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## ***MUSCULOSKELETAL DISORDERS AFFECTING WORK PERFORMANCE AMONG GROUND-HANDLING PERSONNEL: A SYSTEMATIC LITERATURE REVIEW***

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<b><i>Article Information</i></b>	<b><i>Abstract</i></b>
Sent Feb 25, 2024 Revised Mar 14, 2024 Accepted April 22, 2024  Department of Occupational Health and Safety, Faculty of Public Health, Universitas Indonesia  <i>ismailifyongo@gmail.com</i>	<i>Ground-handling personnel are critical for airline operations and ensuring safety during flights. Yet, these workers are at risk of developing MSDs due to highly physically demanding tasks. which can impact their health and work performance. This review examines common risk factors affecting MSDs and their impact on work performance, while also exploring prevention and management strategies for this occupational group. A total of 342 articles were identified through an explorative search of the PubMed database, Direct Scopus, and Google scholar with the limitation of the year from to 2015-2024. Only 16 articles were considered and classified based on their operation category, such as ramp operation, flight maintenance, cabin crew and baggage handler articles. The results reveal that musculoskeletal disorders (MSDs) in ground handling personnel can be influenced not only by physical factors but also by organizational, psychological, and social aspects, which can negatively impact work efficiency and performance. ground handling workers are exposed to various musculoskeletal risks, including physical exertion, unnatural postures, Standing for extended periods., repetitive tasks, tight deadlines, and heavy lifting, as well as organizational and psychological concerns. It is crucial to mitigate these risks to safeguard and enhance musculoskeletal health of the workers.</i>  <i>Keywords: musculoskeletal disorders, ground-handling personnel, airports, work performance, prevention strategies</i>

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### **Introductions**

Global ground-handling personnel at airports are commonly referred to as the essential components of airline systems. Within this system, ground handling operations play a crucial role in ensuring the sustainable functioning of air transportation.(1,3). International Air Transport Association (4) defines Ground handling as extensive procedure for preparing an aircraft for departure and integrating it with arrival preparations (5) Ground handling is physically demanding and can cause musculoskeletal issues. Workers' MSDs may affect their health, well-being, and job performance. also (3,6) reported that MSDs can cause pain, discomfort, and decreased workplace productivity for airport ground-handling staff globally.(7,9) MSDs are injuries or pain and disorders that affect human body movement or the musculoskeletal system (10,11) MSDs can lower productivity and increase disability/absenteeism among ground handling workers in both developed and developing countries. According (12) Global Burden of Disease (GBD) data, 1.71 billion people

worldwide have musculoskeletal issues like low back pain, neck, wrist and knee pain, (13) reveals that neck, back, knee pains contribute to global disease burden. (14) Global data reported that MSDs cause 42%-58% of occupational illnesses and 40% of occupational health costs.

Along with (4) Ground handling performance refers to the efficiency and effectiveness of ground services for aircraft operations.(2) ground handling comprises check-in, boarding, ramp handling, maintenance, fuelling, catering, and baggage handling.(3) Coordination among sections ensures aircraft ground handling workers to become more efficiently. (15,16) Aircraft workers' faces MSDs issue as result from frequent exposure to risks such as heavy lifting, twisting, static standing, and poor posture, impacting shoulders, neck, and back, which in turn diminishes productivity and efficiency.(17) Repetitive lifting and awkward position puts airport ground handlers, at risk of MSDs (6) Repetitive actions, awkward posture, and static standing cause aircraft wing maintainers pain. (18,19) Iranian airport baggage handlers most often had lower back, neck, and shoulder MSDs that affected their efficiency. (20) Pain and discomfort can distract ground handlers, causing errors and low performance. Also study done by (21) and (15) MSDs risk factors affect ramp crew performance and increase accidents, which also impacts organizations Performance.

The key purpose of this systematic review was to identify the prevalent types of musculoskeletal disorders (MSDs) affecting ground-handling personnel and analyse their impact on work performance. while also exploring prevention and management strategies for this occupational group.

## **Methodology**

### **Searching Strategy**

This systematic review utilized the PRISMA Framework (22) for article selection, including screening and eligibility. Searches were conducted using English language limit. publications from 2015 to 2024 with keywords and controlled vocabulary concepts applied to the research topic. three databases were (PubMed, ScienceDirect, and Google Scholar) search was limited to English language, peer reviewed journal articles, abstracts, and keywords. searched for the terms used. (See table 1. below)

**Table 1.** Keywords of the study focus. (*search strategy*)

Population	Exposure	Outcome
(all field): "ground-handling personnel*" OR "Ground crew*" OR "Ramp personnel*" OR "Airport ground staff*" OR "Apron worker*" OR "Ground operations team*" OR "Aircraft support staff*" OR "Airfield handler*" OR "Airport ground	"Musculoskeletal disorder*" OR "Orthopedic Disorder*" OR "Musculoskeletal Disease*" OR "Orthopedic Disorder*" OR "Musculoskeletal Diseases"	OR "Work Performance*" OR "Job Performance*" OR Efficiency OR productivity

*NOTE \* was used as a truncation operator to search for documents containing the word root followed by any number of characters.*

## Literature Screening and Inclusion/Exclusion Criteria

The study's screening process began by excluding non-English articles, and then the remaining citations underwent a first round of screening for relevancy based on their abstracts or full documents. In the second round, irrelevant and duplicate articles were filtered out using specific inclusion criteria. The primary inclusion criterion for the studies was documentation of the prevalence of musculoskeletal disorders among ground handling staff, including cabin crew, aircraft maintainers, baggage handlers, customer service, and ramp service workers. Studies were excluded if they did not mention the prevalence of musculoskeletal disorders among ground handling workers, if the study population was not listed as ground handling workers, or if the full report was not available online. The review focuses on ergonomic factors that contribute to musculoskeletal disorders, such as loading, unloading, and aircraft servicing, and their impact on absenteeism, healthcare costs, and productivity. Cross-sectional studies and taxonomy literature reviews were included for a comprehensive analysis of ground handling personnel's musculoskeletal health.

## Quality assessment

The study used research publications and review papers to collect high-quality documents. Duplicates were reviewed and found using Rayyan before being exported to Zotero to ensure reliable findings. To ensure quality and relevance, article abstracts were carefully evaluated. To ensure validity and reliability, each study paper was carefully analysed.

## Data cleaning

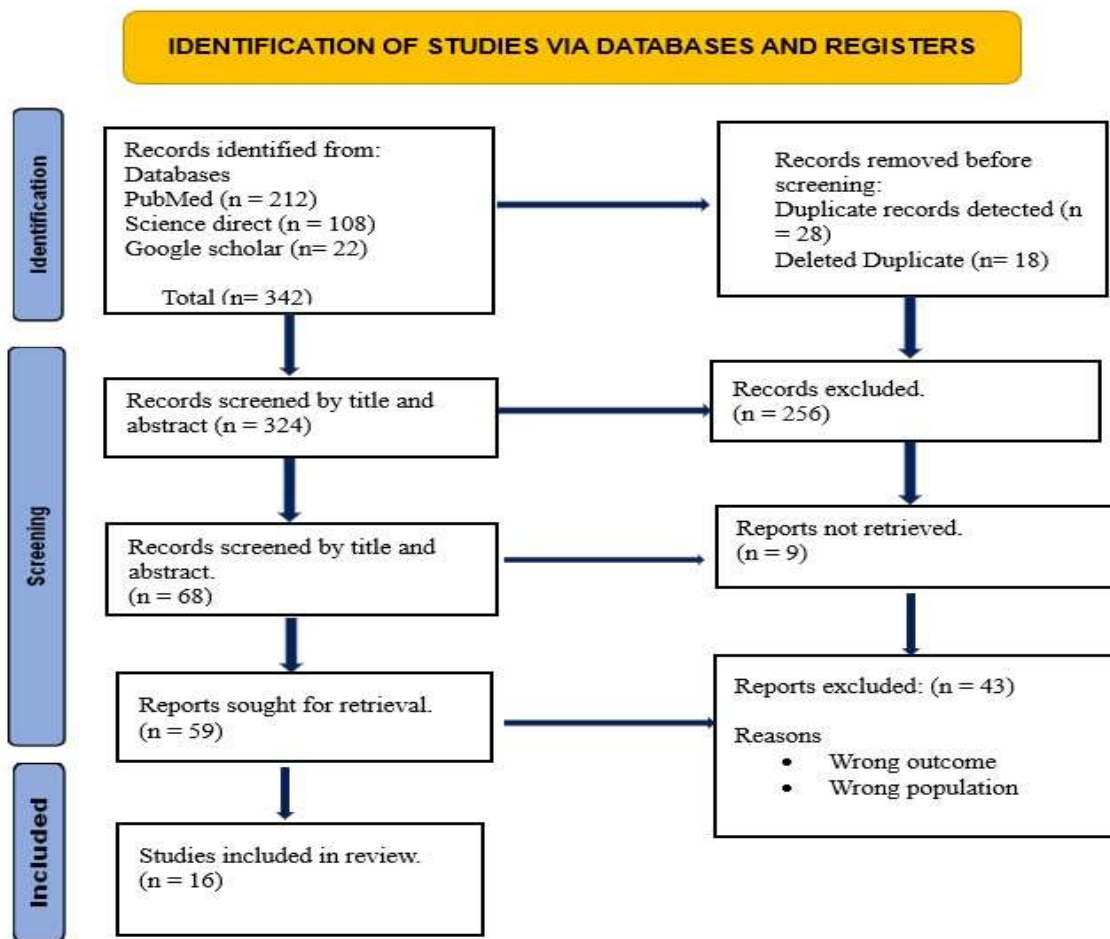
A systematic review attached to the PRISMA method has been previously suggested. The data cleaning process was facilitated by the Rayyan tool for literature reviews, which was

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subsequently exported in the RIS format for compatibility with the Zotero application. The Zotero application was then used to obtain PDF documents for the full text.

### **Results of the study**

This review identified 342 original papers found through the database search. After removing 28 duplicate records and screening 324 papers by title and abstract, 256 were excluded. of the 68 articles retrieved, 9 were not relevant. Following full-text screening, 43 out of 59 papers were excluded, resulting in 16 articles included in the review. Consider (Fig 2) Flow diagram of database search profile. Most of these articles were published between 2015 to 2024, and were published in Iran, USA, Taiwan, Turkey, Denmark, Norway, and Bangladesh (6,23–26) several international journals were used to publish the selected articles, most of selected review utilized approach being the cross-sectional design.(1,20,23,26,27) In general, studies focused mainly on ground handling workers specifically on the cabin crew, (1,24,25)baggage handlers,(11,17,28) flight security personnel (26,29) while two studies used taxonomy approach to identify and analyse risk factors (2,3) The most often used data collection method was the survey, which mainly used Kuorinka's (1987) Standardized Nordic Questionnaire. Furthermore, some studies relied on self-reported data, which raises concerns about the accuracy and reliability of the results..(25,26)



**Figure 1.** Flow diagram of database search (PRISMA)  
 Source: (22)

**Table 2.** Summary of general characteristics of the included articles.

Author	Title	Study design/country	Journal	Limitations of the study	Sample size
(1)	Musculoskeletal Disorders and Ergonomic Factors among the Cabin Crews of the National Airline of Bangladesh	Cross-sectional study/ <b>Bangladesh</b>	Indonesian Journal of OSH	Small sample size was 246.	246
(25)	Psychosocial Job Strain and Musculoskeletal Pain in Cabin Crew – Does Gender Matter?	Cross-sectional study/ <b>Norway</b>	Journal Occupational health	self-reported MSDs from cabin crew small sample size limits its generalizability.	427
(18)	Baggage handler seniority and musculoskeletal symptoms: is heavy lifting in awkward positions associated with the risk of pain?	Cross-sectional/ <b>Denmark</b>	BMJ Open	Selection biases, Relied on self-reported data.  Study overlooked symptom without consider onset of their causes.	1827
(17)	Epidemiological and biomechanical evaluation of airline baggage handling	Epidemiological and biomechanical evaluation/ <b>Iran</b>	Int. J. of Occup. Safety and Ergonomics	Confounding variable	209
(30)	Ergonomic Risk Factors in Ground Handling Operations to Improve Corporate Performance	Taxonomy approach/ <b>Turkey</b>	International Journal of Aviation Science and Technology	generalizability of findings,	×
(3)	Development of risk factors taxonomy in ramp operations for corporate sustainability	Taxonomy literature review/ <b>Turkey</b>	Aircraft Engineering and Aerospace Technology	small sample size of this study limits its generalizability	×
(28)	Load Lifting and the Risk of Work-Related Musculoskeletal Disorders among Cabin Crews	Industrial survey and experimental study/ <b>Malaysia</b>	IOP Conference Science and Engineering.	×	158
(20)	Full-Shift Trunk and Upper Arm Postures and Movements Among Aircraft Baggage Handlers	Cross-sectional study/ <b>Sweden</b>	Journal of Occupational Hygiene	Standard approach used to measure postures was insufficient.	54
(26)	The relationship between individual, physical and psychosocial risk factors with musculoskeletal disorders and related disabilities in flight security personnel	cross-sectional study/ <b>Iran</b>	International Journal of Occupational Safety and Ergonomics,	reliance on self-reported data  Retrospective nature recall bias.	316
(24)	Prevalence of musculoskeletal discomfort among female cabin crew in Taiwan.	Cross-sectional study/ <b>Taiwan</b>	Journal Occupational Health	Small sample size  Lacks generalization to more cabin staff	88

(6)	Ergonomic Evaluation of Aircraft Wing Recovering Tasks in General Aviation Maintenance	Cross-sectional study/ USA	Proceedings of the Human Factors and Ergonomics Society	small sample size of only two maintainers observed,	32
(23)	The relationship between individual, physical and psychosocial risk factors with musculoskeletal disorders and related disabilities in flight security personnel	A cross-sectional study Sweden /	Bio Med Research International journal	Limited sample size (only ramp workers included	525

*Note: x means not included*

### **Prevalence of MSDs in Ground-Handling Personnel**

Musculoskeletal disorders (MSDs) as conditions or injuries affecting the tendons, muscles, ligaments, nerves, and soft tissues (15) Airport ground handling staff are particularly susceptible to MSDs due to the physical demands of their job, which includes tasks such as luggage handling, passenger services, and catering.(15,18,31) In a study conducted by (17,26) Musculoskeletal disorders (MSDs) were most common among Iran National Airport luggage handlers' lower back, neck, and shoulders. Age, work experience, BMI, smoking, physical activity, and job satisfaction were MSD risk factors. (11) Swedish luggage handlers reported 70% low back discomfort and 60% shoulder pain within a year. (1) found that Bangladesh airline cabin crew experienced 25.6% low back pain, 22.8% shoulder pain, 20.7% neck pain, and 18.7% knee joint pain.(2,32) fatigue issues were most common. the study also linked MSDs to ground-handling workloads and repetitive movements actions. (3) found ramp workers have higher workloads and musculoskeletal disease.(28) Over the last year, cabin staff reported the most discomfort in the lower back (80.0%), neck (68.0%), and shoulder (59.0%). Cabin staff most often have these three conditions.(24) Similar findings showed that cabin workers who frequently pushed and pulled had higher MSDs than others. study done by (33,34) showed that ground handler workers often experience minor discomfort in their upper arms, left forearm, hips, and thighs. Also (11,35) MSDs can impact airline ground crew, particularly luggage handlers. At large international airports, workers must perform various tasks dictated by baggage and aircraft design, as well as their physical demands.(36,37) The study found that flight attendants get frustrated by turbulence, aggressive passengers, and work-related psychosocial variables including psychological job expectations and decision flexibility. (29) Work-related stress and pressure promote work-related musculoskeletal diseases.(21,35,38) In



addition (10) Flight crews are more likely to be exposed to risks due to their extended flight time.

### **Musculoskeletal disorders (MSDs) risk factors in ground handling personnel**

Several studies investigated the risk factors for musculoskeletal disorders in baggage handlers, flight security personnel, cabin crew, load and unloading workers, aircraft maintenance staff, and flight attendants. (3,6,7,17,19) for instance (28) A study found hazards for Biman Bangladesh's aircraft crews, such as poor sleep, heavy workloads, insufficient breaks, job stress, and ergonomic issues, leading to increased MSDs among workers. (11) showed how musculoskeletal diseases (MSDs) can affect physical, mental, and occupational performance. While (3), the study indicates ramp workers are overworked physically and mentally which surpasses their capabilities. due to awkward positions, heavy object handling, and confined work.(25) Prolonged sitting in the same position can cause physical decline, including a decrease in fitness and flexibility, leading to recurring pain and musculoskeletal issues. (15,26) Aviation security workers are at risks of MSDs due to age, work experience, BMI, gender, and education, as well as unhealthy lifestyle habits like stress and poor choices. (24) Female workers with higher occupational status or exposed to physical/psychological stress are more likely to develop musculoskeletal pain (MSP). 16% reported pain location, while 14% experienced pain at only one site. (7) study observed shoulder musculoskeletal disorders are associated to repetitive activities and job postures such raising two hands (10 kg), lifting at or above shoulder level (9 kg), and pushing/pulling (32 kg). (15,39) The study analysed the postures of skilled aircraft loaders while performing their tasks, which involved bags weighing from 9 to 19 kg, causing significant pain and discomfort.

### **MSDs impact the work performance of ground-handling personnel.**

Numerous studies have shown a strong connection between musculoskeletal disorders and job performance among ground handling staff, including baggage handlers, cabin crew, ramp workers, and flight security personnel.(18,40) MSDs, mainly impacting the lower spine, knees, neck, and upper back, significantly influence luggage handlers, hindering their physical proficiency for task efficiency. A substantial number of workers were absent due to discomfort, suggesting MSDs result in decreased productivity and absences. Similarly, Asadi(2) MSDs were found to cause decreased productivity, increased absenteeism, and hinder job responsibilities. Furthermore MSDs can lead to physical discomfort, affecting job performance and overall well-being of ground-handling personnel. (7) This study stressed the need for



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measures to reduce ergonomic hazards and enhance worker conditions. The interventions suggested by (3,30) Modifying equipment, facilities, and work procedures can reduce MSDs risk and enhance productivity. A study conducted by (1) found that MSDs have significant impacts on employee productivity and well-being, which may require organisations to provide support.(18) Adopting a risk management strategy to address human factors that affect performance and sustainability is crucial. Also study done by (24) suggested that efficient time management and ergonomic work arrangements can create a work environment that promotes occupational performance and reduces musculoskeletal discomfort.(25) Time limits, shift work, and emotional expression rules put cabin crew workers at risk of musculoskeletal problems.(24) Female flight attendants more commonly experience neck, shoulder, and ankle/foot musculoskeletal pain, which reduces their productivity. A table was created to identify MSD prevalence and risk factors in ground handling workers, based on literature reviews across various categories.

**Table 3.** Summary of MSDs prevalence and their associated risk factors in work performance

Authors	Focus section of the study.	Risk factors	MSDs prevalence	Impact on work performance
(24)	Female cabin crew	Heavy lifting objects Pushing, pulling, and Anxiety and depressions, poor posture	60% right shoulder pain and ache 50% left shoulder and lower back Pain 15% were neck, upper back, and right wrist.	lower efficiency and production.  frustration due to back pain
(2)	Ramp Agents (Aircraft Loading Agents)	Repetitive motions, on ticketing, boarding, and loading. Static standing, Awkward posture, Baggage lifting, Physical demands Pulling, pushing, packing the bags vibrations, lighting, ventilation	Low back pain, Neck and upper back pain Shoulder, elbow, wrist, hip, knee pain: caused by sliding, pushing, and stacking bags in the bag room and cargo areas.	Fatigue and tiredness among the workers,  Pain and discomfort increased absenteeism. medical leave from work. Lower production
(41)	Airline maintenance, repair & overhaul	Pulling, pushing, and lifting heavy object,  Moving floor rug during cabin carpets installation Lifting replacement carpet rolls. Awkward posture inspection positions Heavy lifting (>40lbs) ladder work and overhead postures. Servicing positions that make using engine parts twisted trunks Prolonged standing	88–93% of CB, EC, and LG workers experienced pain and discomfort. on knees, and the back, wrists, shoulders, and neck.	long-term disability for airline MRO and lower production.
(23)	Swedish flight handlers	Baggage physical workload work demands, pushing/pulling Awkward postures	low back pain 70% shoulder pain were and 60%,	low back pain 70% Pain and suffering can distract workers and impair their concentration.
(3)	Ramp operations	Prolonged standing, Awkward posture, vibrations, lighting, loading unloading. Time pressure, Repetitive tasks like aircraft fueling.	Shoulder, elbow, wrist, hip, and knee pain: caused by sliding, pushing, and stacking bags in the bag room and cargo areas	Can lead accidents or occupational diseases.
(20)	Aircraft handlers	Baggage physical demand: frequent lifting, uncomfortable postures, trunk bent forward >60° (FP) for 2%, upper arm postures.	LBP (60% Shoulder pain 50%	Increasing workplace accidents and injuries  productivity declining

(26)	Flight security personnel	age, gender, job experience, daily hours, BMI, and education. Lifestyle, occupational stress, and mental workload Physical demands Time pressure	neck, 67.4, left knee, 62.3, right knee, 60.8, and waist 59.2%, While left arms. 31.5% right arms 30.4%.	Job dissatisfaction, absenteeism, and poor performance
(28)	Cabin crew	Repeated load lifting, force, and awkward position with a high load 25.0% WMSD hazard.	Results show 88.3% of cabin crew suffered WMSD at Lower back, neck region, shoulder, higher back, knee, ankle, hands/wrists, thigh/hip.	Crew discomfort increased with heavier loads, especially on their neck, affecting efficiency.
(25)	Cabin crew	Time pressure, shift work, Handling luggage High strain job	neck, shoulders, and ankles or feet	Both high strain and passive work are compromising work performance  Tiredness, decreased endurance

*MSDs prevalence and their associated risk factors in work performance*

## Discussions

Table 3 examined musculoskeletal disorders in ground-handling workers, including ramp operations, baggage handlers, aircraft maintainers, cabin crews, and flight security. The review assesses risk factors, prevalence, and work performance impact for each group, focusing on the most common musculoskeletal disorders and prevention strategies.

This study's finding reveals a high incidence of musculoskeletal disorders (MSDs) among ground handling workers, particularly in the airline maintenance, repair, and overhaul sectors. Approximately 88-93% of these workers found experiencing pain and discomfort in their knees, back, wrists, shoulders, and neck. (41) Similarly, (24) Female cabin crew reported discomfort and pain, with 60% experiencing right shoulder pain and 50% left shoulder pain due to frequent luggage carrying.. (25) This literature review found that airport baggage handlers are at high risk of developing MSDs because of the physical demands and job requirements of their tasks. According to the literature, approximately 60-70% of baggage handlers experience lower back and shoulder pain, respectively..(20) ground-handling jobs, including ramp operating, loading, unloading, refuelling, marshalling, and aircraft maintenance leads MSDs, per literature analysis. MSDs common affected body region are the shoulder, lower back, knee, ankle, and wrist.(1,2,28) This literature evaluation also found that ramp

workers and cabin crew members have the greatest average risk scores for awkward postures and positions while operating. (2,3,24) also the analysis identified repeated actions, prolonged standing, unpleasant postures, and manual handling of large objects, such as pulling, pushing, and lifting are common risk factors among ground handling workers (3,17,20) This study found a strong relationship between MSD prevalence and reduced ground-handling job performance. As heavier loads increased pain and discomfort, especially in the neck and back, job dissatisfaction, absenteeism, and poor performance became more common.(2,26) Moreover the likelihood of developing musculoskeletal diseases (MSDs) can vary depending on the specific roles within ground handling, such as ramp operations, flight security, or baggage handling.(11,29)

The outcomes of this literature review demonstrate a connection between physical overload and the development of MSDs in ground handling crews,(2) and suggest that organizational, psychological, and social factors may also contribute to the prevalence of MSDs.(7,17,27,37,42) and further more (26) This review stresses the significance of addressing individual, physical, and psychosocial risk factors to reduce ground-handling worker musculoskeletal diseases.(7,29,35) Musculoskeletal disorders, such as those affecting the lower back, knees, neck, and upper back, can significantly impact the job performance of airline luggage handlers by causing pain, discomfort, and potential limitations in physical abilities that can hinder their efficiency in lifting and handling tasks..(6,17) This literature analysis found that discomfort led to a high rate of absenteeism among ground-handling staff, indicating that musculoskeletal disorders (MSDs) Can lead accidents.(39,41,43,44) Repetitive and forceful movements during luggage loading into the overhead compartment can cause work-related musculoskeletal diseases.(18,21,26) furthermore this literature evaluation discussed that more crew members had MSDs. and female crew members had a higher prevalence.(24,25) reasons to that is biomechanical structures and physical features differences impact how men and women perceive and handle work physical demands, increasing women's risk of MSDs.(24,25) furthermore Female cabin crew staff had foot pain due to wearing high heels as part of the uniform, (25)The study revealed that baggage handlers who regularly handle heavier loads (5-10kg) are at a greater risk of injury compared to those who handle lighter loads (5 kg). This increased risk is consistent and occurs every two minutes.(20,27) to mitigate lifting risks to undergo weight lifting task training is necessary to lessen the effect and mitigate the risks of MSDs (17,28) also this paper discuss(3,7,37) This literature review discuss how team

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lifting techniques can enhance the lifting environment, lowering individual risks for ground handlers, and boosting worker performance and efficiency.

## **Conclusion**

Several studies show significant musculoskeletal issues in ground-handling workers, mainly in the lower back, neck, and shoulders.(1,18) ground handling staff often share common risk factors for MSDs including work demands, physical exertion, awkward posture, prolonged standing, repetitive tasks, time constraints, and heavy lifting (3,41) Few studies have explored the influence of organizational, psychological, and social factors on MSDs and work performance. (7,17)ground handling workers must be equipped with proper personal protective equipment (PPE), training, and clear instructions to prevent musculoskeletal disorders and associated health problems..(18) enhancing human risk assessment and management boosts operational safety and ground-handling staff efficiency. (1,33) factors like organizational structure, communication, and resource allocation impact risk and prevention. To improve safety, effective leadership, culture, and resources are essential.

## **Recommendation**

By based on numerous studies on musculoskeletal disorders affecting work performance among ground-handling personnel across various industries, the following recommendations can be made to reduce the occurrence of MSDs in ground-handling staff at airports worldwide and improve work performance.

1. Implement policies that prioritize ground-handling staff health by mandating rest breaks, ergonomic equipment, and access to healthcare.
2. It is essential to reevaluate current approaches to managing heavy loads to reduce the effects of physical work-related risk factors such as force, repetition, and unsettling posture.
3. Training should be provided to improve posture and lifting techniques, and to prevent musculoskeletal illnesses. Assistive technology can also be supplied to reduce physical labour and eliminate heavy lifting tasks.
4. Redesign and improvement of tasks are necessary to eliminate the risk factors of MSDs, including force, repetition, and uncomfortable posture, which can lead to MSDs among ground handling staff.

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5. Further investigation is required to examine the workplace factors that increase the likelihood of musculoskeletal disorders (MSDs) among ground-handling personnel in the aviation sector.

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