THE PREVALENCE, PATTERNS AND FACTORS ASSOCIATED WITH WORK-RELATED MUSCULOSKELETAL SYMPTOMS AMONG SURGICAL RESIDENTS AT KENYATTA NATIONAL HOSPITAL

By

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Declaration

I hereby declare that this dissertation is my original work and has not been presented as a dissertation at any other university. All works used from other authors have been accordingly referenced.

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Abbreviations

CDC – Centre for Disease Control

ERC – Ethics and Research Committee

EU-OSHA – European Agency for Safety and Health at Work

KNH – Kenyatta National Hospital

NMQ – Nordic Musculoskeletal Questionnaire

PDS – Physical Discomfort Survey

PGY – Postgraduate Year of Study

UK – United Kingdom of Great Britain and Northern Ireland

UON – University of Nairobi

UK – United Kingdom

US – United States of America

WRMSDs – Work-related Musculoskeletal Disorders

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Abstract

Background: Workers all over the world are faced with work-related musculoskeletal disorders (WRMSDs) and symptoms, which have a large cost on both employers and employees. Within the medical sector, surgeons work in an environment that is not ergonomically ideal, and many suffer work-related musculoskeletal symptoms. The effects are significant, with some practitioners having reported early retirement due to work-related symptomatology. While a lot of data exists on musculoskeletal symptoms in practising surgeons, this is not the case for trainee surgeons. No published local data exists on work-related musculoskeletal symptoms among trainees in surgery.

Study Objective: To determine the prevalence, patterns and factors associated with work-related musculoskeletal symptoms among surgical residents working in Kenyatta National Hospital.

Study Design: This was a cross-sectional survey.

Study setting: The study was carried out in Kenyatta National Hospital.

Participants and methods: An electronic questionnaire prepared based on the Nordic Musculoskeletal Questionnaire (NMQ) was sent to all participants via electronic messaging across various online residents' groups. The questionnaire captured data on demographics and musculoskeletal symptoms experienced.

Data Analysis: Data was cleaned and analysed using the statistical software R. Both demographic and comparative analysis such as logistic regression was carried out. The results were then presented as tables and charts.

Results: 217 responses were received from residents across various thematic units working in Kenyatta National Hospital. The female-to-male ratio was 1:2.4. The overall prevalence of work-related musculoskeletal symptoms was 93%. The most commonly affected anatomic region was the lower back (68%) followed by the neck (47%). Residents from the thematic units of urology, paediatric surgery and general surgery had a 100% prevalence rate of work-related musculoskeletal symptoms. Residents from plastic surgery and ophthalmology units had the lowest prevalence rates (83% and 84% respectively). Neck symptoms were associated with the use of loupes (OR, 2.9, p=0.02) and microscopes (OR, 2.2, p=0.05). Female gender was associated with presence of wrist/hand symptoms (OR, 3.84, p=0.01). Age was associated with symptoms in the neck (OR, 1.22 p=0.002) and lower back (OR, 1.15 p=0.03). No association was found between overall prevalence and thematic unit (p=0.13), year of study (p=0.903) or hours in theatre (p=0.97).

Conclusion and recommendations: Surgical residents experience a significantly high prevalence of work-related musculoskeletal symptoms. Plastic surgery and ophthalmology residents had the lowest overall prevalence of work-related musculoskeletal symptoms. Further studies should be conducted assessing work-related musculoskeletal symptoms' impact on trainee surgeons.

1.0 INTRODUCTION

1.1 Background

Work-related musculoskeletal disorders or symptoms are preventable injuries of the muscles, nerves, tendons, joints, and intervertebral discs. They are conditions in which the work environment has a major contribution to the condition, or in which the work environment causes the condition to persist(1). They however exclude disorders resulting from trips, falls, or similar occurrences (2). While musculoskeletal disorders were recognised to result from workplace aetiology since the 18th century, it was only in the 1970s that these factors were studied under epidemiologic standards. Since then, there has been a dramatic increase in the literature linking the work environment to various musculoskeletal conditions and symptoms, with multiple articles addressing ergonomics in the workplace (1).

1.2 Cost and Burden

Work-related Musculoskeletal disorders (WRMSDs) have a high cost both to the employee and the employer. Events such as days off work, reduced output, elevated healthcare costs, disability, as well as workers' compensation, consist of a few of the costs to the employer (2). For the worker, effects include time out of work with reduced income and productivity, with some requiring various treatments including physiotherapy, medications and surgery (3,4). According to a review of the evidence for WRMSDs by the American National Institute for Occupational Health in 2004, musculoskeletal disorders caused an average of 8 days off work, while non-fatal ailments and injuries resulted in 6 days missed from work (5). In a report published by the National Institute of Medicine in 2001 on musculoskeletal disorders and the workplace, the annual economic burden due to WRMSDs was estimated to be between $45 and $54 billion(6). A more recent report by the British Health and Safety Executive in 2019 showed that WRMSDs accounted for 37% of all work-related illnesses (7).

1.3 Medical Sector

Numerous studies among healthcare professionals across the globe detail the extent of work-related musculoskeletal symptoms in the workforce. Many of these studies have shown a significant burden of WRMSDs across the different professional groups (3,8,9), with the prevalence ranging from 50% to over 90% (10).

Studies done in at-risk physician populations - surgeons and interventional practitioners - showed a significant burden of work-related musculoskeletal disorders and symptomatology (11). Comparative studies have shown a higher prevalence of WRMSDs in procedural than non-procedural physicians (12), with others reporting higher rates than those reported in labour-intensive occupations such as manufacturing labourers (13).

Work-related musculoskeletal symptoms may cause reduced surgeon well-being, resulting in increased disability, reduced quality of life, as well as diminished career longevity (14). As much as 30% of surgeons have reported having sought treatment, ranging from prescription pain medicine to even undergoing surgery for physical pain and discomfort, with 6.1% retiring early (15).

2.0 LITERATURE REVIEW

2.1 Introduction

The US Department of Labour defines work-related musculoskeletal disorders or symptoms are preventable injuries of the muscles, nerves, tendons, joints, and intervertebral discs (1). They may include strains, tears, back pain, extremity pain, and stiffness. Several factors have been associated with these injuries such as repetitive motion, excess force, awkward and sustained posture as well as prolonged sitting and standing (16). They have a significant cost on the individual worker, organisations and ultimately on the society, with costs running into billions of dollars (6). They have also been referred to as overuse injuries and repetitive strain injuries.

2.2 Theories of Musculoskeletal Disorders

It has been postulated that the human body is not well adapted to the modern workplace, which requires force application, repetitive actions and the use of unnatural postures over long periods (17). These are often observed across most work environments, whether at a construction site, accountant's office, chef's kitchen or in the operating room at a hospital. This has therefore resulted in work-related injuries. However, a clear understanding of the mechanisms causing these injuries has been elusive. Therefore, theories have been constructed to try to explain how these injuries arise.

In his paper published in the Journal of Industrial Medicine, Kumar discusses four theories of work-related musculoskeletal disorders (17). These rely on data in the literature regarding how musculoskeletal injuries occur in the work environment. They are based on the proposition that the symptoms are biomechanical. The various mechanical properties of the different parts of the system determine the nature of the disruptions that affect the different structures. In each individual, the four theories are likely to be operating simultaneously.

2.2.1 Multivariate Interaction Theory

According to this theory, injuries result from various interactions between morphologic, genetic, psychosocial and biomechanical factors. Each of these categories contains variables that may potentiate each other and precipitate injury. Accordingly, multiple interactions are likely to occur in different proportions. Hence many interactions may lead to several outcomes or injuries, depending on the relative interactions of the different components in the system, and how much exertion has occurred in the individual. This is illustrated in Figure 1 below.

2.2.2 Differential Fatigue Theory

To maximise output, the work environment is designed to achieve productivity targets rather than optimise compatibility with the human element of the system. To increase productivity, these activities are made to be repetitive to allow for muscle memory and reduce delays. These activities incorporate multiple muscles and joints to achieve industry-specific positions and motions that tend to be asymmetric in nature(18,19). Depending on the activity being performed, many joints will be differentially loaded, and so too the different muscles operating the said joints. The exertion effected on the different tissues may also be beyond the specific capabilities of the said tissues. This has two effects. In the immediate term, the disproportionate demands on the various muscles around a joint result in different fatigue rates and magnitude on the muscles involved in motion. Long term, with continued activity, different tissue kinematics result in unnatural joint loading (20). This repeated kinematic imbalance causes uncoordinated joint movement, with abnormal tissue exertion resulting in injury (21).

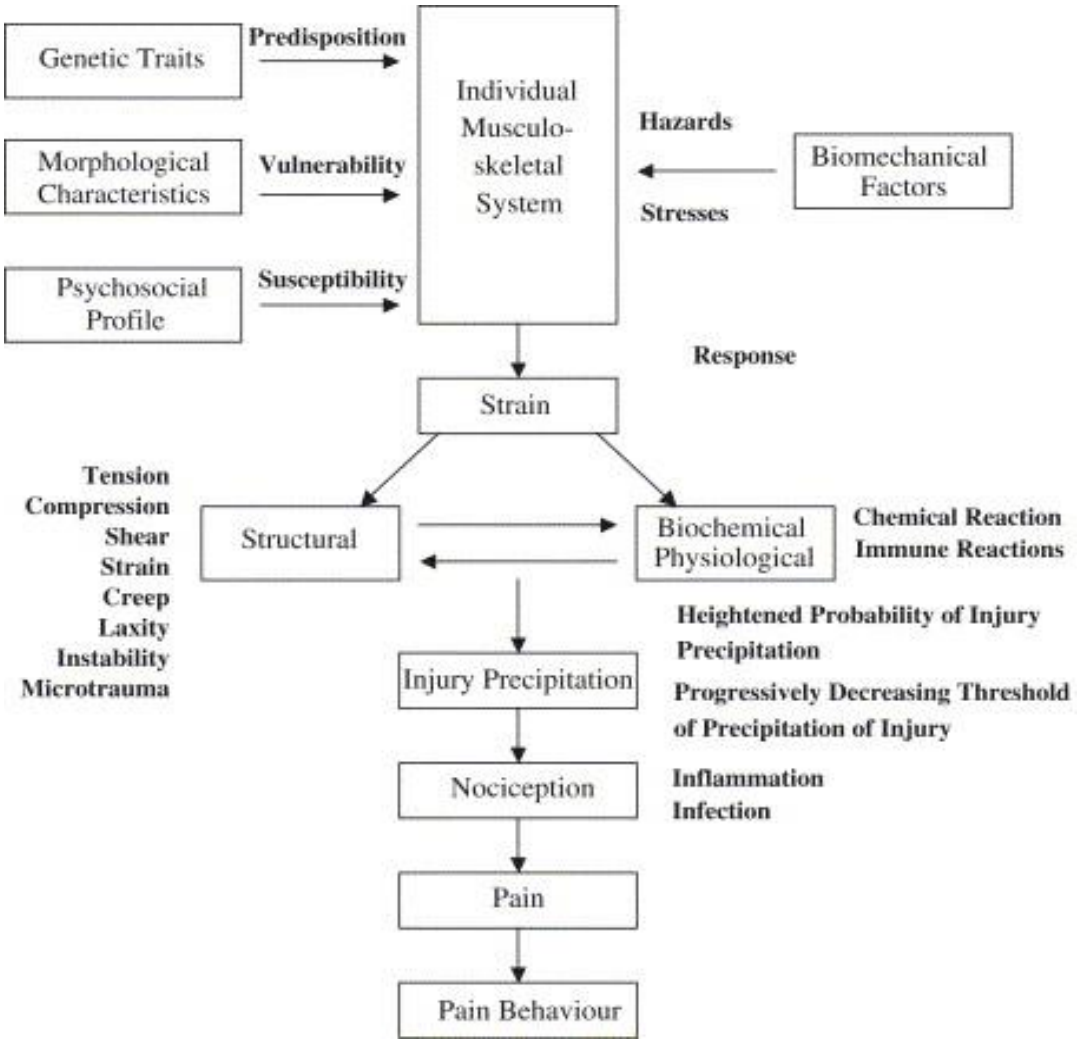

Figure 1 – Multivariate Interaction Theory of Musculoskeletal injury causation (Adopted from Kumar, S. (2001). Theories of musculoskeletal injury causation: Ergonomics

2.2.3 Cumulative Load Theory

Biological tissues have a finite life with a propensity to undergo wear and tear. With repeated loading, they suffer mechanical degradation even though they have repair mechanisms. Being viscoelastic, prolonged loading may result in cumulative fatigue and injury due to the inability to bear further stress. A strong association has been shown between cumulative biomechanical loading and exposure time (22). In their experimental protocol to evaluate fatigue failure of the lumbar spine, Brinckmann et al found that both the magnitude of loading and frequency of loading affected the spinal unit failure (23). High load and low frequency, and low loads and high-

frequency stressing of the spinal units resulted in fatigue failures. Rapid cycling does not allow for the time needed for recovery of the viscoelastic biological tissues, hence making them susceptible to injury (24).

2.2.4 Overexertion Theory

Physical exertion is a product of force being generated from one point (posture) to another (motion), and occurring for a certain period. Exertion refers to activity done above what can be tolerated by the different parts of the biological system. A recent report showed that the majority of musculoskeletal injuries were attributed to overexertion (26). The relationships of the various components of the musculoskeletal system vary depending on the initial posture and the amount of motion about a joint. At the extremes of the range of motion, the tissues are at their maximum mechanical and physiological disadvantage. When muscles contract, this results in the stretch of tendons, with associated compression of microvasculature supplying these tissues, resulting in ischemia and subsequent fibrillar tearing and inflammation (24). Furthermore, contraction impedes blood flow and hence the availability of nutrients as well as the removal of metabolites resulting in pain. Abnormal postures cause muscles and tendons to become inflamed and increase the force requirements for the task, and this predisposes tissues to injury.

2.3 Risk Factors for Work-related Musculoskeletal Symptoms

Work-related musculoskeletal symptoms are multifactorial (27,28). Some authors have tried to divide them into different groups or classifications but no standard classification system exists and these are usually author dependent. Generally, however, three sets of risk factors have been accepted as Physical, psychosocial and individual factors (29). Physical factors are work-related and include awkward or sustained posture, repetitive movements, forceful exertions and use of ergonomically unfavourable tools. Psychosocial factors are work-related such as autonomy, work and rest cycle, task demands, relationships between colleagues and management job satisfaction and workplace uncertainties. Individual factors are non-work-related and

include age, sex, obesity, cigarette use previous musculoskeletal injuries (27). These different risk factors interact in varying degrees and may result in injury.

2.4 Prevalence of Work-related Musculoskeletal Symptoms

Work-related musculoskeletal disorders and symptoms are commonly experienced in many occupations all over the world (1). Their effects are well documented in literature and reveal high socioeconomic costs (7). The European Agency for Safety and Health at Work showed that more than 50% of European workers are faced with this problem (30). This is high, especially considering that many studies have shown that there is underreporting of these symptoms (15).

Multiple studies have been done within the context of healthcare professionals, with many of these studies carried out in the nursing profession. Other professional groups covered include physiotherapists, dentists, surgeons and physicians (3,4,12).

Surgeons have been described as being at risk of work-related musculoskeletal symptoms. Several activities defined by Kroemer as high-risk are common during the performance of surgery. They perform activities requiring exertion in the upper limbs and trunk, with these activities done in abnormal postures and for long periods (31). This is reflected in many studies showing a high prevalence of musculoskeletal symptoms, with Epstein et al reporting a pooled prevalence of estimates for pain ranging from 35% to 90% in their meta-analysis published in the Journal of American Medical Association (11).

While multiple studies have been done on practising surgeons, less attention has been given to surgeons in training. This is in spite of the fact that they are exposed to environments and factors similar to their seniors and trainers, albeit for a shorter period. The few studies done on trainee surgeons seem to indicate that they also suffer high rates of work-related musculoskeletal symptoms. Many of these studies have shown significant levels of work-related musculoskeletal symptomatology, and many have reported a relevance for surgical ergonomics in the operating room. In a

study by Scheidt et al, the use of lead aprons was associated with back and foot pain (32).

In their multicentre study published in the Journal of American Academy of Orthopaedic Surgeons, Deckey et al reported a prevalence of 97% of work-related musculoskeletal symptoms among trainees in orthopaedic surgery after a day in the operating room (10). The most commonly affected location was the lower back (35%), neck (29.7%), and feet (25.7%). They reported average pain scores of 3.52/10, with higher pain scores reported in the lower back (3.8/10), upper extremity (3.8/10) and feet (3.5/10). 42% of respondents reported pain cores above 4/10. Most residents believed that pain experienced in the operating room would determine whether they would be able to operate in the future. Of the respondents, 34.3% also reported that pain experienced while in different rotations would be a determining factor when considering which fellowships to apply for. In the study, no association was found between higher pain scores, year of study, age or BMI.

In another study by Knudsen et al (33) among orthopaedic surgery trainees, the most common site affected were the neck (59%), lower back (55%), upper back (35%) and shoulders (34%). 10.3% of residents indicated that they had to stop operating because of neck, hand or thigh difficulties. The highest rates of moderate symptoms were reported in the knees, hips and feet. They found that 10% of respondents had missed time in the operating room due to their symptoms, with 12.9% having to stop operating due to intraoperative pain.

In a study done among general surgery trainees of the Royal College of Surgeons of England, Chambers et al reported a prevalence of 81% of procedure-related pain in laparoscopic work (34). They found 42% of respondents frequently had symptoms during or after surgery. In another study of general surgery residents, Cerier et al reported 100% of respondents had experienced musculoskeletal pain (35). The neck was most commonly affected (79%), followed by the back (76%) and shoulders (61%). Residents in their senior years reported more back symptoms than their junior counterparts. Females also reported having more muscle fatigue than male respondents. In a study of orthopaedic surgeons and trainees, Fram et al reported that

female surgeons were more likely to report work-related musculoskeletal symptoms than males, a finding that was attributed to the use of surgical instruments (36).

In their nationwide study published in the Annals of Plastic Surgery, Kokosis et al reported an overall prevalence of 94% of musculoskeletal pain after a case in the operating room among plastic surgery residents(37). The most commonly affected area was the neck (54%), the back (32%) and the extremities (12%). Increasing postgraduate year did not have any correlation with pain experienced. Pain symptoms were reported as frequent for 47% of respondents and 5% reported pain with every case performed. Eighty nine percent of respondents had an awareness of poor posture while operating.

In a study of Saudi orthopaedic surgeons, Al-Morhej et al reported that the most commonly affected region was the lower back (38). They reported that smoking was associated with thigh and knee pain, while lack of exercise was associated with shoulder, knee and foot pain.

Wong et al sought to define the prevalence of injuries in otolaryngology trainees, and found symptoms in the neck (82.3%), lower back (56%) and shoulders (40.4%) (39). Female residents had more neck and hand pain than their male counterparts.

Numerous studies have been carried out on practising surgeons across many specialties. In a study published in the Canadian Journal of Surgery, AlQahtani et al reported an injury prevalence of 66% among orthopaedic surgeons with 27% needing time off work (3). They found the most commonly affected site to be the lower back (29%), wrist or forearm (17.4%) and feet (14%).

In a study of general surgeons, 86.9% of respondents reported experiencing symptoms that they attributed to performing minimal access surgery. In the study which was published in the Journal of American College of Surgeons, high rates of neck, hand and lower extremity symptoms correlated with high case volumes (40). Dabholkar et al in their review of WRMSDs in minimally invasive surgeons found a high prevalence of symptoms (up to 89%), and low awareness of ergonomic

practices (41). In a study carried out among neurosurgeons, Gadjradj et al found that 73.6% of respondents had pain while operating (42).

In a study published in the Journal of the American Society of Plastic Surgeons, Capone et al reported an overall prevalence rate of 81.5% of work-related musculoskeletal injuries (13). The most common complaint was cervical spine pain (24%) lumbar spine pain (20.4%) and shoulder pain (18.3%). Sivak-Callcott et al reported a prevalence of 75.2% procedure-related pain among 130 ophthalmic plastic surgeons studied (9). 7.6% of respondents had spinal surgery and 9.2% ceased operating due to pain or a spinal disorder.

As stated earlier, there is a scarcity of published local data in the surgeon community. However, some local data does exist on musculoskeletal symptoms in nurses. In their study of WRMSDs in nurses in Mombasa County, Kenya, Tanui et al found an overall prevalence rate of 70.8% (43). The most common complaints were reported in the lower back (76.9%), neck 53.8% and ankles and feet (48.5%). All respondents who had suffered musculoskeletal symptoms had taken analgesics for their symptoms, while others sought alternative care like physiotherapy. Of those surveyed, 93% reported having had no training in workplace injury prevention.

2.5 Evaluation Instruments

While interpreting the many studies on work-related musculoskeletal symptoms in at-risk physicians, a notable level of heterogeneity is shown (11). This was attributed to differences in the mean age of physicians, workload, years of practice, gender proportions and geographic locations among the studies. Another contributor to this was the use of different instruments for symptom evaluation. Most of the studies use the Nordic Musculoskeletal Questionnaire (NMQ) followed by the Physical Discomfort Survey (PDS). Other studies used reliable de novo instruments.

The Nordic Musculoskeletal Questionnaire (NMQ) or Standardised Nordic Questionnaire is a validated tool that has been extensively used in studies of musculoskeletal disorders and symptoms (33,44). It was developed by Kourinka et al with the support of the Nordic Council of Ministers (45). It contains forced-choice

variants questions and may also be used as a self-administered questionnaire. The questions are on symptomatology in 9 defined musculoskeletal regions of the body over a 12-month period and over the last week. Its main purposes are to screen for musculoskeletal symptoms in an ergonomic context and for occupational healthcare assessment. It is not meant to be used for diagnostic purposes, and it has been used in multiple studies across multiple industries.

The Physical Discomfort Survey is a validated tool for the assessment of work-related musculoskeletal discomfort, developed by the Workplace Safety and Health Division of Manitoba, Canada to assess workforce musculoskeletal disorders (46). The questions are for symptoms in 12 defined musculoskeletal regions of the body and also have additional questions on the severity and frequency of complaints. It may be used in industry to assess whether ergonomic assessment is required.

2.6 Statement of the Problem

Work-related musculoskeletal symptoms are a common occurrence in the general working population with a high cost and burden, at an individual, organisational and ultimately societal level. Among physicians, this issue is in some cases just as bad, and sometimes more severe than in labour-intensive industries such as manufacturing. This has been shown to have a negative effect on the surgeon workforce. Having dealt with pain in their practice, surgeons have had to take time off work, used medication and at times have had to undergo surgery themselves to manage their suffering. Those who have been unable to cope with their pain have had to retire early. In the end, both the patients and their carers end up losing. The surgeons' livelihood and work are affected, while the patients lose their source of healing.

2.7 Study Justification

For a long time, work-related musculoskeletal symptoms have been associated with the work environment, but it is only in the last about 50 years that this area has generated research-worthy interest. In the medical field, this interest has only recently increased, with the realisation that professional groups within the medical field suffer work-related pain more than earlier imagined (13). A lot of research has been done on musculoskeletal symptoms in surgeons. Generally, most of these studies have been done in practising surgeons who have been exposed to risk factors for a prolonged period. Few articles exist detailing the extent of musculoskeletal symptoms in surgical trainees. What has continued to surprise many researchers is that trainee surgeons often seem to have similar rates of symptomatology as their older colleagues, despite a shorter period of practice (34). Despite the interest this topic has generated, little data exists in the African context on procedure-related musculoskeletal disorders in surgical trainees.

Summarily, the findings of this study will help achieve the following:

- Provide data on the prevalence of musculoskeletal symptoms in surgical residents in Kenyatta National Hospital
- Provide data on patterns of musculoskeletal symptoms in surgical residents in Kenyatta National Hospital
- Help in finding solutions to reduce work-related musculoskeletal symptoms in surgical residents and even the greater surgical community

2.8 Study Objectives

2.8.1 Broad Objective

To determine the prevalence, pattern and factors associated with work-related musculoskeletal symptoms among surgical residents working in Kenyatta National Hospital.

2.8.2 Specific Objectives

i. To determine the prevalence of work-related musculoskeletal symptoms among surgical residents in Kenyatta National Hospital
ii. To determine the pattern of work-related musculoskeletal symptoms among surgical residents in Kenyatta National Hospital
iii. To determine factors associated with work-related musculoskeletal symptoms among surgical residents in Kenyatta National Hospital

3.0 METHODOLOGY

3.1 Study Design

The study was a cross-sectional study.

3.2 Study Setting

The study was conducted in Kenyatta National Hospital (KNH), in the Upper Hill area in Nairobi County. It is a Kenya Essential Package for Health (KEPH) level 6 national referral hospital and is the largest hospital in the country. It has a bed capacity of 1800 and caters to patients from all over the country and the region as a whole. It also serves as the training hospital for the University of Nairobi for its undergraduate and postgraduate programs, with residents taking a leading role in patient care. The hospital runs inpatient and outpatient services for both surgical and non-surgical patients. Operating theatres run daily on a 24/7 basis all year-round performing elective and emergency procedures, a large proportion of which are done by residents. Within the Department of Surgery, residents are enrolled in programs like General surgery and Plastic, Reconstructive and Aesthetic Surgery that usually take 5-6 years, except ophthalmology which runs a 3-year program. The programs are divided into 2 parts, with part 1 consisting of basic sciences as well as basic surgical principles. Part 2 is training in the specialty of interest and is 3-4 years long. During the full duration of the training, residents perform theatre work as part of their duties and training.

3.3 Study population

The study population included residents undertaking training in surgical specialties within KNH in surgical programs run by the University of Nairobi. During the duration of the study, 333 students were studying in the various thematic units in the Department of Surgery.

3.4 Inclusion and Exclusion Criteria

3.4.1 Inclusion Criteria

i. All residents working in KNH and undertaking surgical training in the Department of Surgery, University of Nairobi.

ii. All those who gave consent to take part in the study

3.4.2 Exclusion Criteria

i. Residents who declined to give consent for the study

3.5 Sample Size Calculation

For this cross-sectional survey, Cochrane's formula was used to calculate the sample size (47). A confidence interval of 95%, with a margin of error of 5% was used in the calculation. A conservative expected rate of 50% was used, seeing that there are no regional studies detailing prevalence rates in surgical residents. The formula is as shown below:

$$n = \frac{z^2 \cdot P(1-p)}{e^2}$$

n = sample size

z = critical value for 95% confidence interval

e = margin of error (desired level of precision)

p = estimated proportion of the population with work-related musculoskeletal symptoms/pain

The inputs were substituted as shown:

$$n = \frac{1 \cdot 96^2 \times 0.5(1-0.5)}{0.05^2}$$

Therefore n = 384

To correct for a finite population of 333 residents, the following formula was used:

$$n(adj) = \frac{n_1}{1 + \frac{(n_1 - 1)}{N}}$$

where n_1 is the sample size for an infinite/large population

n(adj) = 178.0

Hence adjusted n = 178

Adding 10% for non-responders gives a total of 196 as the minimum sample size.

3.6 Sampling Procedure

Because the various surgical thematic units have different numbers of residents, stratified consecutive sampling was used. The questionnaire was sent to residents from different thematic units via electronic messaging through the different resident online groups. Reminders were sent to the various groups up to 4 times. After 4 weeks, the survey was closed after sample sizes were achieved for all thematic units. Respondents from different thematic units filled the questionnaire at different rates. As a result, some units achieved their minimum sample sizes before others. The survey was closed when the Ophthalmology unit which was the last to achieve its target sample size, did so. This resulted in some thematic units receiving responses above their minimum target. A total of 217 questionnaires were eventually filled.

The target sample sizes and responses per thematic unit were as shown in *Table 1* below.

3.7 Data Collection Procedure

The self-administered electronic questionnaire was based on the Nordic Musculoskeletal Survey, one of the most commonly used validated tools for work-related musculoskeletal symptoms. It was divided into sections on demographics and work-related musculoskeletal symptoms experienced in various anatomic regions. The questionnaire was developed using Google Docs and sent electronically via WhatsApp messaging application.

All electronic data was stored in a password-protected computer accessible only to the principal investigator.

Table 1 -Sample size by thematic unit

Thematic Unit	Number in Unit (%)	Minimum sample size	Actual respondents
Ophthalmology	32 (9.6%)	19	19
Paediatric surgery	24 (7.2%)	14	16
Cardiothoracic surgery	25 (7.5%)	15	18
Neurosurgery	46 (13.8)	27	28
Plastic surgery	36 (10.8%)	21	23
ENT surgery	31 (9.3%)	18	23
General surgery	35 (10.5%)	21	26
Orthopaedic surgery	68 (20.4%)	40	42
Urology	36 (10.8%)	21	22
Total	**333 (100%)**	**196**	**217**

3.8 Data Processing and Analysis

All data was checked by the principal investigator for consistency and validity before analysis. Data was then cleaned for errors, coded and tabulated for ease of processing then analysed using the R statistical package. Measures of central tendencies and dispersion such as mean (for the number of hours spent in theatre per week) were carried out. Percentages were used to report demographic data. The prevalence of musculoskeletal symptoms was presented as percentages. Statistical analyses such as Chi-square and Fischer's test were carried out for statistical significance. Multivariable regression analysis was then carried out for associations between the prevalence of symptoms in various anatomical regions and independent variables such as devices and some demographic characteristics. The significance level was set at $p < 0.05$.

3.9 Ethical Considerations

Approval for the study was sought from the Department of Surgery, Orthopaedic Surgery Unit, and the Kenyatta National Hospital – University of Nairobi Ethics and Research Committee (KNH-UON ERC), a copy of which is attached in the appendices. Further approval for the research was sought from NACOSTI (National Commission for Science Technology and Innovation).

Consent was sought from the respondents before filling out the questionnaire. Participants' confidentiality and anonymity were ensured as no names or identifiers were collected.

All study material was stored safely by the principal researcher and password protected. The data collected was only used for conducting this study.

4.0 RESULTS

A total of 217 participants responded to the electronic survey.

4.1 Sociodemographic Characteristics

Of the 217 respondents, 153 (71%) were male while 64 (29%) were female. The mean age was 32.9 years, with a median of 33 (IQR 31 to 34 years).

Table 2 Resident Demographics

Variables	n	Percentage
Gender		
Male	153	71%
Female	64	29%
BMI		
<18.5	6	3%
18.5-24.9	80	37%
25-29.5	89	41%
>30	42	19%
Handedness		
Right	211	97%
Left	6	3%
Glove size		
≤6.0	8	4%
6.5	33	15%
7.0	33	15%
7.5	96	44%
8.0	45	21%
≥8.5	2	1%
Year of Study		
1st	23	11%
2nd	28	13%
3rd	56	26%
4th	42	19%
5th	62	29%
6th	6	3%
Physical exercises		
Yes	97	45%
No	120	55%
Smoking		
Yes	5	3%
No	212	97%

The mean weight was 77kg, while the mean height was 1.7m. The mean BMI was 27. Right-handed individuals made up 97% of respondents. The majority of individuals used glove sizes 7.0 to 8, with 44% using glove size 7.5 (Table 2).

The average amount of time that respondents spent in theatre per week in the previous year was 22hrs, with a median of 20 hr/wk (IQR 10 to 30hr/wk). Of those who responded, 45% engaged in regular physical activities. Only 3% of respondents were smokers.

When stratified into the year of study, respondents from the 3rd and 5th year had the most respondents, consisting of 26% and 29% respectively (Table 2). Respondents from Orthopaedic surgery consisted of the greatest percentage of respondents (19.4%) with those from the Paediatric surgery thematic unit representing the least (7.4% of respondents) (Figure 3).

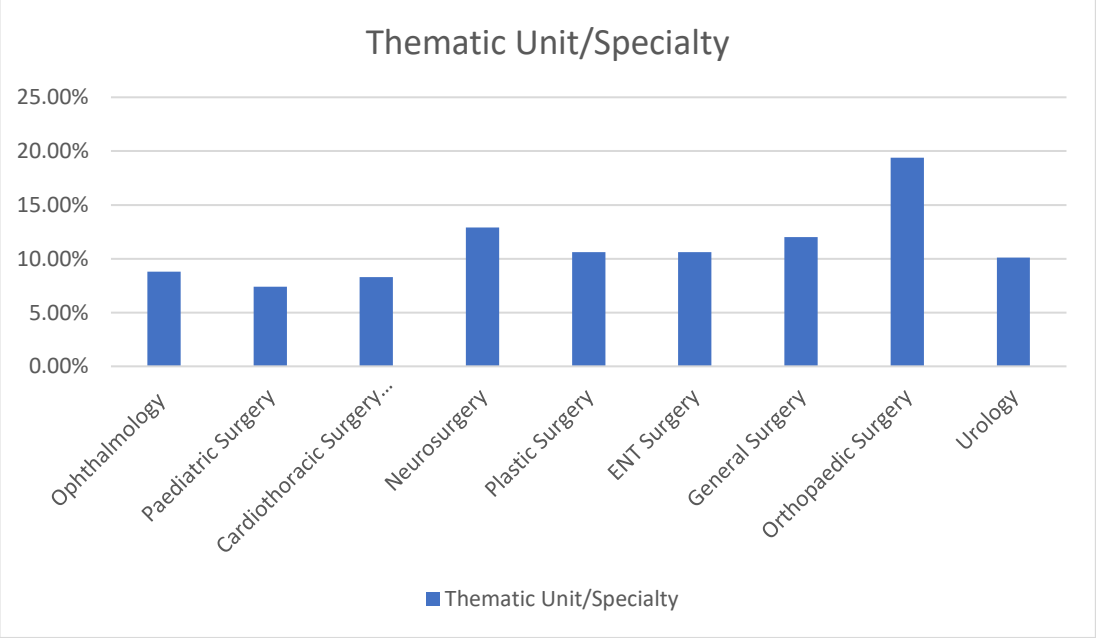

Figure 2 Bar graph showing thematic unit representation N=217

Lead gowns were the most commonly used devices by respondents, with 28% of respondents reporting that they had used them. Only 15% of respondents reported using surgical loupes. Overall, 42% of respondents denied using either surgical loupes, microscopes, head-lamps or lead gowns.

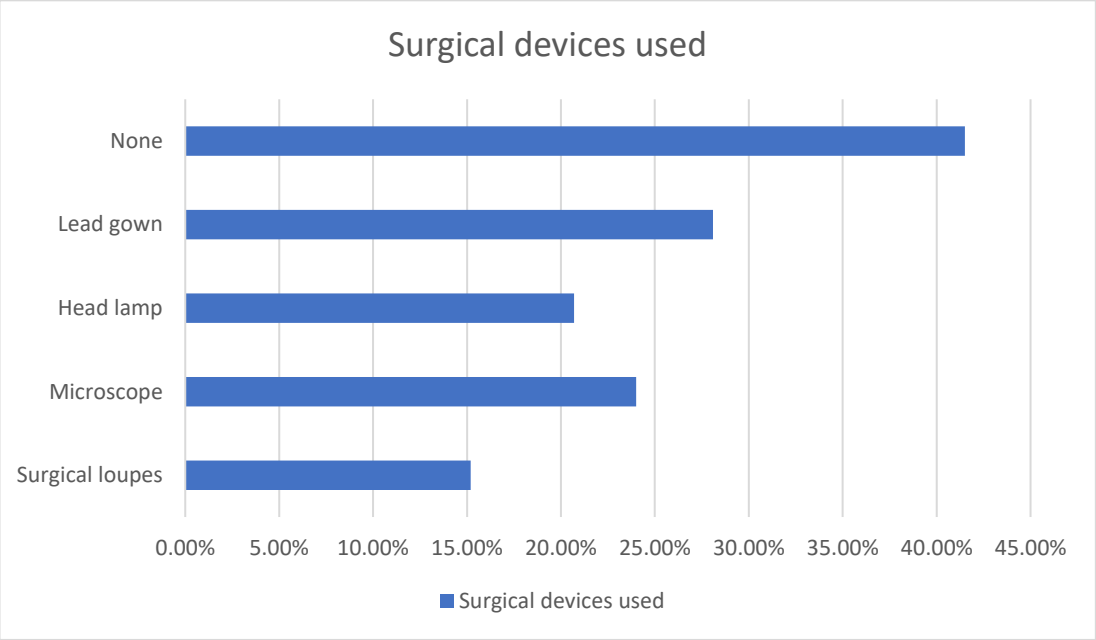

Figure 3: Bar graph showing the use of surgical devices by surgical residents N=217

4.2 Symptomatology

Overall, 93% of respondents reported experiencing musculoskeletal symptoms after a day in the operating room during the previous 12 months. The most commonly affected region was the lower back with 68% of respondents reporting symptoms in the area, followed by the neck with 47% of respondents reporting symptoms. The elbow was the least affected area with an overall prevalence of 7% (Fig 6).

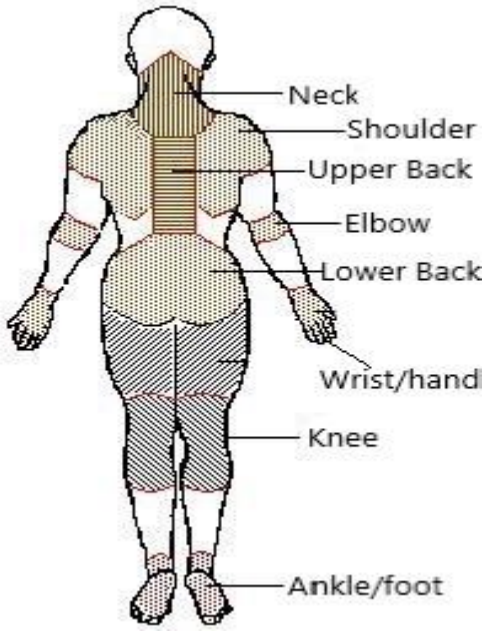

Figure 4: Illustration of the body regions as per the Nordic Musculoskeletal Questionnaire (NMQ)

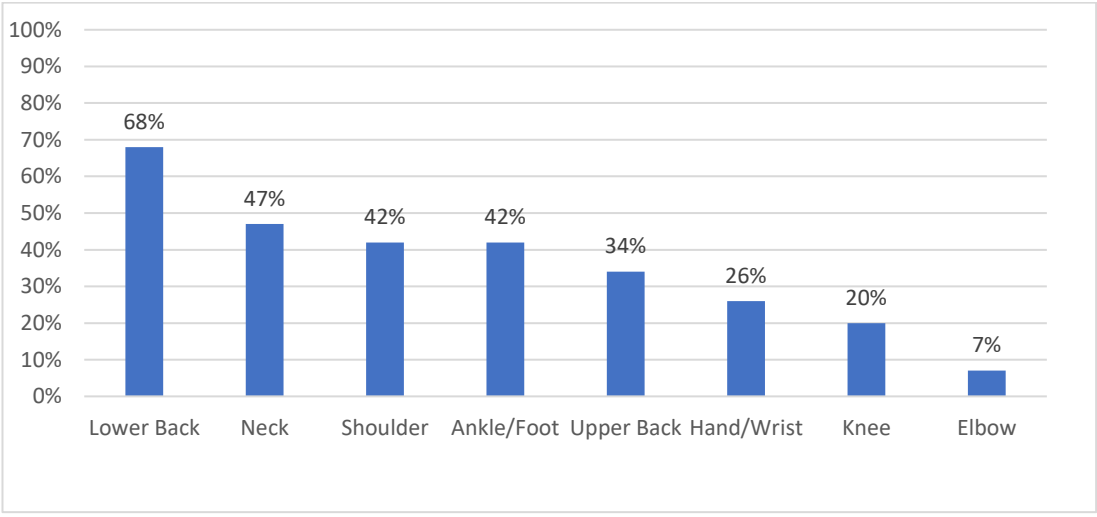

Figure 5: Symptoms of WRMSDs among surgical residents stratified by anatomic location N=217

Stratified by thematic units, residents in the departments of urology, paediatric surgery and general surgery recorded the highest overall levels of musculoskeletal symptoms at 100% of respondents (Table 3). The least proportion of symptoms was noted among residents in plastic surgery and ophthalmology thematic units (83% and 84% respectively), but this was not statistically significant (p=0.13). Respondents in the first and fifth year of training reported a lower prevalence of symptoms (91% and 90% respectively) compared to those in their sixth year of study (100%) but this was not statistically significant (p= 0.903). Female respondents had a higher proportion of musculoskeletal symptoms (97%) than their male counterparts (91%), but this was not statistically significant (p=0.348). Respondents using smaller glove sizes (<7) had higher prevalence rates than those with higher glove sizes (>8) (97% versus 89%) but this was not statistically significant (p=0.36). While smokers recorded a higher prevalence of symptoms than non-smokers (100% vs 92%), this was not statistically significant. Individuals who engaged in regular physical exercises had the same prevalence of symptoms as those that did not (93%).

Table 3: Table showing Work-related musculoskeletal symptoms among surgical residents

Variables	N	WRMSK symptoms present (%)	P-value
Gender			
Male	153	140(91%	0.348
Female	64	62 (97%)	
BMI			
<18.5	6	6(100%)	0.05
18.5-24.9	80	76(95%)	
25-29.5	89	78(88%)	
>30	42	36(86%)	
Handedness			
Right	211	196(93%)	1
Left	6	6(100%)	
Glove size			
<7.0	41	40(98%)	0.36
7.0-8.0	129	120(93%)	
>8.0	47	42(89%)	
Thematic Unit			
Cardiothoracic surgery (TCVS)	18	17(94%)	0.13
ENT Surgery	23	21(91%)	
General Surgery	26	26(100%)	
Neurosurgery	28	27(96%)	
Ophthalmology	19	16(84%)	
Orthopaedic Surgery	42	38(90%)	
Paediatric surgery	16	16(100%)	
Plastic surgery (PRAS)	23	19(83%)	
Urology	22	22(100%)	
Year of Study			
1st	23	21(91%)	0.903
2nd	28	26(93%)	
3rd	56	53(95%)	
4th	42	40(95%)	
5th	62	56(90%)	
6th	6	6(100%)	
Physical exercises			
Yes	97	91(94%)	0.79
No	120	111(93%)	
Smoking			
Yes	5	5 (100%)	1
No	212	197(93%)	

Respondents were asked if they had a history of previous injury or chronic illness in the various anatomical regions. The commonest area that recorded previous injury or illness was the lower back (n=20) with no previous injury in the elbow recorded. Of those with previous injury in the lower back, 85% reported worsening symptoms after a day in the operating room (Fig 7). All respondents with previous injury in the other regions except the hand and wrists reported that their symptoms became worse after a day in the operating room.

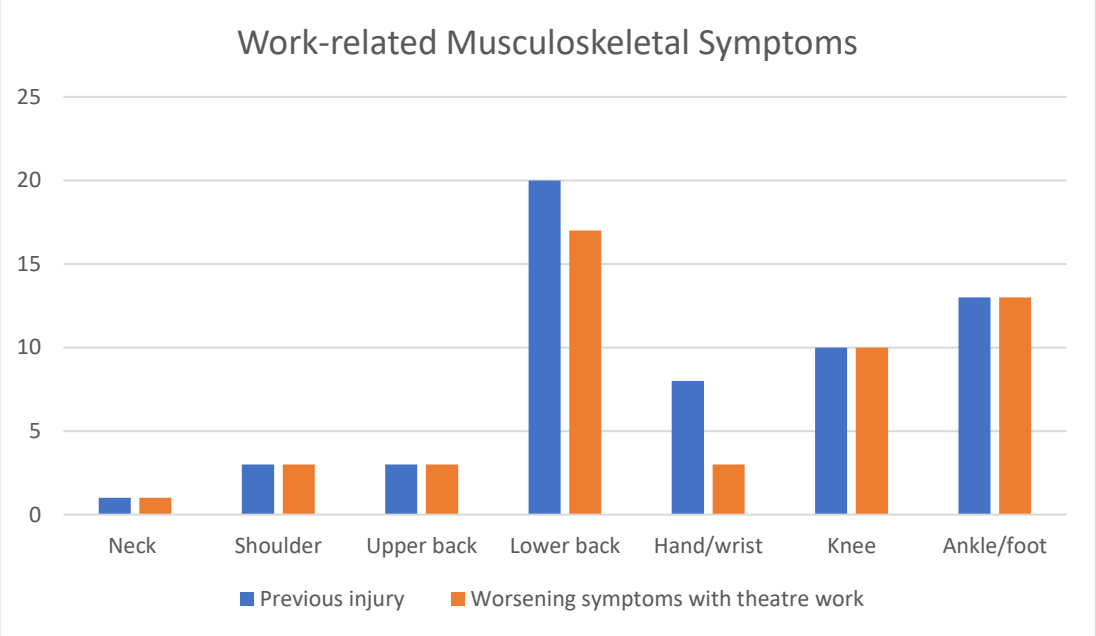

Figure 6: Graph showing respondents with previous injury and those with worsening symptoms after a day in the operating theatre

Respondents were asked the scale of the symptoms they experienced based on a Likert scale from 1-10, with 1 representing the least intensity of symptoms and 10 representing the greatest intensity possible. The severity was then categorised into mild-to-moderate and severe or significant. Scores greater than 4 were categorised as significant. Respondents who reported low back symptoms had the highest proportion of significant symptomatology at 32%. The other body regions that registered high proportions of significant symptoms were the foot and ankle (30%),

upper back (23%) and hand and wrist (21%) regions. Respondents with elbow pain reported the highest proportion of mild symptoms with 87% while only 12% of those with elbow symptoms had significant symptoms. The overall average pain score was 3.32, with the highest average pain scores found in the knee (3.8), upper back (3.73) and lower back (3.55).

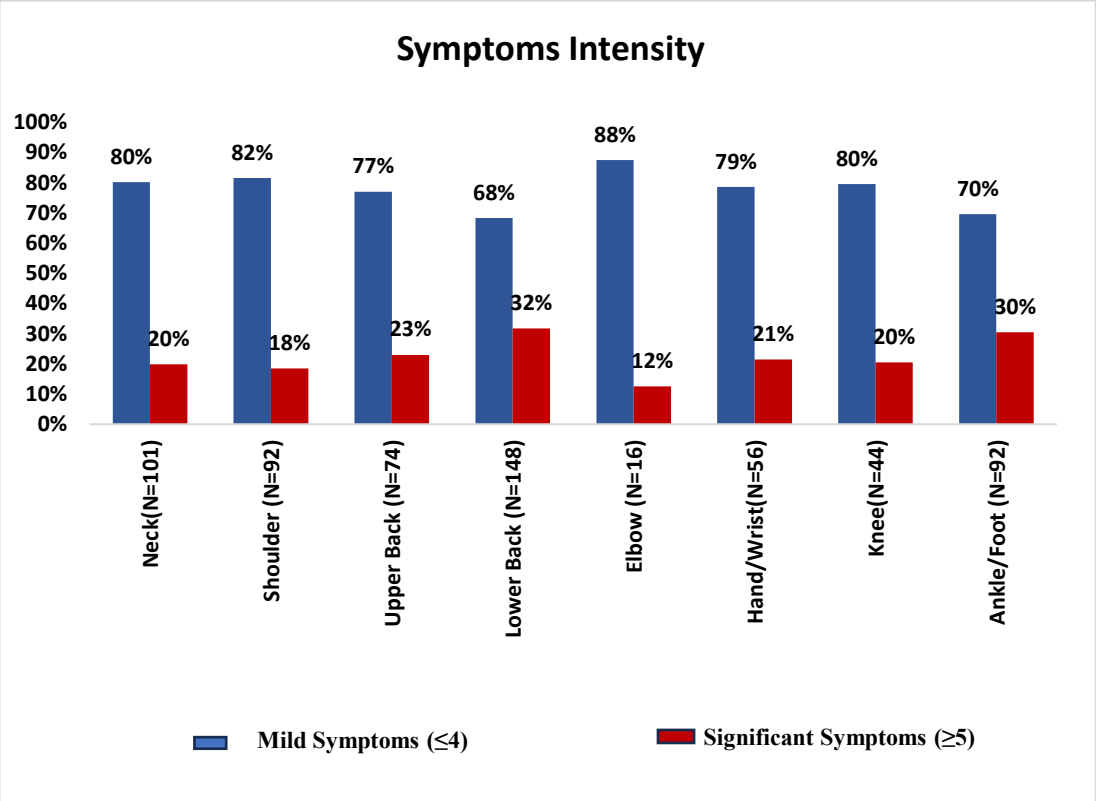

Figure 7: Graph of symptom severity of WRMSS after a day in the Operating room

Respondents were asked about the frequency of the symptoms they experienced on a scale from rarely to always. Across all anatomic regions, the majority of respondents reported experiencing symptoms only “Sometimes” Table 4.

Table 4: Frequency of work-related musculoskeletal symptoms

Frequency	Neck (N=101)	Shoulder (N=92)	Upper Back (N=74)	Lower Back (N=148)	Elbow (N=16)	Hand/Wrist (N=56)	Knee (N=44)	Ankle/Foot (N=92)
Rarely	9%	10%	15%	5%	44%	17%	13%	8%
Sometimes	52%	52%	32%	50%	44%	57%	53%	35%
Often	29%	30%	40%	27%	13%	22%	24%	32%
Almost always	8%	9%	12%	15%	0%	3%	7%	17%
Always	2%	0%	1%	2%	0%	0%	2%	8%

When categorised into high frequency (“Often”, “Almost always” and “Always”) and low frequency (“Rarely” and “Sometimes”), the regions that had the highest prevalence of high frequency of symptoms were the ankle/foot (57%), upper back (53%) and lower back (44%). The ankle/foot had the highest prevalence of respondents who always had symptoms after a day in the operating room (8%).

4.3 Associated Factors

Multivariable logistic regression analysis revealed that the use of loupes correlated with neck symptoms (odds ratio [OR], 2.9 p=0.02). In addition, the use of microscopes was also correlated with neck symptoms (OR, 2.2 p=0.05).

Increasing age was correlated with the presence of symptoms in the neck (OR, 1.22 p=0.002) and lower back (OR, 1.15 p=0.03), but not overall symptomatology (p=0.223).

Female gender was associated with the presence of symptoms in the wrist and hand (OR, 3.84, p=0.01). No other association was noted for wrist/hand symptomatology.

No association was found between the overall prevalence of symptoms and thematic units (p=0.13), year of study (p=0.903) or hours in theatre (p=0.97). Lower back symptomatology was not associated with the use of any of the devices assessed, BMI, smoking, age or sex (p>0.05).

5. DISCUSSION

The demographics of this study were similar to that of previous studies carried out on residents, such as that by Deckey et al carried out on orthopaedic surgery residents in North America (10). In this study, the mean age was 32.9 years, while male respondents accounted for 71% of respondents, the mean hours in the operating room per week was 22 hours and 97% of respondents were right-handed. This was comparable to the study by Deckey et al, where the mean age was 29.9 years, male respondents accounted for 72%, the mean hours in theatre per week was 24 hours and 97.3% of respondents were right-handed.

5.1 Symptomatology

The overall prevalence of work-related musculoskeletal symptoms after a day in the operating room within the previous year was high at 93%. Previous studies done among surgical residents also showed a high overall prevalence of work-related musculoskeletal symptoms. Deckey et al reported a prevalence rate of 97% in their study among orthopaedic surgery residents, while Kokosis et al reported a prevalence of 94% in their study of plastic surgery residents. While studies conducted among practising surgeons have shown high prevalence rates of musculoskeletal symptoms such as Al Qahtani et al (66% in orthopaedic surgeons) (3), some authors have suggested that trainees may be expected to have lower rates than their senior counterparts. This is because the number of years in practice and caseload has been associated with higher rates of musculoskeletal symptoms in the older population (48). This high prevalence among residents may partly be due to residents assuming the role of assistants, which causes them to assume awkward prolonged positions while retracting, while at the same time attempting to visualise the surgical field.

The most commonly affected anatomical region was found to be the lower back and the neck, both registering rates of 68% and 47 respectively. Most other studies also found the lower back and the neck to be the most commonly affected regions, although some found the neck to be more affected than the lower back. Deckey et al reported that the lower back (35%) and the neck (30%) as the regions to have the

highest rates of significant symptoms (10). Kokosis et al reported the neck (54%) and the back (32%) as the most affected areas in their study of plastic surgery residents (37). In a meta-analysis carried out by Epstein et al on symptoms among practising surgeons, they reported the most commonly affected region to be the neck (65%) followed by the back (59%) in studies that used the Nordic Musculoskeletal Questionnaire (11).

In this study, female respondents had a higher proportion of musculoskeletal symptoms (97%) than their male counterparts (91%). This was also reported in a study among general surgery residents by Cerier et al (35). In their study, they reported that females had higher symptomatology than male respondents (100% vs 73%). While in our study this difference was not statistically significant (p=0.348), Cerier et al calculated a p-value of 0.03. This variation may be attributed to differences in demographic characteristics in the sampled respondents.

Symptom severity was based on a Likert scale from 1-10, with 1 being minimal severity and 10 representing the highest severity possible. This was then categorised based on the Borg pain scale into mild to moderate (1-4) and significant, notable or severe symptomatology (5-10). The significance of this categorisation is that a threshold of 4 indicates pain that is tolerable in the postoperative setting, above which some pain control regimens allow the use of narcotics for pain management (49). The study found that the regions which most frequently had notable pain were the lower back (32%), ankle/foot (30%) and upper back (23%). Deckey et al (10) reported the most frequently affected regions with significant pain to be the lower back (35%), the neck (29.7%) followed by the feet (25.7%), among orthopaedic surgery residents. Davila et al reported that 63% of respondents had severe pain after performing interventional procedures in a study carried out in vascular surgeons (15).

The majority of respondents responded they experienced symptoms “Sometimes.” This observation was made across all anatomic regions. The ankle/foot had the highest proportion of individuals reporting the frequency of their symptoms as “Always,” followed by the lower back and neck. In a study of general surgery trainees in the UK, 42% of respondents reported their symptoms in the neck, back

and shoulders as often or always (34). In a study of plastic surgery residents, Kokosis et al found that 42% of respondents had musculoskeletal symptoms “Often” while 5% experienced symptoms after every case (37).

5.2 Associated Factors

Loupes, which were used by 15% of respondents showed a correlation with neck symptoms (OR 2.9 p=0.02). Microscopes were used by 24% of respondents and also showed a correlation with neck symptoms (OR, 2.2 p=0.05). Kokosis et al also found a correlation between the use of a headlight and neck pain (37). However, they did not find any correlation between neck pain and the use of microscopes and loupes.

The use of other devices such as lead aprons and head-lamps did not reveal any correlations with symptomatology in other regions of the body. This is despite some authors attributing work-related musculoskeletal symptoms to these devices in those that use them (10). The use of lead aprons was associated with back and foot pain in a study by Scheidt et al (32).

Age was correlated with symptomatology in the neck, and lower back ($p<0.05$), but not the other regions. In a study done among orthopaedic surgeons, Al_mohrej et al found that age was correlated with knee and foot/ankle symptoms (38).

The study found female gender was associated with hand/wrist symptomatology (OR, 3.84, p=0.01). In a study of general surgery residents by Cerier et al, they reported a higher overall prevalence of work-related musculoskeletal symptoms among females, which was statistically significant (p=0.03) (35). Fram et al in their study of orthopaedic surgeons reported more physical symptoms among female than male surgeons, which was attributed to the size and design of procedural tools (36). In this study, no association was made between glove size and wrist/hand symptomatology.

Lower back symptoms which were the commonest of the affected regions were not found to correlate with sex, smoking, hours in theatre per week or devices used in theatre. Similarly in a study of orthopaedic surgeons, Al Mohrej et al did not report

any association between lower back pain and age, sex, smoking or years of experience.

6. CONCLUSION

The results of this study revealed a significantly high prevalence of work-related musculoskeletal symptoms among surgical residents after a day in the operating room, with the lower back being the most commonly affected anatomic region. The results also suggested a correlation between symptomatology in the neck with the use of surgical loupes and microscopes.

6.1 Recommendations

Given the high prevalence of work-related musculoskeletal symptoms among surgical residents, further studies should be done to assess the impact of work-related musculoskeletal symptoms on their behaviour and daily life, as well as the approaches they take to deal with these symptoms.

Further studies should be carried out to assess the role of ergonomics in work-related musculoskeletal symptoms among surgical residents. This may help guide training in workplace ergonomics that may help reduce the burden of work-related musculoskeletal symptoms.

Structures should be put in place for residents to report symptoms as this may allow for a conducive environment for them to access institutional support in handling their symptoms.

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8.0 APPENDICES

8.1Appendix I: Informed Consent

This informed consent has two parts:

i. Information sheet (to briefly share information about the study with you)
ii. Certificate of consent (for you to sign if you agree to participate in this study)

8.1.1 Section 1: Information Sheet

TITLE: THE PREVALENCE, PATTERNS AND FACTORS ASSOCIATED WITH WORK-RELATED MUSCULOSKELETAL SYMPTOMS AMONG SURGICAL RESIDENTS IN KENYATTA NATIONAL HOSPITAL

My name is Dr Kamweya Macharia, a resident in the Department of Surgery, Orthopaedic Surgery Unit, University of Nairobi. I am conducting a study on the prevalence of work-related musculoskeletal symptoms in surgical residents working in Kenyatta National Hospital. The purpose of this consent is to enable you to decide whether or not you want to participate in the study.

Please read through the form carefully and feel free to ask any questions or seek clarification about the study.

This study has been approved by the KNH/UON Ethic and Research Committee protocol No…….…….

The investigator will be available to answer any questions that come up while filing the form and thereafter.

Brief description of the study

Many surgeons have been found to have work-related musculoskeletal symptoms such as pain and stiffness during and after operating. Surgical ergonomics have been proposed to help alleviate frequency and severity of these symptoms. This study aims to define the prevalence and patterns of these symptoms among surgical residents working in Kenyatta National Hospital. The study also seeks to find the attitudes towards surgical ergonomics among surgical residents in Kenyatta National Hospital.

Participation in the study

If you agree to participate in this study, you will be given a four-part questionnaire to fill. The questionnaire will cover individual demographics, musculoskeletal symptoms experienced, effects of said symptoms and attitudes towards surgical ergonomics.

Your participation is voluntary and you are free to decline participation or withdraw at any time without any repercussions.

There will be no compensation for participating in the study.

Benefits

The information you provide will better understand symptoms experienced by residents while operating and how the said symptoms may be alleviated.

Risks

No risk or harm will come to you for participating in this study.

Confidentiality

No personal information will be collected and the data will remain anonymous and not traceable to you. All data obtained will be stored in a password-protected computer accessible only to the principal investigator.

Additional information

If you have any questions, you can contact:

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8.1.2 Section 2: Certificate of Consent

I have read and understood this consent form. I have had my questions answered in a language that I understand. The risks and benefits of participating in this study have been explained to me. I understand that my participation in this study is voluntary and that I am free to withdraw anytime. I freely agree to participate in this research study. ☐

Signature: _____ Date: _____

8.2 Appendix II: Data Collection Form

PREVALENCE OF WORK-RELATED MUSCULOSKELETAL SYMPTOMS IN SURGICAL RESIDENTS WORKING IN KENYATTA NATIONAL HOSPITAL

Section A: Demographics

1. Age _____ years
2. Gender

   ☐ Male ☐ Female
3. Weight _____ kgs
4. Height _____ cms OR ___ ft ___ In
5. Handedness

   ☐ Right ☐ Left
6. Glove size

   ☐≤6.0 ☐6.5 ☐ 7.0 ☐7.5 ☐ ≥8.0
7. Specialty of training/thematic unit

   _____
8. Level/year of study

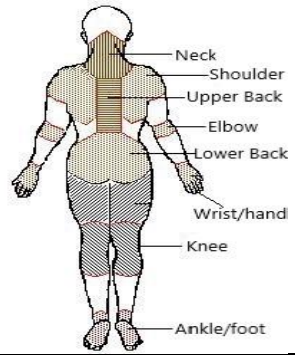
   ☐1st ☐2nd ☐3rd ☐4th ☐5th ☐6th
9. Do you engage in regular physical exercise? ☐ Yes ☐No
10. Do you smoke cigarettes?

    ☐Yes ☐No
11. In a typical week in theatre, how many hours on average do you spend operating per week? _____ Hours
12. Do you use any of the following devices while operating? (tick all that apply)

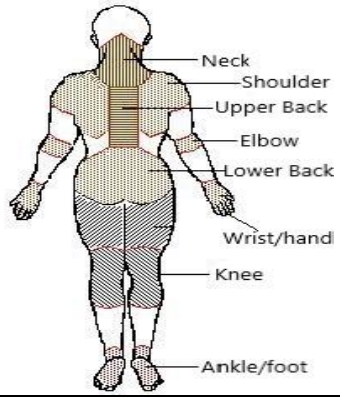
    ☐Surgical loupes ☐Microscope ☐Lead gowns ☐ Head Lamps

Section B: Work-related musculoskeletal symptoms

13. Please fill every question as applies to you:

	In the past 12 months, have you had any work-related musculoskeletal symptoms (pain, discomfort, numbness, or stiffness) in the following regions after a day in the operating room? (Tick all that apply)
Neck	☐
Shoulder	☐
Upper back	☐
Lower back	☐
Elbow	☐
Hand/wrist	☐
Knee	☐
Ankle/foot	☐

14. If you have experienced work-related musculoskeletal symptoms in the last 12 months, please answer the following section as applies to you.

	Pain intensity 0~10 0 for no pain; 10 for worst pain	Frequency of symptoms (1-5) 1-Never 2-Rarely 3. Sometimes 4–Often 5-Always	Previous injury/trauma or chronic illness diagnosed in the region (Tick all that apply)	If previously injured, did working in theatre worsen symptoms (Yes or No)
Neck			☐	☐Yes ☐No
Shoulder			☐	☐Yes ☐No
Upper back			☐	☐Yes ☐No
Lower back			☐	☐Yes ☐No
Elbow			☐	☐Yes ☐No
Hand/wrist			☐	☐Yes ☐No
Knee			☐	☐Yes ☐No
Ankle/foot			☐	☐Yes ☐No