6% of medical laboratory staffs were watching TV and reading books. Doing physical exercise did not a part of majority MLPs lifestyle.

Binary logistic regression analysis revealed marital status, monthly salary, work experience, regular physical exercise, repetitive movement of works within 30 seconds, section of laboratory, number of customers served in a day, average standing time, and average sitting time were significantly associated with WMSDs. Likewise, work experience and sections of laboratory are significantly associated with WMSDs.

About one third 77(32.4%) of MLPs heard about ergonomics that inversely explained majority of MLPs did not aware about ergonomics at the workplace. More specifically 15(55.5%) laboratory

managers did not know (heard) anything about ergonomics and 12(44.4%) know little about the concept and 37% of managers reported that the duty of applying ergonomics principle should be obligation of MLPs and managers.

The workstations scored of standing bench, seating bench, laboratory chairs, Microscopes, pipettes, computer and micromanipulation were noncompliance. The final overall score was 2.28, which showed poor ergonomic workstation.

Recommendations

Based on the current study, the following specific recommendations were drawn:

Medical laboratory professionals and managers

To decrease WMSDs, laboratory workplace setup takes priority. Modification of tools and equipments were necessary to fit with the body nature of MLPs. For instance, another measure to have healthy body condition in any workstation was repositioning of standing and sitting workstations, providing antifatigue matting, contact stressor, neutral positioning of neck, arm and wrists, sufficient leg room. All chairs should have adjustability feature and back support. The computer workstation should have antiglare screens to protect eyestrain.

It is better to give training and orientation about causes of WMSDs for especially less experienced MLPs to adopt preventive measures and whenever newly graduated employed staffs.

It is better to create and enhance awareness about ergonomic risk practice and good workstation organization by teaching each other in the form of continual professional development (CPD), browsing websites and reading books. Moreover, take an action using the available information.

MLPs also should influence their immediate responsible bodies to get training about ergonomic risk practices and work station arrangements.

Managers of Health facilities

The Wellness of medical laboratory workers are a prerequisite for the effectiveness of health facilities, thus it is better to prepare and execute immediate orientation, and training for every laboratory worker. Especially intervention program that centered on eliminating repetitive movements and awkward posture, and redesigning the workplace should be performed. It is necessary to upgrade health facilities' laboratory department with regard to the organization of workstations. Hence, most workstations are under standard score.

Regional health bureau

An attention given to implementation of safety and health policy about ergonomic risk practice and workstation convenience was very low, consequently the magnitude of WMSDs was high that calls the needs necessary actions.

Ergonomically adaptable furnitures and buildings should be specified and planned to make and build in the future. Moreover, an assessment system should be created and applied to be saved MLPs from WMSDs.

Ministry of Health

Clear and actionable guideline should be formulated in regard to orientation and training of medical laboratory professionals about ergonomic risk practice and workstation.

Higher Educational institutions

Educational programs should be encouraged, to develop on WMSDs preventive strategies mainly on safe ergonomics that results health and wellbeing of medical laboratory professionals.

To minimize WMSDs and to increase attrition rate, the concept about medical laboratory work place ergonomic risk practices and workstation adjustment should be included in training jointly with ministry of health.

Researchers

To make strong conclusion, it is necessary to conduct studies in different study design and large setup to provide deeper perceptions on WMSDs.

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11. Annexes

Data collection Tools

Annex 1: Participant's Information Sheet and consent

Title of the Research Project: Magnitude of work related musculoskeletal disorders, ergonomic risk practices and their perceptions among medical laboratory professionals of Bahirdar, Ethiopia.

Principal Investigator: Mekuriaw Temeche (BSc)

Name of the Organization: Department of Medical Laboratory Sciences, College of Health Sciences, Addis Ababa University

Introduction

Hello. You are invited to participate as a study subject in a research conducted by Mekuriaw Temeche MSc candidate, from Addis Ababa University. Your participation is voluntarily. The research teams will include one principal investigator, two advisors; one from Addis Ababa University clinical laboratory department and one from Amhara public health institute. Please take as much time as you need to read or listen in the information sheet.

Purpose of the research project

We are asking you to take part in this study because we will try to assess the magnitude of work related musculoskeletal disorders, ergonomic risk practices and their perceptions among medical laboratory professionals**.**

Purpose of the research:

Presently the health laboratories lack standardized furnitures, design of building and high workload. Beyond this, they have limited knowledge and management of WMSDs and ergonomic risk practice. Therefore, the purpose of this proposed study is to assess the magnitude of work related musculoskeletal disorders, ergonomic risk practices and their perceptions among medical laboratory professionals**.** You have been chosen for this study. Therefore, we invite you to take part in this study and contribute to the best of yourself and your profession. The result of this study will help policy makers and hospital managers for planning, implementing and evaluating various interventions for management of work related musculoskeletal disorders, ergonomic risk practices and their perceptions among medical laboratory professionals. This further prevent possible occurrence of disorders affected medical laboratory professionals directly and their families, the health facilities and the society indirectly.

Procedures and the expected participation

For this study to be successful, we need your participation if you are willing to respond self-administered questionnaires. If you are willing to participate, you need to understand the purpose of the study and give your consent.

Procedures: After agreeing that you can take part, one or more of our research staff will give you some self-administered questionnaires, which will take up to 15 minutes. Your weight, height will be measured.

Potential risks and Discomforts

No potential risks and discomforts expected.

Confidentiality

We respect your privacy and confidentiality. Any information that identifies you will not be shared with anyone else outside the study team. The information we will collect from you as part of the study will be kept in a locked file cabinet, or be protected by a password on the computer only accessible to personnel involved in the study. There is no sensitive issue that you will be asked related with your social desirability but any information that is obtained in connection with this study and that can be identified with you will remain confidential.

Potential benefits to subjects and/or to the society

You will not receive any payment for your participation in this research study as compensation. However, when you go through the questionnaire you will aware and take measures to adapt yourself to work place and condition of the clinical laboratory.

Participation and withdrawal from the Study

The participation is voluntary and you have the right not to participate in this study. You may withdraw at any time and place without consequences of any kind. You can ask any questions regarding to this study.

Contact information

If you have any questions about this study, you can contact the following principal investigators and advisors for further information.

Name: Mekuriaw Temeche **Phone:** +251948015174

E-mail: mekuht@gmail.com

Informed consent form in English version

I will been informed that the objective of this study is to assess the magnitude of work related musculoskeletal disorders, ergonomic risk practices and their perceptions among medical laboratory professionals of Bahirdar city, Ethiopia. The results of this study have great contribution to aware, understand, measure issues related musculoskeletal disorders and ergonomic risk practice of clinical laboratory. I had been also informed about the confidentiality of this study. The principal investigator requested me to participate in the study that would require my willingness to provide the required data that include filling of questionnaires. Therefore, with full understanding of the importance of the study, I agreed voluntarily to provide the requested data and my benefit will be only from understanding of the issue and make the workplace adaptable for me to prevent myself from WMSDs.

I_____ hereby give my consent for providing the requested information.

Signature: _____ Date_____

Annex; 2 English version questionnaires

Part one: Socio-demographic characteristics of the study participants

Identification number_____ Date_____

Table 11. Socio-demographic characteristics for the study subjects

S. No	**Questions /variables**	**Coding category**	**Skip to**
101	Sex	1☐Male 2☐Female	
102	Age	Age in years _____	
103	Marital status	1☐ Single 2☐Married 3☐Divorced 4☐ Widowed	
104	Educational status	1☐College diploma 2☐First degree(BSc) 3☐ Second degree (MSC) 4☐ Third Degree (PhD)	
105	Monthly salary	_____ETB	
106	Work experience	_____years	

Part 2: Individual factors associated with WRMSDs among MLPs

Table 12. Individual factors associated with WRMSDs among MLPs

S. No	Questions /variables	Coding category	Skip to
201	How tall are you?	____m ____cm	
202	How much you are weighing in kilograms?	_____ kg	
203	BMI (body mass index)	Underweight (<18.5 kg/m^2) Healthy (18.5–24.9 kg/m^2) Overweight (25–29.9 kg/m^2) Obese (≥30 kg/m^2)	
204	Do you practice physical exercise?	1□Yes 2□No	If no, Q.206
205	If yes in question 204, How often doing physical exercise per week at least for 30 Minute on average?	Two times per week ≥Three times per week	
206	How do you use your recreation time?	Watching Television and reading books Others specify _____	
207	Do you smoke cigarette?	1□Yes 2□No	If no, Q210
208	If your answer to Q 207 is "yes" how often, do you smoke cigarette?	_____ days per week	
209	If yes in question 208, How many cigarettes do you smoking per day on average?	_____Sticks per day _____ packet per week	
210	Do you drink alcohol two times per week?	1□Yes 2□No	

211	Medical history of systemic illness	1□Yes 2□No	
212	Do you have any symptom related to WMSDs before engaged in this work?	1□Yes 2□No	
213	Do you have any housework?	1□Yes 2□No	If no, to Q. 214
214	On average, How many hours do you use for it?	_____hours	
215	Do you have children younger than 5 years in the house?	1□Yes 2□No	If no, to next part
216	How much time do you spend carrying the child per day?	_____hours	

Table 13. Pain and discomfort questionnaire

S.No	**Questions /variables**	**Coding category**	**Skip to**
301	Do you have previous diagnosis of bone disease	1☐Yes 2☐No	
302	Do you experience pain and discomfort caused by WMSDs within the year?	1☐Yes 2☐No	
303	What is the likely cause of the pain and discomfort?	1☐repetition, 2☐awkward posture, 3☐vibration, 4☐static loading, 5☐forceful exertion, 6☐extreme temperature 7☐If other specify_____	
304	Do you got any medication?	1☐Yes 2☐No	
305	Do you take a sick leave caused by WMSDs in the year ?	1☐Yes 2☐No	If no, to part 4
306	If yes, how many days?	_____days	

Part 4: Prevalence of WRMSDs among MLP by Nordic Musculoskeletal Questionnaire

Human Body segments

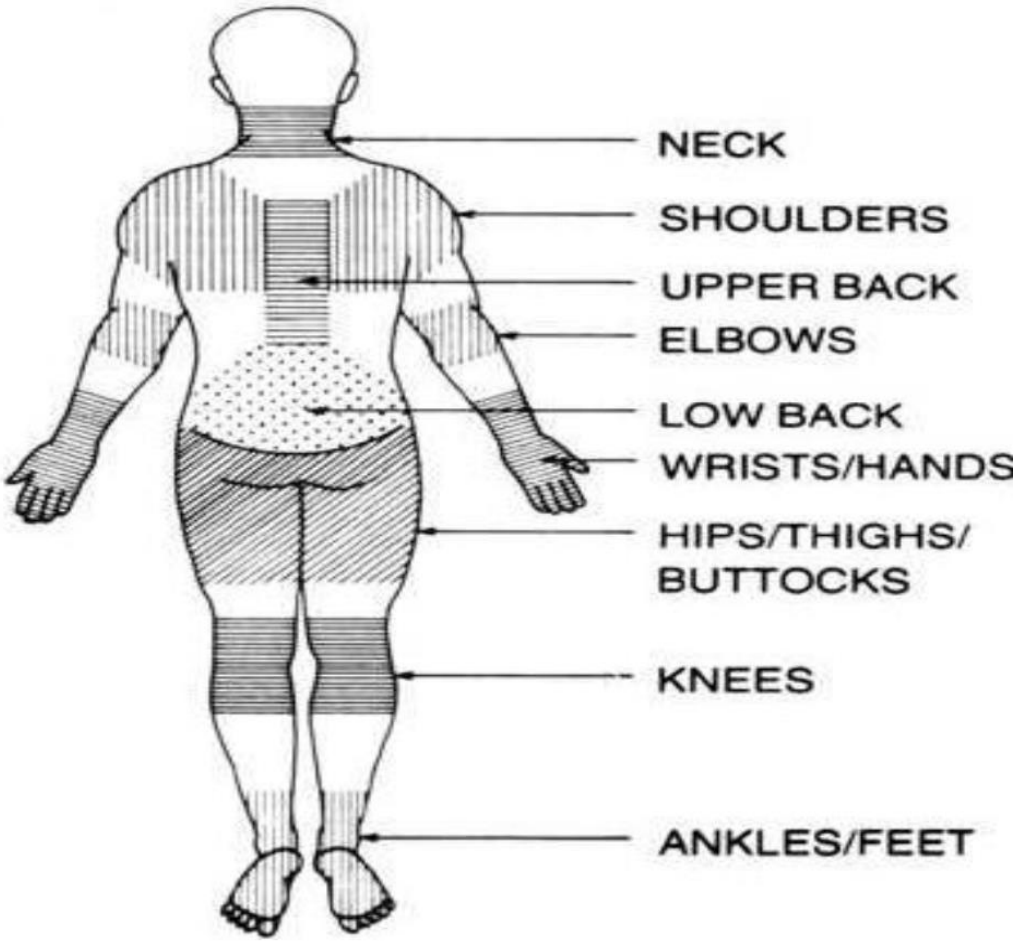

Figure 5 Human body segments

Please answer by using the tick boxes ☐ and one tick for each question

Please note that this part of the questionnaire should be answered, even if you have not had trouble in any parts of your body.

Table 14. Nordic Musculoskeletal Questionnaire

Have you had trouble (such as ache, pain, discomfort, numbness) in any parts of your body:	Have you been prevented from carrying out normal activities(e.g. job, housework, hobbies) because of this trouble:
1 Neck No yes 1☐ 2☐	10 Neck No yes 1☐ 2☐
2 Shoulders(both/either) No yes 1☐ 2☐ 3☐in the right shoulder 4☐in the left shoulder 5☐in both shoulders	11 Shoulders No yes 1☐ 2☐
3 Elbows(both/either) No yes 1☐ 2☐ 3☐in the right elbow 4☐in the left elbow 5☐in both elbows	12 Elbows (both/either) No yes 1☐ 2☐
4 Wrists/hands(both/either) No yes 1☐ 2☐ 3☐in the right wrist 4☐in the left wrist 5☐in both wrists	13 Wrists/hands(both/either) No yes 1☐ 2☐
5 Upper back No yes 1☐ 2☐	14 Upper back No yes 1☐ 2☐
6 Lower back(small of the back) No yes 1☐ 2☐	15 Lower back No yes 1☐ 2☐
7 one or both hips/buttocks/thighs(both/either) No yes 1☐ 2☐	16 Hips/buttocks/thighs No yes 1☐ 2☐
8 one or both knees No yes 1☐ 2☐	17 knees No yes 1☐ 2☐
9 one or both ankles or feet No yes 1☐ 2☐	18 ankles or feet No yes 1☐ 2☐

Part 5: Ergonomic risk practice factors associated with WMDs among MLPs

Part 5.1 Institutional factors associated with WMSDs of MLPs

Table 15. Institutional factors associated with WMSDs of MLPs

S. No	**Questions /variables**	**Coding category**	**Skip to**
401	Ownership of health institution	1☐public hospital 2☐public health center 3☐Private hospital 4☐private clinic 5☐ If other _____	
402	Employment status	1☐ Permanent 2☐ Contract 3☐ If other_____	
403	Payment method	1☐Hourly payment 2☐Fixed monthly	
404	Total working hours per week	_____hours	
405	Total working breaks excluding lunch break	_____minutes	
406	How much customer attending in a day on average?	_____customer	
407	Did you face high workload on the regular work	1☐Yes 2☐No	
408	Do you ever heard the word ergonomics?	1☐Yes 2☐No	If no, Q 411
409	Where do you heard?	1☐Regular education 2☐Training 3☐Orientation 4☐other_____	
410	Is it necessary to apply principle of ergonomics in the work place?	1☐Yes 2☐No	If no, to part 5.2

411	Do you exposed to work place hazards within a year?	1☐Yes 2☐No	
412	What type of risk do you experience?	1☐Biological 2☐Physical 3☐Chemical 4☐others	

Part 5.2: Medical laboratory workplace factors associated with WMSDs among MLPs

Table 16. Medical laboratory workplace factors associated with WMSDs among MLPs

S.no	**Questions /variables**	**Possible answer**	**Skip to**
501	Which is your Laboratory section?	1☐ Clinical chemistry 2☐Hematology 3☐Bacteriology 4☐Parasitology and Urinalysis 5☐ ART lab. 6☐Blood Bank 7☐Miscellaneous	
502	Which is your main workstation? (tick more than one if there)	1☐Standing bench 2☐Seating bench 3☐Laboratory chairs 4☐Microscopes 5☐Pipettes 6☐Micromanipulation 7☐Miscellaneous 8☐Computer work station	
503	Repetitive work within <30 seconds	1☐Never 2☐Sometimes 3☐Always	

504	How many days did you work per week?	_____days	
505	How much time did you spend on this work per day?	_____hours	
506	How much hours sitting per day on the workplace?	_____hours	
507	How much time standing per day on the workplace?	_____hours	
508	Do you have overtime work on the health facility?	1☐Yes 2☐No	If no, to Q. 511
509	Do you take a rest between tasks of overtime work of medical laboratory?	1☐Yes 2☐No	If no, to Q.511
510	If you take a rest, How many minutes?	_____minutes	
511	Do you have second job?	1☐Yes 2☐No	If no, to Q.513
512	How much hours do you work per day?	_____hours	
513	Availability of sufficient light	1☐Yes 2☐No	
514	Types of setting chair	1☐Fixed 2☐Adjustable	
515	Fitness of working equipment with sitting chairs	1☐Fit 2☐Unfit	

Part 6: Psychosocial factors associated with WMSDs among MLPs

Table 17. Psychosocial factors associated with WMSDs among MLPs

Questions to measure job stress (Q 601-607)						
S.no	**Questions /variables**	**Job stress score**				
		Never	Rarely	Some times	Often	Very often
601	Conditions at work are unpleasant or sometimes even unsafe.	1	2	3	4	5
602	I feel that my job is negatively affecting my physical or emotional wellbeing	1	2	3	4	5
603	I find it difficult to express my opinion or feelings about my job conditions to my superiors.	1	2	3	4	5
604	I feel that job pressures interfere with my family or personal life.	1	2	3	4	5
605	I have adequate control or input over my work duties.	5	4	3	2	1
606	I receive appropriate recognition or rewards for good performance.	5	4	3	2	1
607	I am able to utilize my skills and talents to the fullest extent at work	5	4	3	2	1

This scale is adapted from mind Garden international, Inc. (67).

Questions to measure job satisfaction (Q 609-618)

S.no	**Questions /variables**	**Job satisfaction score**				
		Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied
608	I receive recognition for a job well done.	1	2	3	4	5
609	I feel close to the people at work.	1	2	3	4	5
610	I feel good about working at this institution.	1	2	3	4	5
611	I feel secure about my job.	1	2	3	4	5
612	I believe management is concerned about me.	1	2	3	4	5
613	On the whole, I believe work is good for my physical health	1	2	3	4	5
614	My wages are good.	1	2	3	4	5
615	All my talents and skills are used at work.	1	2	3	4	5
616	I get along with my supervisors.	1	2	3	4	5
617	I feel good about my job	1	2	3	4	5

Adapted from a study of at Addis Abeba by Zenebe. G (42).

Part 7: Assessment checklist of medical laboratory workstations and sections

Date:_____ laboratory location:_____

Note: You should follow up on all responses with "yes" or "no" box.

Table 18. Adopted from checklists about ergonomic methods

Adopted checklist adapted from handbook of human factors and ergonomics methods (29).

Computer workstations		Yes	No
701	Is a seat provided?	☐	☐
702	Is the seat height adjustable within the recommendations?	☐	☐
703	Is lumbar back support provided?	☐	☐
704	Is a footrest provided?	☐	☐
705	Is there ample leg room?	☐	☐
706	Are all adjustability features easy to use?	☐	☐
707	Is there ample room to accommodate a keyboard and a computer mouse so the employee can rest their arms at their side and forearms parallel to the floor?	☐	☐
708	Is there ample room to place the monitor at arm length's distance?	☐	☐
709	Is the monitor at the recommended height?	☐	☐
Laboratory benches			
710	If the worker stands, is anti-fatigue matting supplied?	☐	☐
711	Is the height of the bench appropriate for the work that is performed?	☐	☐
712	Is there adequate legroom?	☐	☐
713	Do contact stressors exist such as bench tops with sharp edges?	☐	☐
714	Are necessary tools and materials within arm's reach? (Considered 4-18 inches)?		
Laboratory chairs			
715	Can all laboratory chairs be adjusted to accommodate all the employees who need to use chairs?	☐	☐
716	Can employees adjust their chair?	☐	☐
717	Is there chair backrest?		
718	Is there chair footrest?		

719	Is there adjustable armrests that could be removed if necessary?		
Microscopes			
720	Do the shoulders appear rounded and/or is the worker hunched over?	☐	☐
721	Is there excessive neck flexion (>25 degrees)?	☐	☐
722	Are there contact stresses between sharp edges and the forearms?	☐	☐
723	Is the microscope pulled out to the edge of the workbench?	☐	☐
724	Are armrests or padding provided?	☐	☐
725	Is the sufficient leg room?	☐	☐
726	Is there a foot rest provided?	☐	☐
727	Does the worker rest their feet on the laboratory stool?	☐	☐
728	Has the individual been trained how to properly sit at a microscope workstation?	☐	☐
729	Are microscope work breaks provided?	☐	☐
Pipetting			
730	Are manual pipettes used?	☐	☐
732	Is the pipette designed to reduce contact with sharp edges?	☐	☐
733	Has the individual been trained how to properly operate the pipettor (e.g., pickup tips, eject tips, program electronic pipettor, etc.)	☐	☐
734	Does the worker pipette more than 2 hours per day?	☐	☐
735	Are frequent breaks provided?	☐	☐
Micromanipulation			
736	Do you cap and decap easily?	☐	☐

Part 8: Observational Checklist

Code _____Date: _____

Table 19. Observational Checklist

S.no	Observational Checklist	Yes	No
801	Is the working surface even?	☐	☐
802	Is the space too limited for work movements or work materials?	☐	☐
803	Are tools and equipments suitably designed for the worker or the task?	☐	☐
804	Is the working height correctly adjusted?	☐	☐
805	Is the working chair correctly adjusted ?	☐	☐
806	Is sustained work performed when one arm reaches forward or to the side without support?	☐	☐
807	(If the work is performed adjusted while standing) is there possibility to sit and rest?	☐	☐
808	Is repeated or sustained work performed when the back is: Mildly flexed forward? Severely flexed forward? Bent sideways or mildly twisted? Severely twisted? Correct posture?		
809	Is repeated or sustained work performed when the neck is: Flexed forward? Bent sideways or mildly twisted? Severely twisted? Extended back ward? recommended posture		
810	Is there repetition of: Similar work movements? Similar work movements beyond comfortable reaching distance ?		

811	Is repeated work, with forearm and hand, performed with: Twisting movements? Forceful movements? Uncomfortable hand positions? comfortable hand positions?

Part 9: Interview questions

901. Do you know the word ergonomics?

902. Is there any training and orientation about ergonomics in medical laboratory?

903. Is it necessary to apply principle of ergonomics in the work place?

904. Whose responsibility is to apply the principle of ergonomics in the workplace?

905.Is there any interventional measure about ergonomics in medical laboratory workplace?

DECLARATION

I, the under signed, declare that this thesis is my original work in partial fulfillment of the requirements for the degree of Masters of Science in Medical Laboratory Sciences (Clinical Laboratory Management and Quality Assurance Track). All the sources of the materials used for this thesis and all people and institutions who gave support for this work are fully acknowledged.

Name: Mekuriaw Temeche (BSc)

Signature- ---------- Date: ----------, 2021

Place of submission: Addis Ababa University, School of Health Science Department of Medical laboratory science.

Date of submission: ----------

Approval of the Primary Advisor

This thesis has been submitted for examination with my approval as a university Advisor.

Advisor's Name: Abay sisay (MSc, PhD Cand., Assistant professor)

Signature_____ Date: ----------, 2021