Musculoskeletal Injury Prevention:
Ergonomic Guidance for Retail Store Design and Configuration

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# Introduction

Musculoskeletal injuries (MSI) are soft tissue injuries that may be cause or aggravated by work. This includes strains, sprains, tendinitis, carpal tunnel syndrome, and low back or neck pain, among other disorders. In British Columbia, OHS Regulations 4.46-4.53 outline requirements for managing risk of MSI in the workplace. Demonstrating and documenting an intent to prevent MSI through design or through purchasing decisions can meaningfully contribute to regulatory compliance.

MSI currently result in 36-60% of Workers’ Compensation claims in the retail industry, based on “accident type” (e.g., overexertion, repetitive motion) or “nature of injury” (e.g., strains, tendinitis) classifications. MSI-related costs to employers include insurance premiums, time loss, accommodations for injured employees, lowered productivity for employees who continue to work through symptoms of unreported or unrecognized MSI, and hiring or training costs to replace employees who leave their retail job due to symptoms that are aggravated by work. Prevention of MSI has financial and social benefits.

The risk of MSI in retail work is directly related to the physical demands of that work, which are influenced by the layout and design of the physical store environment, the equipment provided, and the products that are handled. This presents an opportunity to reduce MSI risk when designing a new store or planning changes to an existing store (e.g., renovation, reset, seasonal changes).

Retail businesses vary in company and store size, and in merchandise type and scope. Each enterprise will have unique characteristics and complexities, with unique challenges in managing the risk of MSI among employees. This document provides guiding principles and factors to consider when designing a new store or planning changes to an existing store that can reduce the likelihood and severity of MSI when applied to the unique characteristics of a specific retail business. Success in this endeavour begins with an intent to prevent MSI through design that is good for the core business and good for the employees who drive that business.

# Guiding Principles

Three guiding principles in the design of a retail environment that will reduce the risk of MSI:

1. Understand MSI risk factors and prevention strategies (risk controls) to minimize MSI risk in the retail environment.
2. Employ a User-Centred Design process that involves and engages employees with experience in the retail environment.
3. Recognize that characteristics and abilities of employees (and customers) will vary, and there will be need for accommodations to address that variability.

Each of these guiding principles are explained below. More specific guidance is provided in the sections that follow for common areas within a retail store.

## MSI Prevention – Risk Factors and Risk Control

### MSI Risk Factors - Generic

Understand the generic risk factors for MSI. Design to minimize the severity of and exposure to individual risk factors.

The key generic risk factors that contribute to work-related MSI or to the aggravation of pre-existing MSI are:

* Forceful exertion – lifting, lowering, pushing, pulling, carrying or gripping;
* Awkward postures – reaching, bending, twisting;
* Repetition – similar movements or forceful efforts that are repeated with inadequate rest;
* Sustained effort – awkward posture or forceful exertion that are held with inadequate rest;
* Contact pressure – hard or small surfaces, like edges or small handles, that compress tissue.

Risk increases with the severity of individual risk factors (e.g., higher force), with exposure to combinations of risk factors (e.g., forceful lifting in an awkward posture), and with the duration of exposure to risk factors.

Contributing factors that may increase MSI risk from the factors above include:

* Thermal environment (cold or hot);
* Poor lighting (low level, glare or high contrast lighting);
* Workplace layout (flooring, reaches, adjacencies);
* Work organization (task variability, work-rest balance, work rate)

### MSI Risk Factors – Company or Site Specific

Be aware of the specific MSI risk factors that exist in the retail environment being designed. Information is likely available through corporate Human Resources, Occupational Health and Safety personnel, and/or the Occupational Health and Safety Committee that can assist with understanding the current challenges. Ask for:

1. MSI claims history for the company (new store) or the specific store (renovation, modification) to understand which jobs are at greatest risk, what injuries are occurring, where in the store they occur and why.
2. Existing MSI risk assessments or inspections for tasks performed in the areas being designed to understand what risk factors have been identified and what changes may eliminate or minimize risk (controls).

Use this to inform design decisions and to prioritize focus on design aspects that are known to present risk to employees within the existing store environment. Making changes during the design or planning stage is more effective at addressing risk factors than attempting to retrofit solutions after a store has been built and is open for business. Designing new environments that are safer for employees begins by understanding the injuries that currently occur, the risk factors for those injuries, and existing ideas to control MSI risk. Apply that understanding to design decisions.

### MSI Risk Control

Eliminating or minimizing exposure to known or predicted MSI risk factors is achieved through physical configuration of work and the work environment (engineering controls), and through organizational configuration of work (administrative controls). Planned changes to the work environment provide an opportunity to make decisions about the physical work environment (layout, furnishings, workstations, equipment and tools) that can reduce the severity of exposure to MSI risk factors and guide the behaviours of people using the space.

The objective in controlling MSI risk is to eliminate or minimize exposure to risk factors by reducing the magnitude of singular risk factors (e.g., less force, handling items fewer times, better working postures), reducing the duration of exposure to work that contains risk factors, and providing opportunities for employees to configure their work to accommodate personal needs (e.g., adjustability, options for technique).

Engineering controls may include consideration for human size, patterns of movement, equipment, product selection or placement, and work processes. There are opportunities to address these issues in the layout of spaces, the configuration of fixed furnishings (e.g., shelving, display tables), the layout and adjustability of workstations (e.g., check-out), and the selection and integration of equipment and technologies.

Administrative controls may be supported by the physical environment but usually require organizational or supervisory decisions rather than design of the physical environment. Administrative controls that must be implemented in addition to the engineering controls outlined below include: MSI awareness education for all employees to ensure an understanding of relevant MSI health effects, signs and symptoms, hazards and controls; and implementation of an MSI risk management program, as part of the ongoing health and safety efforts, to identify, assess and control MSI hazards in work.

Documenting identified MSI hazards and the controls that are implemented to address those hazards during the design or reconfiguration of a facility is a component of MSI risk management that assists with demonstrating regulatory due diligence and that communicates a design intent to manage MSI risk through engineering controls.

Considerations and ideas outlined below are based on observations in multiple retail locations, an understanding of commonly identified MSI risk factors and strategies to control risk in those environments. The specific needs and practices will vary between different retail environments and should be reflected in the design decisions for those environments.

#### Layout of Spaces

Layout and space planning are specific design skill sets. Layout of retail spaces will consider both front of store (displays, shelving, aisles, check-out, entry/exit, queuing) and back of store (shipping, receiving, warehouse, office, processing). Logical layout of spaces should consider the experience of the customer, employees, and secondary users such as delivery personnel or product vendors. Prevention of MSI will have a focus on employees and the work performed by employees.

MSI risk can be minimized through layout and space planning by considering the volume and characteristics of product handled, the equipment used when handling product, the tasks performed by employees as product moves from incoming shipments to warehousing to store floor and through to checkout (process flow), and weekly or seasonal variations in how all of this occurs. Key aspects of layout and space planning to control MSI risk for employees include:

* allocation of adequate space for product;
* allocation of adequate space for the work to be performed and for the equipment required to perform that work; and
* logical movement of product, people and equipment through the space to minimize handling and distances travelled (adjacencies and process flow).

There is often a constraint in the total available space that necessitates a trade-off in the allocation of space between front of store and back of store space. Decisions regarding this balance will influence how work is performed in both areas. Insufficient space for safe work in either area will result in physical constraints that limit postures, prevent the use of mechanical assists or other equipment, and interfere with efficient flow of materials within or between spaces. Ideas to consider in layout planning for available space are outlined in subsequent sections for specific store areas.

#### Configuration of Workstations and Furnishings

The configuration of workstations and furnishings will define workflow, patterns of movement and the postures required to perform work in these areas.

Workflow objectives are to:

* Organize according to the logical sequence of activity. This minimizes repetitive movements, distances moved and the duration of the task.
* Minimize the distances reached, carried, lifted, pushed or pulled. This minimizes awkward postures and the duration of exposure to manual handling aspects of the task.
* Minimize the number of steps in a sequence and the number of times that single items are handled. This minimizes the repetitiveness of the task and exposure duration.

Postural objectives are to:

* Support working in neutral postures for individuals who are a variety of sizes. This will generally require some degree of adjustability in key aspects of the workstation or the position of equipment on the workstation.
* Minimize reaching that requires movement of the elbows away from the body (awkward shoulder postures for forward, backward, or lateral reach).
* Support smooth, fluid patterns of movement and minimize sustained postures with little opportunity for movement.
* Provide line of sight that avoids sustained or repeated awkward postures of the neck (looking down, looking up, turning to either side).

Workstations that act as a primary location for employees to perform work for more than two hours per shift ideally have adjustability to enable neutral working postures. This is relevant for areas such as check-out, customer service counters, or office workstations. Workstations or furnishings that are used intermittently through the day for short periods of time, or that are shared by multiple employees simultaneously often have little or no adjustability (fixed height or depth) but still need to function well for a range of employees. This may be relevant for areas such as deli meat slicing stations, product displays, racks, or shelving.

Workstations or furnishings that are fixed height or fixed depth will not fit everyone. A plan to accommodate smaller or larger employees is prudent to minimize risk to employees who do not fit the fixed height or depth. For example, the use of height adjustable chairs, step stools, or portable platforms can elevate smaller people to align with a higher worksurface. Conversely, the use of a worksurface insert can elevate the working height to align with a taller person’s height. Providing options for workstations of different fixed heights is one strategy to accommodate a range of employee sizes by enabling employees to select the workstation that fits them best.

#### Selection and Integration of Technologies and Equipment

Technologies and equipment define how work is performed. Each technology or piece of equipment that is selected for use in the retail environment has the potential to reduce or to increase risk of MSI. Technologies such as barcode scanning, computerized inventory tracking, anti-theft tracking devices and others are now common. Equipment to implement those technologies, storage and display systems, checkout and bagging systems, and materials handling equipment are common. The selection and integration of technologies or equipment is an opportunity to reduce MSI risk, if MSI hazards are fully considered during the selection, planned installation and integration of that technology or equipment.

Consider how the equipment will be used within the store environment from the perspective of the employee interacting with the equipment. Consider other equipment or furnishings that may be used in the same area or as part of the same sequence of work. The interaction between the equipment and employees, and the interaction between different pieces of equipment are both important to ensure gains in productivity and safety.

Interaction with employees may consider ease of use (intuitiveness, simplicity, comprehension, ability to recover from errors), adjustability or physical fit (working heights, reaches, postures, grip, length of cables), whether it will add or remove steps from the process, and any physical hazards that may be introduced or removed. For example, security tags to reduce theft may require additional steps for each purchase to remove tags and to install tags on new merchandise, may involve repetitive awkward wrist and finger postures to install and remove tags, may result in puncture wounds from sharp metal, and may be missed by employees during check-out. These factors should be considered in the selection and integration of a security tag system to minimize risk of MSI while addressing the issue of theft.

Interaction with other equipment may consider aspects such as the ability to use rolling stock, carts, or mechanical assists that are intended to reduce MSI risk. For example, the selection of a bakery oven that enables full tray racks to roll in/out of the oven could eliminate manually transferring trays from cart to oven and oven to cart, reducing handling and associated MSI risk. The selection of a back-of-store refrigeration unit that has a raised edge at the entry may prevent the use of pallet jacks or hand trucks for moving product in/out of the refrigeration unit, increasing manual handling and associated MSI risk.

Considering the interaction with employees and other equipment within the retail environment during the selection and planned installation of technologies or equipment can reduce MSI risk and increase the likelihood of successful implementation. Pilot testing or mock-ups of intended installations can be effectively used to select technologies, to compare options for installation, to identify MSI hazards, and to identify opportunities to control MSI risk.

## User-Centred Design

Small changes in the design of a work environment can have large impact on MSI risk, with both intended and unintended consequences for the people who work in that environment. It is preferable to anticipate and eliminate negative outcomes during design than attempt to address these after installation. User-centred design is one approach to target positive outcomes and to avoid unintended negative consequences through a focus on the people who will interact with the design (users) and involvement of a representative sample of the intended user group or user advocates in the design process.

The primary users in a retail environment will typically include employees, customers, and janitorial/maintenance staff. Secondary users who spend less time in the space but who have an interest in the design may include security, marketing, vendors or product representatives. User advocates may include managers, supervisors, OHS personnel or committee members, union members, and others with knowledge of the work and the people who perform it. These user groups can inform design decisions through their direct experience and understanding of the work that is performed and the people who perform it.

Involving “users” or “user advocates” throughout the design process is of value in obtaining positive outcomes through design. Input early (concept and planning) can guide general direction for improvements. Input during iterative technical design (layout, equipment/technology selection, workstation design, design review) can ensure that the design is refined to best meet the employee’s needs and to minimize MSI risk.

Possible activities to engage and involve users and user advocates in the design process may include:

* Surveys – brief interview, paper or web-based surveys to understand experience in existing environments. Employee discomfort, concerns, ideas, and values can be gathered relatively quickly using this method. This may inform specific outcome goals.
* Focus groups – guided small group interactions to address specific questions regarding current or future work environments to provide more insight into the user experience, and to explore issues that may not be consensus-driven.
* Design reviews – design presentation or walkthrough sessions with user groups to identify both gains and pains in proposed design or modifications.
* Mock-ups, trials or work simulations – to evaluate specific options for workstation design, equipment selection, or other changes to the work environment. This may vary from drawings or sketches, to low fidelity physical mock-ups, to full scale “pilot testing” of high fidelity models or actual samples in work simulation or actual work.
* Observation and seeking input from other locations or other companies who have already implemented design ideas or equipment that is being considered.
* Post-occupancy review – feedback on a new or modified environment to inform any needed minor changes in the new environment or to inform future planned changes.

## Human Variability – Designing for Differences

Human variability is normal within a population and across an individual’s lifetime. There will be diversity among the people who are employed in any company. Designing for human variability and diversity will expand the pool of employable people, minimize risk of MSI and other injuries among employees, and require fewer modifications to accommodate employees who may have differing needs or who have experienced an injury or health condition that limits their abilities on a temporary or permanent basis. Many of the design strategies that address human variability provide opportunities to minimize causation or aggravation of MSI, while enabling injured employees to remain working.

The full range of factors that may be considered when designing for diversity is broader than the context of this document; however, key factors that have the potential to reduce MSI risk while addressing employee diversity include consideration for a range in size and strength (anthropometry), mobility (balance, ambulation, endurance - often referred to as “accessibility” issues), handedness (left or right hand dominant), and sensory abilities (vision or hearing).

### Anthropometry – Size and Strength

Anthropometry is the study of size and strength among populations of people. Anthropometric databases provide measurements for different geographical, racial, and gender populations that are based on measuring large numbers of people. These databases provide guidance when trying to fit a range of people with a fixed size feature (e.g., shelving or workstation height), or when trying to determine a range in adjustability to accommodate many people (e.g., adjustable chair, keyboard or monitor height).

Anthropometric databases use percentiles to specify the smallest (1% or 5%), median (50%), and largest (95% or 99%) measurement within a population. The 50th percentile measurement means that half of the population is larger and half of the population is smaller. The 5th percentile measurement means that 95% of the population is larger and 5% is smaller. The 95th percentile measurement is the opposite, with 95% smaller and 5% larger. When designing for a population that is predominantly or entirely male or female, use the gender-specific data for that population. When designing for a mixed gender population, use the smallest female data and the largest male data to define the range of sizes and consider the difference between the 50th percentile male and 50th percentile female if designing for “average” without adjustability. The average for a mixed gender population can be estimated as the midpoint between 50th percentile male and 50th percentile female.

Design guidance that considers variability in size and strength uses the following principles in selecting anthropometric data to inform the design:

1. Reaches – design for the smallest and everyone larger will be able to reach.
This is relevant for vertical and horizontal reach.
2. Clearances – design for the largest and everyone smaller will be able to fit.
This is relevant for any openings such as doorways, hand access for maintenance, or leg clearance beneath a seated workstation.
3. Working heights – ideally, adjustable between smallest and tallest elbow height and everyone can adjust to fit. This is modified to be above elbow height (precision tasks) or below elbow height (high force tasks or large size product handling tasks) depending on the work to be performed.
4. Line of sight – design for the smallest eye height for view over obstacles or for the largest eye height for view under obstacles. For example, shelf height to maintain a view into the store (design for small stature) or signage hanging from the ceiling (design for tallest stature).
5. Lifting heights – target safe lifting zones as between largest knee height and smallest shoulder height. This ensures that low lifts are above knee height for all, and high lifts are below shoulder for all.
6. Strength – design for the weakest and everyone stronger will be able to do it.
This is relevant for manual materials handling, tool operation, grip force, door handles and force to open/close. An alternative is to design for a reduction in force requirements to as low as reasonably achievable.

Anthropometric data that can be used as design guidance when specifying factors listed above are summarized in Table 1. The limiting or adjustability range parameters for each measure are highlighted in Table 1.

Plan for employees who are larger or smaller than the anthropometric percentiles that the work or workstation is designed for. Failure to accommodate for employees outside the targeted range of size or strength is likely to result in repeated or sustained awkward postures that are required for these employees to perform their work, and an increase in MSI risk for those employees. For example, smaller employees at a worksurface that is too high will require awkward shoulder postures to raise their arms to working height; and larger employees at the same worksurface may need to bend over or stoop to perform work. Accommodations for smaller stature may consider the provision of height adjustable seating, risers, platforms, or steps to elevate the employee at a workstation. Accommodations for larger stature may consider the provision of a work surface riser to elevate the work. These kinds of accommodations can be planned for to ensure that there is space to store the equipment used for the accommodation and space to implement the accommodation. Similarly, purchasing items such as office chairs that are “standard” sized will result in fit challenges for the 5% of the population who are smaller or the 5% of the population who are bigger than the intended range of adjustment in the chair.

**Table 1. Anthropometric data (5th to 95th percentiles) and application for workstation design.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| \*\*all data in inches\*\* | **Female** | **All** | **Male** |  |
| **Body Measurement** | **5%** | **50%** | **50%** | **50%** | **95%** | **Relevance in Design** |
| Stature | 60.8 | 65.2 | 67.9 | 70.5 | 75.8 | Standing vertical clearance. |
| Eye height sitting | 42.8 | 45.8 | 47.8 | 49.8 | 53.8 | Monitor height. Line of sight. |
| Eye height standing | 56.6 | 60.9 | 63.4 | 65.9 | 71.2 | Monitor height. Line of sight. |
| Elbow height sitting | 23.4 | 25.5 | 26.7 | 27.8 | 30.2 | Seated work surface height. |
| Elbow height standing | 39.1 | 42.3 | 44.1 | 45.8 | 49.5 | Standing work surface height. |
| Shoulder height stand | 50.0 | 54.0 | 56.4 | 58.7 | 63.3 | Upper lifting height target. |
| Waist height standing | 37.4 | 41.0 | 43.0 | 44.9 | 46.8 | Ideal lifting height. |
| Knee height  | 16.7 | 18.4 | 19.6 | 20.8 | 22.6 | Lower lifting height target. |
| Popliteal (back of knee) height | 15.5 | 16.9 | 17.9 | 18.9 | 20.6 | Seat height with feet on floor |
| Forearm grip reach | 12.0 | 13.4 | 13.8 | 14.2 | 15.1 | Forward reach, neutral shoulder (frequent work) |
| Forward arm grip reach | 22.0 | 24.0 | 25.2 | 26.4 | 28.5 | Forward reach, awkward shoulder (infrequent work) |

\*Note 1: Shoe allowance of 1 inch has been added to anthropometric data (barefoot) in this table.
\*Note 2: Sitting measurements are based on chair height with feet on the ground (popliteal height).
\*Note 3: “All, 50%” represents median for the entire population, estimated as mid-point between female 50th and male 50th percentiles.

### Accessibility – Mobility, Reach and Clearance

Design for easy access by customers generally results in easy access for employees. The concept of “accessibility” spans many factors that include the ability to move through spaces (mobility) or to rest while moving through spaces (endurance), to get close to features for ease of interaction (clearance, ease of approach), to reach items that need to be grasped or touched (range of motion, reach), to have clear line of sight to items that must be seen, and to have redundant sensory cues for critical features like alarms or navigation (typically visual and auditory, may include tactile or olfactory). Use of accessibility guidelines within building codes, as a minimum standard for design, can assist with reducing barriers for both employees and customers. For example, aisle widths that enable two wheelchairs (or two shopping carts) to pass will also support the use of stocking carts, rolling racks and mechanical assists for moving product on the store floor. Ease of approach and reach for customers tends to result in ease of approach and reach for employees.

Design for endurance may include provision for work from both a standing and sitting position, or opportunities to sit while remaining productive. North American retail tends to serve from a standing posture, particularly at check-out workstations. This can limit accommodations for people with permanent or temporary limitations in their ability to stand or to stand continuously.

Design for vertical (top shelf) and forward reach (shelf depth) generally aims to fit the smallest individual, with consideration for reach from a seated position (wheelchair). Design for low reach (bottom shelf) generally aims to fit the largest individual, with consideration for clearance to enable a stooped or squatting posture.

Consideration of design for accessibility is beyond the scope of this document but can have benefits in the consideration of MSI risk controls for employees and in expanding the population of employees who are capable of performing work.

# Back of Store – Receiving/Shipping/Warehousing

Back of store space needs to be well-planned and organized for the volume of deliveries, the pattern of stock handling and storage, and the use of mechanical assists. Minimizing MSI risk will involve design for materials handling, load breakdown and/or construction, product flow and product storage. Generic materials handling guidance is provided in a separate section. Ideas to consider for back of store to minimize risk of MSI include:

* Understand the usual (or intended) pattern and volume of deliveries, and the requirements for warehousing residual stock in the back of store. Allocate adequate space to manage incoming deliveries, sort and deconstruct loads, and storage/retrieval of warehoused goods efficiently and safely.
* Understand the manual materials handling plan and the equipment that will be used to mechanically assist with movement of product. Plan for adequate space to both use and to store mechanical assists as close to the intended area of use as possible.
* Allocate space for temporary storage and staging of full truck/container loads of incoming and/or outgoing pallets or product loads. Space to stage an entire truck/container load prevents the use of aisles that are intended for other purposes, supports the use of mechanical assists, and reduces time-based pressure on employees unloading trucks and breaking down pallet loads.
* Consider the use of portable roller conveyors if hand-bombing is used to load/unload trucks, or for movement of product as loads are deconstructed. If using roller conveyors, plan for adequate space to use the roller conveyors and to store roller conveyors near the intended area of use. This will minimize carrying and improve productivity.
* Provide clear access to both sides of pallets or incoming product loads with a cart or pallet jack to support employees deconstructing loads for warehousing or shelf stocking. This may be reinforced by clearly marking floor spaces according to intended purpose (pallet storage, pallet access, tote storage, tote access, movement pathways). Clear access to two sides of a load promotes the use of mechanical assists and good body mechanics.
* Provide a clear path for movement of pallets and carts that is distinct from space used for more stationary work, such as breaking down or sorting pallet loads. This promotes safe separation between moving equipment and employees who are focused on depalletizing or sorting.
* Designate space to store empty pallets that are stacked flat rather than tipped vertically. Flat stacking empty pallets eliminates the need to manually lift or tilt empty pallets, and allows the use of pallet moving equipment for handling empty pallets.
* Designate space to store empty reusable totes or boxes used to transfer goods between stores. Prevent these items from filling up space otherwise designated for movement of people or goods.
* Plan specific locations for storage of heavy, awkward, or large items that supports the use of mechanical assists (e.g., forklift, pallet jack, hand truck, dollies). Aim to eliminate or minimize the need for manual handling of these items.
* If using vertical storage strategies (shelving, racking), plan for safe access to product stored above shoulder height. This will require the use of a forklift, manlift or portable platform. Provide adequate space for these strategies. Avoid the use of ladders or steps that require employees to carry items up or down steps because three-point contact cannot be maintained when carrying items in the hands and traversing up or down steps.
* Plan the transit path for items requiring refrigeration directly into the storage cooler or freezer using mechanical assists. This minimizes manual handling and minimizes costs associated with keeping the cooler doors open.
* If using deep racking to store product that is not moved in full pallets, provide reaching devices (e.g., pole with hooked end) in convenient locations to support easy access.
* If loads are constructed that require pallet wrapping, consider designating a space for wrapping and the use of a wrapping machine or rotating platform.

# Shelving, Racking and Product Stocking

The volume of shelving and aisle space needed will be determined, in part, by the usual products and volume of products sold; however, the following ideas may be of value in establishing the space requirements, placement and configuration of shelving, racking and displays.

* Aisle width should enable the use of mechanical assists (e.g., carts, pallet jacks, dollies) when stocking shelves, while maintaining adequate width for customers to safely move past employees or the ability to lock-out customers from an aisle or portion of an aisle if safe passage cannot be provided. Determine which mechanical assists or steps are required for stocking the product and to access the shelving height. Use this, along with consideration for customer flow, to establish minimum aisle widths.
* Plan storage or display of heavy, awkward, or large items to support the use of mechanical assists (e.g., forklift, pallet jack, hand truck, dolly) when stocking shelves or when retrieving product for customers.
* Minimize the use of store shelving that is above shoulder level or below knee level. This prevents awkward postures when stocking shelves and enables better access for customers.
* For stocking low shelves, consider the provision of a portable seat or low stool that gives employees the option of sitting in addition to squatting or kneeling. Use of a low stool on wheels can enable employees to move along a shelf or along an aisle more easily.
* For stocking shelves above mid-chest level, consider the provision of a step and a means of elevating the product being stocked to within easy reach from the step. A stocking cart with adjustable platform or a scissor lift cart can reduce the need for repetitive bending and increase productivity.
* For high racks or displays that require reach above head height, consider the provision of a reaching aid such as a pole with a hook on the end. Placement of light, infrequently accessed items on high racks or displays will minimize the frequency of needing to access or restock these items.
* Plan stock assignment within shelving that reflects the product size and frequency of interacting with product. Heavier, awkward items that are moved using mechanical assists (hand truck, dolly, pallet lift) should be placed on low shelves, skids or on the ground to facilitate use of the assist. Moderate to heavy items that will be manually handled should be placed on shelves between knee and chest level (waist level preferred) to promote the use of good posture while lifting. This includes heavier items that will be manually transferred between carts and shelving. Small, lighter items may occupy the higher shelves or bottom shelves where awkward lifting postures present greater risk. High frequency items that require frequent restocking or handling to tidy shelves should be in mid-height shelf zones to minimize the need for awkward postures.
* Space for seasonal displays, promotional displays or seasonal increases in product volume should be planned with designated locations that will not hinder movement within aisles or at customer queues for check-out. Placement of temporary displays within aisles or at the end of aisles where movement of goods is required for stocking or for retrieval of large items from back of store may hinder the use of mechanical assists and promote manual handling that increases risk. Planned locations with space for seasonal displays can prevent hinderances.

# Check-out Counters

MSI risk at check-out counters will be influenced by working height, reaches, clearance to get close to the counter, handling of merchandise, interaction with technology, and flooring. Ideas to minimize MSI risk associated with each of these is provided below. The specific size, shape and layout of any retail check-out counter should reflect the merchandise and method of processing transactions that is specific to the store.

Workflow:

* The usual sequence of activity performed by employees for retail check-out involves handling merchandise, scanning barcode or entering price/code and quantity, bagging or packaging purchases, and processing payment. There may be additional steps associated with specific merchandise. The layout of the work area should support this logical sequence of activity.
* The provision of options for right-to-left and left-to-right workflow can be of benefit in providing task variety and accommodating worker preferences related to handedness or related to upper extremity conditions that limit the use of one limb.

Worksurface:

* Guidance for standing worksurface height is based on standing elbow height, with consideration for the size and weight of product handled on the worksurface. The worksurface height should support grasping merchandise on the worksurface below standing elbow height. Target just below elbow height for small, light merchandise. Target waist height for large, heavy merchandise. Ideally, the counter working height would be adjustable for each employee. Fixed height worksurface should be below elbow height for the smallest employee (5th percentile). Fixed-height check-out worksurface heights are generally between 36-42” for standing work.
* The worksurface depth needs to accommodate merchandise but should support and promote work without awkward reaching. “Forearm grip reach” (elbow to palm of hand) guides depth for frequent work (e.g., handling merchandise at the counter) and “forward arm grip reach” (shoulder to palm of hand) for occasional work (e.g., reaching a receipt on a printer). Worksurface depths are generally between 12-22” to avoid forward reaching, with some of that depth to enable mounting of displays or touchscreens in addition to active counter depth.
* If larger orders are processed, use a conveyance system to move items from where the customer queues their purchase on the counter into easy forearm reach of the worker. Where a conveyance system is not used, limit the size of the incoming counter to force placement of merchandise within reach of the employee.
* If smaller orders are processed, provide a clear target zone for customers to place merchandise that is within easy forearm reach of the worker. Limit the size of the “incoming” counter space to avoid the need for lateral reach when processing orders.
* Round all edges that the employee may lean against or reach across to reduce contact pressure on tissues.

Scanners:

* Flush mount passthrough scanners with the counter surface to eliminate the need to lift items over the leading edge.
* Where tags need to be oriented beneath a raised scanner, position the scanner within forearm grip reach and centred on the body of the employee. This enables scanning to occur with either hand, without reaching, as the merchandise is moved across the counter.
* Encourage heavy, bulky merchandise to remain with the customer and use a code sheet, barcode scanning sheet or removable tag for these items to eliminate the need to directly handle and scan large items. Alternatively, or in conjunction with this, provide a handheld scanner with a long enough cord to enable items to be scanned in a cart without direct handling of the merchandise.
* Select scanners with strong laser systems and keep these calibrated and functioning smoothly. The need for multiple scanning or multiple attempts to scan individual items increases repetitive movements.

Monitor or Touchscreen:

* Height adjustable mounts that are easy and efficient to adjust are preferable to enable positioning of monitors or touchscreens according to the height of each worker.
* Monitors that are purely visual (not touchscreen) should be positioned directly in front of the worker to avoid neck rotation, and with the top of monitor at or slightly below eye height.
* Touchscreen monitors should be positioned directly in front of the worker and at a height that places the middle of the screen within easy reach and below shoulder height. The ability to tilt a touchscreen monitor slightly upwards can assist with viewing angle and managing any glare issues.

Keyboard and Mouse:

* When a keyboard and/or mouse is required, height should be aligned with workers’ elbow height and within easy forearm reach.

Millwork/Cabinetry – Leg and Foot Clearance:

* Provide foot clearance of at least 4” depth that enables the feet to slide beneath the millwork and the worker to stand tight against the edge of the worksurface.
* Provide leg clearance and a foot shelf at about 6” height directly in front of the standing work zone to enable the worker to place one foot up on the shelf with the knee and leg inside the millwork. This provides variation in posture and can alleviate postural strain associated with prolonged standing.
* Shelving or cabinetry to hold the computer system, supplies, bags, cash drawer and any other stored items should be beside the standing zone or above the leg clearance area.

Bagging Area:

* Bagging merchandise should be done without the need to elevate the elbows (awkward shoulder postures). This will depend on the type of merchandise and the type of bag.
* Vertical bagging (e.g., grocery) requires a lowered bag well or bagging surface that places the top of the bag at about elbow height. The ability to adjust the height of the bag (e.g., adjustable counter height or bag shelf height/hooks) will allow individual workers to adjust this task to their height.
* Horizontal bagging (e.g., apparel) where merchandise is slid horizontally into a bag requires a worksurface below elbow height that is large enough to accommodate the size of a typical bag.
* Consider eliminating the need to bag purchased items by providing an area for customers to bag their own merchandise. This is becoming more common as customers bring their own bags.
* Where smaller items are bagged and larger items are passed through to a counter, provide a continuous portion of counter that enables larger items to slide from the scanning area to the customer counter without the need to lift.
* Where possible, design with the intent that customers can pick up their bags from the bagging area without the need for the worker to lift full bags out of a bag well or across a worksurface. This may be accomplished by having a bag well that is accessible on the customer side as well as the worker side or by having the bagging counter directly accessible on the customer side.

Payment Area

* Configure POS terminals to be easily accessed by customers without the need for workers to directly interact with the terminal. Mounted terminals on the customer side of the check-out counter support this.

Cash Drawer:

* Cash drawer location should enable full opening that is beyond reach of the customer but within easy reach and below elbow height of the worker.
* The cash drawer should not open directly into the worker unless there is clear ability to step back out of the way during cash transactions.

Flooring:

* Considering that check-out is often a full-shift, standing activity, ensure that flooring is either resilient material (e.g., carpet or cork on rubber underlay) or there is a resilient anti-fatigue mat covering the entire standing area of the workstation. If using anti-fatigue mats, ensure that the edges are secured to avoid tripping hazards and that the mats are maintained in good condition and replaced as they become worn.

Traffic Flow and Security

* Provide a barrier or clear separation between the worker and customer to ensure the ability to avoid physical contact with an agitated customer. If there is traffic flow of customers behind the worker, provide a rear barrier between the worker and customers.
* Provide the ability to step back from the counter and create space between the worker and an agitated customer.

# Customer Service Areas and Specialty Counters

Customer service areas for specialty counters (e.g., deli, bakery, meat/fish, jewellery, prescriptions, and others) or for returns and order pickup have requirements that differ from check-out counters. The dimensions and construction of the specialty counter will define the postures required to serve customers across the counter and to reach merchandise within the counter. Ideas to minimize risk of MSI in these areas include:

* Use trays that are easy to slide in/out of the display case to access merchandise rather than reaching into the case.
* For service from taller display cases, consider lowered “cut-out” counters to enable merchandise to be passed to customers with minimal vertical reach. Where service is provided across taller display cases ensure that the case height is below shoulder height.
* For customer-facing tags, consider placing duplicate information on the rear of the tag or on the rear side of a tray to enable the worker to read codes, prices or product descriptions without reaching for or removing the tag.
* Where scales, wrapping, printing, or sales transactions are provided at the specialty counter, ensure that a work surface is provided that is near elbow height to avoid vertical reach and awkward shoulder postures.
* Returns counters should have a staging area nearby that is large enough to position stocking cart(s) to sort and gather items as they are returned, and prior to placement back into stock or shipping back to source.

# Materials Handling

Materials handling activities are a component of many jobs within retail, including receiving/shipping, warehousing, stocking, curbside service, and check-out. Materials may be manually handled (lifted, pushed, pulled, carried), handled using mechanical equipment (forklift, pallet stacker, crane, conveyor), or handled using mechanical assists that reduce physical effort (dollies, carts, hand trucks, manual pallet jacks). The use of mechanical assists often requires manual handling to load/unload the assistive device or to push/pull the loaded device. Consideration for how materials handling will be performed during the design of spaces and the selection of equipment ensures that MSI risk is reduced, as intended. Plan the materials handling strategies before or during the design of a retail space to enable the design to support the intended strategy.

Risk of musculoskeletal injury (MSI) associated with materials handling is related to characteristics of the load (weight, size, handles), how it is stored (pallets, floor, shelves or racking), equipment available to assist (carts, pallet jacks, hand-trucks, dollies, forklifts), the frequency (repetitiveness) of the handling, and the postures required when lifting, carrying and putting down a load. Postures required for lifting are constrained by several factors: height of the load when picked up and when put down (above shoulders and below knees increases risk); horizontal distance of the load from the body when picked up, carried and put down (further from the body increases risk); the ability to get square to the load (twisting increases risk); and space to approach and move with the load once picked up (clearance and clear path).

WorkSafeBC provides an evaluation method for manual lifting and lowering in the MSI Risk Assessment Worksheet (2022) or via online calculators that can be used to determine high risk lifting activities by considering the weight lifted, start and end positions (where it is picked up and where it is put down), and with maximum acceptable weight reduction multipliers based on twisting (x 0.85), and based on a combination of frequency (lifts per minute) and duration (hours). If lifting more frequently than once per 2 minutes or lifting for greater than 2 hours per day, the frequency and duration multipliers reduce the maximum acceptable lift outlined in the image below. This same approach can be used to inform the design of workspaces to minimize risk associated with manual materials handling by using this information to plan the placement, storage or accessibility to materials that will be manually lifted or lowered.



The maximum acceptable weight to remain below “high risk” is determined by selecting the lowest weight from the image at left that represents the work performed and hand position when picking up or putting down the weight. This unadjusted weight is then multiplied by the factor in the table above that best represents the rate and duration of lifting, and multiplied again by 0.85 if the lift involves twisting the torso 45 degrees or more.

Design strategies to minimize MSI risk associated with materials handling include the following, considering a general philosophy of using mechanical assists where possible, targeting optimal postures, and designing work to optimize manual handling.

* Minimize the number of times that each item must be handled. For example, movement directly from pallet to store shelving requires fewer touchpoints per item than depalletizing onto storage shelving, retrieving from the storage area onto a cart, and stocking store shelves from the cart. An alternate example is keeping heavy or awkward items in the cart at check-out and scanning without handling the item.
* Provide a selection of mechanical assists to address the variety in scenarios for materials handling. This may include forklift, pallet stacker, pallet jack, stock cart, wheeled racking, dolly, hand truck or any other means of mechanically moving materials without lifting or carrying. Ensure that employees are trained to use the equipment provided.
* Design and allocate standard locations to store mechanical assists that are close to where they will be used. This increases the likelihood that they are selected for use when needed, and provides known, convenient storage for each assist where employees know to “park” the equipment when not in use. Avoid storage of mechanical assists in aisles or pathways that are otherwise used.
* Aim to avoid storage of materials in the high-risk zones for manual lifting. Target between knee and mid-chest for the most frequent, heaviest, or most awkward items that must be manually handled.
	+ The use of height adjustable stock carts, pallet stackers, scissor lifts can set the height for lifting to a more favourable zone that is near waist level.
	+ Selective allocation of shelves or racks in optimal lift zones for frequent manually handled items, leaving the lowest and highest levels for mechanical handling or infrequent manual handling.
	+ Plan to raise items above the floor to avoid lifting to/from a height below the knees. Raised shelving, empty pallets, empty totes, or any other means of elevating loads to be lifted can assist.
	+ Plan to avoid lifting heavier items to or from heights above mid-chest. Allocate higher shelves to smaller, lighter items. Provide a step or portable platform to elevate the worker where higher shelves need to be accessed by employees.
	+ Plan for close approach to avoid forward reach when lifting. Access around pallet loads, foot clearance to stand close, or the ability to slide an item towards the near edge of a shelf can assist. In back-of-store areas, the use of rotating pallet tables or forklifts to rotate pallet orientation can improve access to loads.

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