Electro *Kinetic* Technologies

Ergonomic Solutions for Transport

IMPACT OF MUSCULOSKELATAL INJURIES IN THE WORKPLACE

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What are Musculoskeletal Disorders?

Musculoskeletal Disorders or MSD, are injuries and disorders that affect the human body's movement or musculoskeletal system, muscles, tendons, ligaments, nerves, discs, or blood vessels. An injury occurs when the applied load on the body exceeds the failure tolerance or strength of the supporting tissue. Common musculoskeletal disorders include;

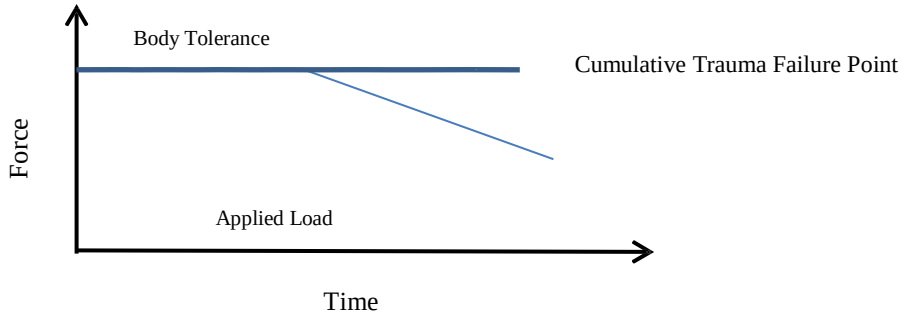
- Sprains
- Strains
- Tendonitis
- Arthritis
- Carpal Tunnel

When a musculoskeletal disorder is caused by or is associated with work, it is usually referred to as a work related musculoskeletal disorder or WRMSD. The risk factors contributing to WRMSD can be defined as the actions in the workplace that may cause or aggravate a MSD such as;

- Forceful Exertion
- Awkward Posture
- Repetitive Motion
- Exposure to Extreme Environmental Conditions, heat, cold, humidity or vibration.

What Causes Musculoskeletal Disorders?

The obvious cause of a musculoskeletal injury is the result of the body sustaining a very high load that leads to damage of the supporting tissue. An example of this would be a person tries to move or lift an extremely heavy load that exceeds the capacity of the supporting tissue within the arms, shoulders, legs, or back. However a more likely scenario for an injury comes from accumulated trauma over time, produced by either a repetitive application of a relatively low load or the application of a sustained load for a long duration.



How Can Musculoskeletal Disorders be prevented in the Workplace?

Companies in the United States often set standards so that 75% of the female population and 99% of the male population can safely perform a manual (push, pull or lift) task. Studies conducted by Liberty Mutual Group Loss Prevention Organization have shown that two-thirds of low back claims can be prevented if the tasks are designed to accommodate at least 75% of the female work population. To this end, Liberty Mutual developed tables, based on research conducted by Drs. Stover Snook and Vincent Ciriello at the Liberty Mutual Research Institute for Safety.

The following data is a useful subset of the Liberty Mutual Tables for push, pull and lifting limits so that 75% of the female population can safely perform the tasks. The complete tables should be

consulted if more conservative standards are deemed necessary. Using these Tables effectively requires basic level training in ergonomics and manual handling task analysis and evaluation. Once the analysis and evaluation of the actual task has been completed, these Tables can provide the necessary guidelines to help identify which tasks are being performed within safe limits and which tasks require a redesign of the equipment.

Definitions

- ***Initial Force***; The initial force to take a body at rest and initiate movement. In the case of a manual cart, the cart starts off at rest. A person will then exert a force to get the cart moving. This force is the initial force.
- ***Sustaining Force***; Once the body is moving, the sustaining force is the force required to keep the body moving at the same speed. The sustaining force is always lower than the initial force assuming the cart is moved on the same level surface and floor texture.
- ***Frequency***; How often a person will initiate the action, pull, push or lift. In the case of these Tables, there are figures for frequency at once every, 30 seconds, 1 minute, 5 minutes, 30 minutes and 8 hours. Maximum force levels are less if the frequency is higher, once every 30 seconds versus once every 8 hours.
- ***Hand Distance***; During a lifting task, this is the distance between the person's body and their hands when grasping the load. As this distance increases, the safe weight limit decreases.
- ***Lifting Distance***; During a lifting task, this is the distance that the load will be moved vertically.
- ***Hand Height***; During pushing or pulling task, this the distance between the floor and the handle of the cart.

Lifting Tasks

Lifting Task (Object Weight in Pounds)
Ending Height Less than 28" from Floor

	Hand Distance Away from Body														
	7 inches					10 inches					15 inches				
Lifting Distance	Frequency					Frequency					Frequency				
	15 s	30 s	1 m	5 m	8 h	15 s	30 s	1 m	5 m	8 h	15 s	30 s	1 m	5 m	8 h
28"	21	21	22	24	37	18	18	19	21	32	13	14	15	16	25
20"	22	23	26	29	42	19	20	23	25	38	14	15	17	19	29
10"	25	26	27	29	44	20	22	23	26	39	16	17	18	20	32

Lifting Task (Object Weight in Pounds)
Ending Height Greater than 28", Less than 53"from Floor

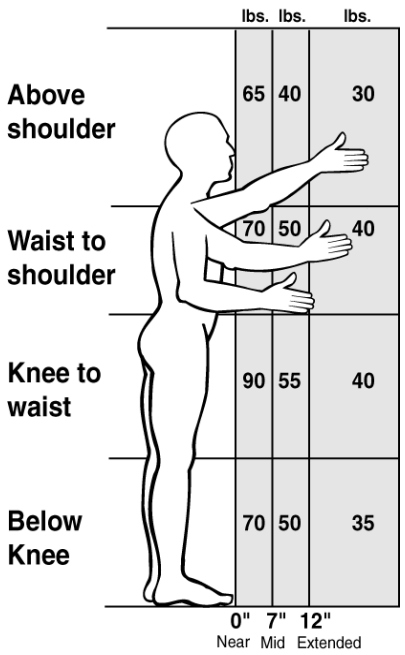
	Hand Distance Away from Body														
	7 inches					10 inches					15 inches				
Lifting Distance	Frequency					Frequency					Frequency				
	15 s	30 s	1 m	5 m	8 h	15 s	30 s	1 m	5 m	8 h	15 s	30 s	1 m	5 m	8 h
30"	17	19	21	23	29	15	17	18	20	26	12	13	14	15	20
20"	21	21	23	25	32	18	19	20	22	29	14	15	16	17	22
10"	21	22	26	27	35	18	20	23	24	31	14	15	17	19	24

Lifting Task (Object Weight in Pounds)
Ending Height Greater than 53" from Floor

Lifting Distance	Hand Distance Away from Body														
	7 inches					10 inches					15 inches				
	Frequency					Frequency					Frequency				
	15 s	30 s	1 m	5 m	8 h	15 s	30 s	1 m	5 m	8 h	15 s	30 s	1 m	5 m	8 h
30"	15	16	18	19	25	13	14	16	17	22	10	11	12	13	17
20"	18	18	20	24	27	16	16	18	19	24	12	13	14	15	19
10"	18	19	22	24	30	16	17	19	21	27	12	13	15	16	21

How Can We Translate These Lifting Tables into My Workplace?

Most of us can understand and can relate to how to measure weight. After all weight is nothing more than the measurement of earth's gravitation pull on an object and is measured throughout the world by using a scale where the magnitude of this force is measured in either pounds (US) or grams (metric). Therefore in order to find out whether the object that you are lifting exceeds the guidelines shown in the above lifting tables, you merely need to weigh the object on a scale.



Once you have determined the objects weight, you need to review how the object is being moved in order to determine whether you are safely performing the lift. Following are some general guidelines that can also be used to evaluate your situation.

- The more frequent the lift, the less weight should be moved. You can see this in all of the above tables. The safe weight limit goes up as you move from left to right in the table.
- A person's "power area" is located between the knee to waist and out to 7" away from the body. This is area where a person can lift the most weight safely.
- A person's "weakest area" is located above their shoulders. This is the area where a person can lift the least amount of weight safely.
- The farther the lift is away from the body, the safe weight limit decreases.

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Pulling & Pushing Tasks

Pulling Task (Initial Force in Pounds)

Hand Height	Frequency				
	30 seconds	1 minute	5 minutes	30 minutes	8 hours
53”	42	44	51	53	56
35”	43	46	53	55	58
22”	46	49	56	58	61

Pulling Task (Sustained Force in Pounds)

	PULLING DISTANCE														
	7 feet					25 feet					50 feet				
Hand Height	Frequency					Frequency					Frequency				
	30 s	1 m	5 m	30 m	8 h	30 s	1 m	5 m	30 m	8 h	30 s	1 m	5 m	30 m	8 h
53”	28	29	33	35	44	24	26	29	31	38	17	21	25	26	32
35”	27	28	32	34	42	23	25	28	30	37	17	21	24	25	32
22”	25	26	29	32	39	21	23	26	28	34	16	19	21	23	28

Pushing Task (Initial Force in Pounds)

Hand Height	Frequency				
	30 seconds	1 minute	5 minutes	30 minutes	8 hours
53”	42	45	52	55	58
35”	41	45	52	55	58
22”	34	37	41	44	46

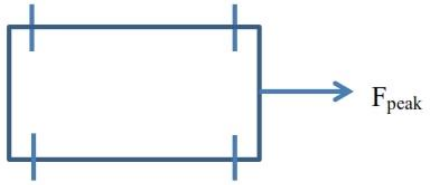
Pushing Task (Sustained Force in Pounds)

	PUSHING DISTANCE														
	7 feet					25 feet					50 feet				
Hand Height	Frequency					Frequency					Frequency				
	30 s	1 m	5 m	30 m	8 h	30 s	1 m	5 m	30 m	8 h	30 s	1 m	5 m	30 m	8 h
53”	27	30	34	37	45	22	23	26	28	34	17	19	21	23	29
35”	25	28	32	34	42	22	24	27	29	36	16	20	23	24	30
22”	22	25	28	30	37	21	22	25	27	33	16	19	21	22	28

How Can We Translate These Push/Pull Tables into My Workplace?

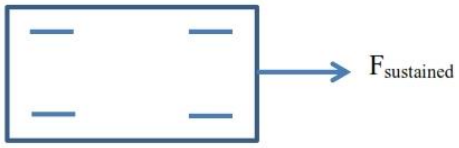
Determining the push/pull forces involved in moving an object is not as straight forward as measuring its weight. Although weight certainly has a factor, the friction forces between the object being moved and the surface determines how much force it will take to move the object. That is why the same object will be easier to move across ice as opposed to a gravel road. Same object, same weight, but the force required to push or pull it on ice is much less.

To measure the rolling friction force of a cart, we can use the same tool that we used to measure the weight of an object, the scale or strain gauge. Note that this procedure will provide you with the pulling force however the pushing force will be equivalent given the same set of test parameters. The highest forces will be when the equipment is at rest and the casters are aligned 90 degrees away from the direction of motion as shown below.



If the equipment only has swivel caster on one end, then only rotate these. Attach the strain gauge to the equipment and start pulling. As you pull you will see the force go up on the strain gauge read out until the equipment starts moving at which point the force on the display will go down. Note the highest level of force displayed. Repeat the test 3 to 5 times to get a good average. You now have measured the peak or initial force to move the cart.

After you have completed the peak force measurements you are ready to measure the sustained force. Again with the strain gauge attached pull the equipment, however now you want to keep the equipment moving at a constant speed. In this case the casters will be aligned as shown below.



After you have gone about 10 feet you will notice that the force on the strain gauge stays reasonably constant. Note the force displayed. Repeat the test 3 to 5 times to get a good average. You now have measured the sustained force.

After you have determined the initial and sustained you need to review how the object is being moved in order to determine whether you are safely performing the operation. Following are some general guidelines that can also be used to evaluate your situation.

- The more frequent the movement, the less weight should be moved. You can see this in all of the above tables. The safe weight limit goes up as you move from left to right in the table.
- Inclines either going down or up, have a dramatic impact on level of force required to move a cart. If your situation has inclines, be sure to take the measurements on the incline as well.
- Floor materials. In general, carts moving on a cart surface require less force than a softer surface. Concrete easier than carpeting as an example.
- Wheel and casters impact the force required to move a cart. Some areas of impact include;
    - Diameter, small diameter wheels take more force.
    - Material
    - Bearing technology
    - Physical damage
- Floor materials. In general, carts moving on a cart surface require less force than a softer surface. Concrete easier than carpet
- Although there are known industry wide numerical standards defining the maximum weight that can be safely moved manually, some companies have begun to define recommended standards. For themselves. One such study was conducted by the

Ergonomics Group of Eastman Kodak that resulted in the following general recommendations.

- Payloads on 2-wheeled carts should not exceed 250 pounds
- Payloads on 3 and 4-wheeled carts should not exceed 500 pounds
- Payloads on hand pallet trucks should not exceed 1500 pounds.

How Much Does a Musculoskeletal Injury Cost?

It is estimated that over 40 million people age 45 and older in the United States have some form of musculoskeletal condition. With an aging workforce and increases in healthcare costs, the number of people who will become injured and the costs associated with treating them will no doubt increase. According to Liberty Mutual the largest workers compensation insurance provider in the United States, overexertion, lifting, pushing, pulling, holding, carrying or throwing an object, costs employers $13.4 billion every year.

Statistics compiled by the U.S. Department of Labor for 2011 reported 1,181,290 occupational injuries requiring days away from work to recuperate. Of this total, 387,820 or 33 percent were directly related to a musculoskeletal disorder. Further, musculoskeletal injuries had an overall incident rate, cases per 10,000 full-time workers, of 38.5 and 11 median days away from work for each case.

OSHA breaks down the costs of any injuries into direct and indirect costs. Although direct costs are paid by worker's compensation insurance, employers pay premiums based on their safety performance records. When their safety records decline, their premiums go up to reflect this performance.

OHSA defines indirect costs to include;

- Wages paid to an injured work for absences not covered by workers' compensation.
- Wages related to time lost through work stoppage associated with the worker injury.
- Overtime costs necessitated by the injury.
- Administrative time spent by supervisors, safety personnel, and clerical workers after an injury.
- Training costs for a replacement worker.
- Lost productivity related to work rescheduling, new employee learning curves and accommodation of injured employees.
- Clean-up, repair and replacement costs of damaged material, machinery and property.

Indirect costs not included by OSHA estimates but may factor into total indicate costs;

- Cost of OSHA fines and associated legal action.
- 3rd party liability and legal costs.
- Worker pain and suffering
- Loss of good will from bad publicity.

The average claim costs within the OSHA report were provided by the National Council on Compensation Insurance, Inc. (NCCI). The information in the report reflects the average cost of a lost time workers' compensation insurance claims from unit statistical reports submitted to NCCI

for policy years 2007-2009. Direct costs associated with MSD type injuries include hernia $23,083, sprain $28,338 and strain $32,319.

In the OSHA report, the indirect cost estimates are taken from the Business Roundtable publication, Improving Construction Safety Performance, and are based on a study conducted by the Stanford University Department of Civil Engineering. In this study they concluded that the indirect costs for this level of injury could be 1.1 times the direct cost. Compiling this data provides the following estimates for total costs by injury.

Type of Injury	Direct Cost	Indirect Cost	Total Cost
Hernia	$23,083	$25,391	$48,474
Sprain	$28,338	$31,171	$59,509
Strain	$32,319	$35,550	$67,869

These statistics indicate that a musculoskeletal work related injury can cost an employer anywhere from $48,000 to $67,000 for each incident.

How Am I Impacted by these Injury Costs?

The cost of workers' compensation insurance is determined by the workers' compensation board in each state. Although base rates vary slightly from state-to-state, the basic process each state uses to calculate base rates is similar and is based on size of payroll, classification of company and jobs and experience modification rate (EMR).

The EMR is used to adjust premiums based on 3 years of injury losses. If your EMR is 1.0 you have losses that are average to other companies within your peer group. If your EMR is higher than 1.0, your injury record is higher, if less than 1.0 it is lower. Based on your EMR, your annual premium is then adjusted accordingly. Let's look at an example.

Annual Payroll: $7,000,000
Premium: $230,000 per year
Weight: .24

Existing Compensation Experience Rating

	Primary Losses	Stabilizing Value	Ratable Excess	Totals
Actual	$100,665	$210,534	$18,259	$329,458
Expected	$68,233	$210,534	$51,800	$330,567

Based on this data the company's EMR is $329,458/$330,567 or 1.0

The company's workers compensation premium $230,000 when multiplied by the EMR, 1.0, would result in no adjustment, up or down in the annual insurance premium.

Now let's inject a single strain injury that results in a direct cost of $30,000 paid against the company's workers compensation insurance.

First, we separate the $30,000 injury into actual incurred losses of $20,000 and primary losses of $10,000 as required by the state workers' compensation board where the injury took place. Next we multiply the primary loss, $20,000 by the weight, 0.24 which is added to the ratable excess, $4,800.

Revised Compensation Experience Rating

	Primary Losses	Stabilizing Value	Ratable Excess	Totals
Actual	$110,665	$210,534	$23,059	$344,258
Expected	$68,233	$210,534	$51,800	$330,567

Based on this data the company's EMR is $344,258/$330,567 or 1.041

The company's workers compensation premium $230,000 when multiplied by the EMR, 1.041, would result in an increase in the annual premium by $9,430. Since this injury stays in the EMR calculation for 3 years, the company will be paying a total of $28,290 over 3 years for this loss, plus $33,000 of indirect costs. Following are the cash flows for these costs and the annual impact to the company's profit & loss statement.

	Year 1	Year 2	Year 3	Year 4
Insurance Premium Increase	$0	($9,430)	($9,430)	($9,430)
Indirect Costs	($33,000)	$0	$0	$0
EBIDTA	($33,000)	(9,430)	($9,430)	($9,430)

How Can I Prevent These Costs from Impacting My P&L?

As seen in the simple above example, safety pays. By implementing a safety program within your organization that includes ergonomics, you are making positive steps to improving the work space for your employees and increase your company's bottom line performance.

If you need to invest in capital equipment in order to achieve this goal, many times this can be done with paybacks less than a year. In the above example if a capital equipment investment of $28,000 was required to eliminate this strain injury the payback on this investment would be 6 months assuming a cost of capital of 4.5%.

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