TOOLBOX

NIOSH

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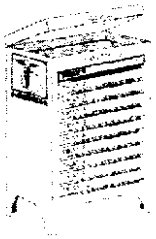
TOOLBOX

DESCRIPTION OF CONTENTS

The "tools" in this Toolbox are the assorted techniques mentioned throughout this primer for identifying, analyzing, and ultimately controlling WMSDs. Reviews of company health records, symptom surveys, or physical examinations for diagnostic purposes are "tools" to help identify musculoskeletal disorders. Similarly, checklists, time-motion analyses, and other methods used to sort job demands and workplace conditions that pose risks for musculoskeletal problems are tools. Also, information sources and other opportunities for learning more about ergonomic issues can help fill individual needs.

This Toolbox contains examples of various data gathering techniques and procedures along with reference materials for elaborating on their use. Also included are information guides and lists of reports that can prove helpful in efforts to address specific problems. The material is organized into sections or "trays." Most of the tools and techniques described are easy to use and adaptable for many purposes. Procedures are stressed that do not require special equipment or laborious data collection and analyses. Some of these tools are based on professional practice, others on scientific research, and still others on a combination of both. While few have been extensively validated and have other limitations, NIOSH has found these tools to be useful. Even with their shortcomings, they should enable readers to take some first steps in determining whether workplace conditions pose a risk of WMSDs and in suggesting remedial actions. Where problem-defining and problem-solving steps prove more formidable, referrals to sources of more in-depth information are provided throughout the Toolbox.



TRAY 1
LOOKING FOR SIGNS OF WMSDs

LOOKING FOR SIGNS OF WMSDs

NIOSH investigations have determined that a wide variety of work settings and job operations have the potential for ergonomic hazards. A log of these NIOSH investigations, included here, provides examples of problem work settings and job operations and the recommendations that were suggested to solve these problems. Readers may find similarities between their businesses and those listed.

The log included in Tray 1–A describes the work settings, the job tasks in question, the findings, and the recommended control measures. Various data collection procedures were used in these investigations. Medical information was largely collected by reviewing OSHA logs, other case records, use of special questionnaires, and surveys. In some instances, physical examinations were given with diagnostic tests added to better assess any apparent musculoskeletal problem. Data on ergonomic stress factors were obtained by walk-through and checklist observations, analyses of videotapes of workers engaged in their jobs, and workstation measurements. Forces involved in certain tasks such as lifting were subjected to biomechanical evaluation as needed.

While the entries in Tray 1–A only offer clues, the information contained in the investigative reports is fairly detailed. Many of these reports can be ordered from the National Technical Information Service (NTIS). (NTIS order numbers are listed for each available report and an order form is provided. Prices for these reports vary; please check with NTIS for current pricing information.)

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
0171 Agriculture (Berry crops)	**Harvesting** wild blueberries. Task involves **combing through bushes with a hand-held rake** to scoop up berries.	Upper extremities (hand/wrist and elbow) and back.	Awkward (stooped) postures, repetitive deviations of the wrist, and repetitive and forceful motions of the hand/arm and shoulder.	Recommended engineering controls included using mechanized harvesting where feasible, and redesigning the rake (substitute material to make the rake lighter). Better work practices, work conditioning, and reducing the loads in buckets were also recommended.	HETA 93–1031–2521 NTIS order no. PB–96–115–472
1752 Construction (Floor work)	**Carpet Installation**. Tasks include use of the '**knee kicker**' to stretch carpet.	Lower limb	Forceful exertions and contact stress	Control recommendations included using knee pads and more use of a hand-operated power stretcher.	HETA 82–065–1664 NTIS order no. PB–86–225–661

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
2011 Manufacturing (Meat products)	Plant **processing beef and pork products.** Tasks studied were **cutting and dissecting cattle and hogs with saws, straight knives, powered hand knives, clippers, and hooks.**	Upper extremity disorders (mainly hand/wrist but also elbows, shoulder, and neck).	Vibration and force found to correlate highest with problem cases. Data on repetitive actions and awkward postures were judged insufficient for analysis.	Engineering changes included reorientation of tools, adjustable fixtures, better layout of workstations and delivery bins, and automating aspects of the work process to relieve workload demands. Train new employees in proper work methods, use of job rotation, and rest breaks suggested along with better maintenance of cutting knives to reduce vibrations. Improved medical management stressed, such as educating workers to report early signs of problems, allowing adequate time off for symptomatic cases to heal, and a slower paced return to work policy after surgery.	HETA 88–180–1958 NTIS order no. PB–90–128–992
2015 Manufacturing (Poultry processing)	**Turkey processing.** Jobs include **eviscerating and boning tasks.**	Upper limb and neck	Repetitive and forceful exertions, awkward postures, low temperature	Engineering control recommendations include use of better designed knives and adjustable workstations. Also recommended were a comprehensive knife and scissor sharpening program and improving the work load distribution throughout the plant. Administrative control recommendations were work practice training and decreasing line speeds.	HETA 86–505–1885 NTIS order no. PB–89–106–546

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
2016 Manufacturing (Poultry products)	**Poultry processing** plant. Focus on workers engaged in **tasks of cutting, eviscerating, and deboning** carcasses as compared with those in lesser manual stress jobs.	Upper extremity (hand/wrist and elbow) disorders as well as tension neck problems.	Repetitive and forceful motions extreme and awkward postures of the upper extremities. Machine-paced work.	Engineering controls included restructuring jobs, use of mechanical devices to aid deboning and cutting tasks, and workstation changes to accommodate workers of varying sizes. New worker training, practice in proper cutting techniques, use of job rotation, and rest breaks to relieve fatigue were underscored. Suggested ways to improve medical management practices included better medical surveillance, employee education in symptom recognition, and cautions on treatment regarding use of drug therapy, splints, and restricted duty.	HETA 89–307–2009 NTIS order no. PB–91–104–620
2092 Manufacturing (Fish products)	**Filleting, fillet trimming, and "sliming" fish** at a packing plant.	Upper limb and neck	Repetitive and forceful exertions, awkward postures	Engineering control recommendations include workstation modifications to adjust work table height to fit workers and to reduce reach distances, texturing cutting table to reduce the force needed to hold fish, and modifying knife handle design. As administrative controls, work practice training and reduced emphasis on speed were recommended for new hires.	HETA 83–251–1685 NTIS order no. PB–87–108–312

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
2328 Manufacturing (Clothing, furnishings)	Various **sewing** tasks at a **uniform maker**.	Upper limb and neck	Repetitive and forceful exertions, awkward postures	Plant-wide workstation modifications were suggested such as providing foot rails, floor mats, adjustable chairs, and padding the edges of tables to reduce contact stress. Improvement in work layout also noted to facilitate access to materials or parts. Job specific engineering control recommendations were also made.	HETA 83–205–1702 NTIS order no. PB–87–106–498
2421 Manufacturing (Sawmills)	Driving and **operating highway and off-highway logging trucks** and stackers.	Upper limb, neck, and back	Whole body vibration	Replacing truck seats with seats offering greater vibration isolation was recommended. Work practice changes, such as driving slower and not lifting loads that are so heavy as to lift the rear wheels off the ground, were recommended. Job rotation and shorter work shifts were suggested to reduce exposures to whole body vibration.	HETA 83–349–1901 NTIS order no. PB–89–107–239

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
2653 Manufacturing (Paperboard containers)	**Corrugating, finishing operations** in **producing cardboard boxes.**	Upper extremity disorders, low back problems.	Repetitive, forceful hand/wrist movements, localized contact stresses, awkward back and upper extremity postures.	Furnish lift tables or load leveling systems to feeder and stacking machines and raise conveyor height to ease materials handling tasks. Add padding to edges and sharp corners of workstations to relieve contact stress. Consider options for reducing travel distance for materials access and disposal and more efficient stacking. Train total workforce on reporting early signs of WMSDs and one person on each shift in risk factor analysis and control.	HETA 96–0062–2588 NTIS order no. (in process)
2711 Manufactuing (Periodicals)	Information processing jobs using **VDTs** at a **newspaper.**	Upper limb and neck, lower limb, eyestrain	Repetitive exertions, awkward postures, glare	Engineering controls recommended included adjustable workstations (chairs, keyboard position) and controlling glare. For administrative controls, a work break schedule was recommended. Vision testing was suggested.	HETA 79 061–844 NTIS order no. PB-84-241-801
2711 Manufacturing (Periodicals)	Multiple departments of a **newspaper. Computer terminal tasks** included writing, editing, communicating through e-mail, and developing graphics.	Upper extremities (e.g., hand/ wrist, elbow, forearm, shoulder, and neck).	Repetition, sustained awkward postures, extended work periods at computer keyboard, and job pressures.	Establish and train a joint ergonomics committee to develop and implement interventions. Furnish adjustable chairs and other workstation equipment, and train employees in its proper use. Institute appropriate health care management.	HETA 89 250 2046 NTIS order no. PB–91–116–251

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
2711 Manufacturing (Periodicals)	Printing layout work in a **newspaper composing room**. Tasks involve long periods of **standing and walking**.	Lower limb	Static standing postures	Recommendations were made to reduce static standing requirements through the installation of footrests and to provide the option to sit. Added recomendations to pad edges of surfaces that workers lean against, install floor mats, and provide well-cushioned shoes.	HETA 90–251–2128 NTIS order no. PB–92–124–437
2711 Manufacturing (Periodicals)	**VDT tasks** at a **newspaper** company.	Upper limb and neck, eyestrain, headaches	Poor illumination, glare, poor workstation layout	Survey conducted that sought to define relationships between VDT-user symptoms and ergonomic aspects of VDT use. Main finding— increasing reports of being bothered by glare, brightness of screen, flicker, fuzziness of characters related to postural discomfort, headaches, and blurred vision.	HETA 80–127–1337 NTIS order no. PB–94–207 776
2711 Manufacturing (Periodicals)	A major **newspaper setting** with tasks involving **use of video display terminals (VDT).**	Upper extremity disorders (neck, hand/wrist, shoulder, and elbow).	Increased hours typing at a VDT keyboard, job deadline pressures, and varying workload demands.	Emphasized that a control plan must address job design, work organization, and psychosocial factors which were all correlated with symptoms reported. Employer's beginning efforts to use work breaks and document workload factors were acknowledged as a start.	HETA 90–013–2277 NTIS order no. PB–93–188–456

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
3069 Manufacturing (Fabricated rubber products)	Various tasks such as **cutting, cementing, and finishing** rubber and nylon fabrics in a plant manufacturing **fuel cells for aircraft.**	Upper limb and neck	Repetitive and forceful exertions, static exertions, contact stress, awkward postures, vibration	Engineering controls recommended include use of power scissors for cutting fabrics, modifying workstations, reducing vibration of powered handtools, providing footrests and floor mats, and securing razor blades used for cutting in handles.	HETA 90–246–2314 NTIS order no. PB–93–234–037
3070 Manufacturing (Plastics, metal products)	Manufacturer of **plastic and metal pails**. Tasks include **inserting gaskets into lids, trimming, attaching handles.**	Upper limb and neck	Repetitive and forceful exertions	Numerous specific engineering and work practice controls were suggested, ranging from workstation modification and automation to assuring trim knives are sharp. Job rotation and identification of light duty jobs were recommended as administrative controls, plus close medical monitoring of workers in identified high risk jobs.	HETA 89–146–2049 NTIS order no. PB–91–115–758
3079 Manufacturing (Fabricated rubber products)	**Manufacturer** of industrial, automotive, and garden **hoses.** Tasks include **loading and unloading hoses into molds, trimming, and attaching couplings.**	Upper extremity (e.g., hand/wrist disorders).	High repetition and force.	Redesign parts delivery bins for easier access, adjust height of work surfaces, and provide easier access to machine controls. Develop job rotation schemes and assign an additional worker to supply and load materials.	HETA 87–428–2063 NTIS order no. PB–91–151–720

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
3079 Manufacturing (Fabricated fibrous products)	**Press operations** and **finishing and assembly** tasks in a plant manufacturing thermo- formed **fibrous glass reinforced products.**	Upper limb and neck	Repetitive and forceful exertions, contact stress, awkward postures	Engineering controls were suggested for using fixtures to hold work, modifying tools (such as adding handles on files), and using power shears for cutting. Worker and supervisor training in the recognition of risk factors for WMSDs was recommended. Textured gloves were recommended for operators of hand sanders to minimize the grasping forces required.	HETA 81-143-1041 NTIS order no. PB 83-201-426
3089 Manufacturing (Plastic products)	**Operating presses and finishing parts** in a plant manufacturing **plastic and fibrous glass products.**	Upper limb and neck	Static and forceful exertions, awkward postures	Provide stool or sit or stand bar, foot rail to relieve back and foot fatigue in jobs requiring standing work. Reposition press control buttons and tilt material bins to reduce reach distances. Furnish rounded, properly sized handles to finishing tools to distribute grip forces.	HETA 91-003-2232 NTIS order no. PB 93-119-360

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
3134 Manufacturing (Leather products)	**Shoe manufacturer.** Tasks investigated included **nailing heels, trimming, hand application of inks and dyes, and waxing.**	Upper extremities (hand/wrist and elbow), shoulder, back, and neck.	Awkward postures of the trunk, shoulder, and wrist; repetition; static exertions; and use of pinch grip.	Engineering ideas to augment ongoing efforts to reduce ergonomic stressors were offered. These included (1) installation of height-adjustable swivel chairs and anti-fatigue mats, (2) use of air-powered shears instead of scissors, (3) raising and tilting machinery with added fixtures to relieve extreme work postures, and (4) improve lighting.	HETA 94–0245–2577 NTIS order no. PB–96–209–747
3231 Manufacturing (Glass products)	Specialty **glass and mirrors. Grinding, buffing, polishing, and buffing tasks.**	Upper limb and neck	Repetitive and forceful exertions, awkward postures	Engineering control recommendations ranged from automating aspects of certain jobs to using special fixtures to hold the products. Continued job rotation for workers involved in certain tasks was suggested as an administrative control.	HETA 89–137–2005 NTIS order no. PB–91–108–134
3261 Manufacturing (Pottery products)	**Ceramic plumbing fixture manufacturing.** The machine-paced tasks include repeated **lifting and moving of toilet bowls weighing up to 70 lb.**	Back	Repetitive and forceful exertions, awkward postures, heavy lifting, and paced work	Arrange for two-worker lifts of heavy product loads Modify height of conveyor and adjoining workstations to facilitate access, ease transfer of product in the course of the manufacturing process. Consider alternatives to the paced work and incentive system that would moderate and more evenly distribute the physical effort.	HETA 88–237–L1960 NTIS order no. PB–89–230–270

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
3261 Manufactuing (Pottery products)	**Lifting and loading** jobs (as much as 73 lb) in a plant manufacturing ceramic **plumbing fixtures.**	Back	Repetitive exertions, awkward postures, heavy lifting	Furnish mechanical lift devices to relieve manual handling of heavy product loads. Redesign carts and workstations to facilitate transfer of product in course of manufacturing process.	HETA 82-229-1286 NTIS order no. PB-84-209-741
3291 Manufacturing (Nonmetal mineral products)	**Abrasive products** manufacture with focus on **press operating tasks.**	Limited to evaluation of potential ergonomic risk factors.	Repetition, sustained awkward postures, forceful exertions, and contact forces.	Guardrails should be adjustable and padded. Prohibit use of hand as "hammer." Modify press to reduce awkward postures. Furnish training to employees about ergonomic hazards. Establish a medical surveillance program.	HETA 92-0001-2444 NTIS order no. PB-95-146-429
3442 Manufacturing (Fabricated structures)	**Assembly tasks** at a **window balance system manufacturer.**	Upper limb and neck	Repetitive and forceful exertions, awkward postures, paced work	Engineering controls are recommended including work layout improvements to facilitate parts assembly tasks, and assuring the fit of parts to reduce assembly forces required. New employees should be given adequate "break-in" times.	HETA 88-361-2091 NTIS order no. PB-91-197-368

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
3442 Manufacturing (Fabricated structural products)	Various production jobs such as **welding, grinding and press operations** in an **automobile components** fabrication plant.	Upper limb, neck, and back	Repetitive and forceful exertions, static exertions, awkward postures, vibration	Engineering controls are recommended including adjustments to workstations, using larger wheels on part carts to reduce pushing forces, and using light beam controls to activate machinery. Vibration-absorbing gloves were recommended as personal equipment.	HETA 91-086-2235 NTIS order no. PB-93-119-915
3444 Manufacturing (Fabricated structural products)	Sheet metal forming **(riveting, swedging, seaming, assembly)** tasks in a plant manufacturing combustion **exhaust systems.**	Upper limb and neck	Repetitive and forceful exertions, contact stress, awkward postures	General engineering control recommendations included finding ways to reduce pinch grips and reach distances. Suggestions made to implement an employee awareness program and encourage early reporting of WMSD symptoms.	HETA 80-109-974 NTIS order no. PB-83-157-933
3463 Manufacturing (Metal forging and stamping)	Aluminum **forging operations.** Focus on tasks performed in **pressing area.**	Musculoskeletal strain and tendinitis dominated injury reports.	Repetitive lifting and pulling actions from awkward positions in handling aluminum pieces. Deviated wrist in use of tools (tongs), hand/wrist strains from extended holding, and kickback of lubrication guns when activated.	Engineering controls were suggested to (1) improve conveyor systems and lift devices to ease heavy load handling, (2) add adjustable height features to presses to relieve awkward postures, and (3) redesign tong handles and use counterbalanced suspension of lubrication guns to reduce upper extremity strains. Job rotation, added training, and medical monitoring also proposed for risk reduction.	HETA 95-0109-2520 NTIS order no. PB-96-115-415

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
3483 Manufacturing (Ordinance)	Inspection of charges in a **munitions plant**. Tasks involve **lifting and manipulation** of charges weighing as much as 40 lb.	Upper limb, neck, and back	Repetitive and forceful exertions and heavy lifting	Engineering controls were suggested to provide adjustable chairs and fixtures to minimize load handling. Administrative and work practices proposals made to improve lifting methods, extend training in ergonomic risk factors, and improve medical monitoring by logging location and type of work performed.	HETA 83-142-1431 NTIS order no. PB-85-184-125
3499 Manufacturing (Fabricated metal products)	Various metal forming jobs such as **cutting, shaping, and threading, and assembly** tasks at a manufacturer of hand-held **lubrication equipment.**	Upper limb and neck, back	Repetitive and forceful exertions, awkward postures, heavy lifting	Engineering controls were suggested for better presentation of stock and parts to eliminate excessive reaches (by using power lifts and better positioned racks), redesign of workstations, and repositioning of machine tools. It was recommended that the company continue to alert workers to ergonomic hazards and encourage early reporting of WMSD complaints.	HETA 81-375-1277 NTIS order no. PB-84-209-717
3544 Manufacturing (Metalworking machinery)	**Grinding, polishing, and deburring** tasks at a **manufacturer of molds** used in glass container production.	Upper limb and neck	Vibration	Recommendations for a medical monitoring program to identify early signs of hand-arm vibration syndrome. Rest breaks, job rotation, and use of gloves were also recommended.	HETA 93-0510-2462 NTIS order no. PB-95-171-294

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
3592 Manufacturing (Industrial machinery)	**Machine shop** and **foundry** of a piston manufacturing company. Piston sleeve and piston **machining** and **casting operations studied.**	Upper limbs and back.	Repetitive, awkward postures in manual handling of products in machining. Awkward postures and static loading in casting tasks.	Suggested use of rotating/lifting devices, gravity feed racks, and positioning palletizers to reduce manual handling risks and back problems in machinists. Use a support device to hold ladle and relieve static strain in molding operations.	HETA 94–0040–2496 NTIS order no. PB–96–106–448
3612 Manufacturing (Electric distribution equipment)	**Manufacture** of high voltage and instrument **transformers. Winding, wrapping, taping, and paper pulling operations** were tasks under study.	Upper extremities (hand/wrist, shoulder, neck), low back and hip.	Awkward postures causing extreme bending and reaching, static standing, and forceful pulling actions.	Provide more height adjustable features to equipment and adjustable fixtures to relieve postural stresses. Reconfigure work areas to ease materials access and handling tasks. Design job rotation and rest break schedules to relieve most fatiguing work tasks. Educate workers in early signs of WMSDs.	HETA 93 0233 2498 NTIS order no. PB 95 269 973
3621 Manufacturing (Electrical industrial)	The tasks include **hammering, crimping, wrapping, winding, soldering, painting,** and various **assembly operations** at an electric **motor and generator plant.**	Upper limb and neck	Repetitive and forceful exertions, awkward postures, contact stress	Engineering controls were suggested such as a raised standing surface, a modified mallet handle, and low-force clamps. Job rotation and training programs were suggested as administrative controls. Early reporting of symptoms was recommended.	HETA 81–369–1591 and HETA 81-466 1591 NTIS order no. PB-86- 133 758

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
3631 Manufacturing (Household appliances)	**Producing microwave ovens.** Jobs of **grinding** and **mounting** parts, **wiring, leakage testing** along a moving assembly line.	Hand/wrist and shoulder tendinitis, epicondylitis, and carpal tunnel syndrome.	Repetitive, forceful work (cycle time of 20 seconds), awkward postures, pinch grips, static muscle loading in use of handtools, time pressures, hand/arm vibration, and lifting.	Engineering controls proposed for reducing forces were to use low insertion terminals, screws needing less push force in mounting, and tools with nonmetal handles, sized to minimize overgripping. Also recommended were adjustments to conveyor height and realignments in work flow to ease lifting. Administrative measures offered to slow down the line and adopt more job rotation and work changes that can broaden worker skills. Ergonomics training of all workers suggested as first step in meeting needs.	HETA 94-0214-2508 NTIS order no. PB-95-270-013
3699 Manufacturing (Electrical equipment)	Manufacturer of **garage door openers, antenna rotors, and motorized remote control switches.** The many tasks included various **hand-intensive assembly jobs, press operations, and use of pneumatic handtools.**	Upper limb and neck	Repetitive, static, and forceful exertions, awkward postures, paced work	Numerous specific engineering controls were recommended to reduce manual handling of parts and ways to adapt foot pedals to assembly equipment.	HETA 85-480-1771 NTIS order no. PB-87-205-951

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
3699 Manufacturing (Electrical)	**Manufacturing electrical cords.** Tasks include **winding and trimming** wire, **assembly** of cord sets, and **packing**.	Upper limb and neck	Repetitive and forceful exertions, static exertions, and awkward postures	Numerous task specific engineering, administrative, and work practices controls were suggested. Recommendations were made for implementing an ergonomics awareness program for workers and early reporting of injuries and symptoms.	HETA 81–217–1086 NTIS order no. PB–83–202–119
3714 Manufacturing (Motor vehicles)	**Assembly tasks** at a bus and truck **wheel manufacturer**.	Back, upper limb, and neck	Repetitive and forceful exertions, static exertions, awkward postures, heavy lifting	Install tilt, lift, and rotating tables in select jobs to ease manual materials handling tasks. Redesign work methods and workstation layout to minimize pulling and pushing tasks, handling loads, above shoulder height.	HETA 88–277–2069 NTIS order no. PB 91 184 523
3721 Manufacturing (Aircraft parts)	**Manufacture and assembly of jet aircraft. Use of air-driven, hand-held tools** (drills, routers, sanders, rivet guns, screw guns).	Limited to evaluation of tool properties.	Vibration levels in use of tools exceeded recommended exposure limits for typical work shift durations.	Continue effort to purchase new vibration reduced pneumatic tools. Maintain or replace tools producing high vibration levels due to wear and tear. Institute health care management practices ensuring early detection of hand/arm vibration disorders. Allow more rest breaks when using tools with highest vibration levels.	HETA 94–0425–2513 NTIS order no. PB–961–106 943

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
3751 Manufacturing (Motorcycles)	**Flywheel milling and assembly tasks** in a **motorcycle manufacturing** plant.	Upper limb, neck, and back	Repetitive, static, and forceful exertions, contact stress, awkward postures, heavy lifting, vibration	Specific engineering control recommendations include reducing the weight of the flywheel forging to reduce milling time and the weight handled, and improving the work layout to reduce manual material handling and excessive reaches. Work practice controls include training in better lifting techniques. Administrative controls, specifically job rotation, were recommended until engineering controls can be implemented.	HETA 90-134-2064 NTIS order no. PB-91-184-531
3751 Manufacturing (Motor vehicle parts)	**Manufacture of flywheels** in motorcycle plant. **Milling, assembly, truing, and balancing jobs** were focus of evaluation.	Hand/arm, back, and shoulder musculoskeletal disorders.	Excessive manual materials handling and lifting, awkward postures, hand/ arm vibration, and repetitive, forceful hammering.	Pre-post evaluations show that engineering controls recommended earlier have reduced risk factors and the number and severity of WMSD cases. Further controls include gravity conveyors, added hoists, and optimal workstation layouts to further reduce manual materials handling loads. Enhance efforts for early detection, awareness training of WMSDs, and risk factors.	HETA 91-0208-2422 NTIS order no. PB-95-147-294

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
3843 Manufacturing (Medical instruments)	**Grinding, buffing, polishing, and lifting** of metal assemblies in a plant manufacturing **dental equipment**.	Upper limb and neck, back	Repetitive and forceful exertions, awkward postures, increased production with reduced manpower	Use of added fixtures to relieve need to hold product items in different positions in finishing process. Installation of movable crane to assist in lifting and handling heavier loads. Use of pedestals under machines and platforms under workers to accommodate varying body sizes of workers and reduce need for undue stretching and bending.	HETA 83–233–1410 NTIS order no. PB–85–179–158
3861 Manufacturing (Photo supplies)	**Wrapping, packing, and lifting** tasks in a plant that converts bulk **photographic products** into consumer-size packages.	Upper limb and neck	Repetitive and forceful exertions, production quotas	A variety of engineering controls were suggested including tool redesign, workstation modification, and the use of new mechanical devices. Job rotation and work practice training, as well as clarification of expected production goals, were recommended as administrative measures.	HETA 76–93 NTIS order no. PB–96–115–431
3911 Manufacturing (Miscellaneous)	**Jewelry manufacturing** where tasks include **soldering, grinding, casting, stamping**, and **packing**.	Upper limb and neck	Static and forceful exertions, awkward postures, and vibration	Recommended engineering controls include adjustable workstations and chairs, added and improved fixtures, and tool redesign. Suggested administrative controls include training, job rotation, and rest pauses, plus a medical management program.	HETA 90–273–2130 NTIS order no. PB–92–133–321

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
4311 Public utilities (Postal service)	Large **sack sorting** and **small parcel bundle sorting** operations at a major airport **mail facility.**	Back and leg discomfort; injuries from being struck with mail exiting chutes; overexertion.	Prolonged standing, heavy lifting, extended reach.	Furnish floor mats, step rails, and sit and stand stools to relieve prolonged standing postures. Design loading procedures and utility carts to eliminate unassisted manual lifts of mail sacks weighing up to 70 lb. Add diverters in chutes to funnel packages within easy reach of worker.	HETA 93–1145–2529 NTIS order no. PB–96–191–770
4311 Public utilities (Postal service)	The work setting was a **mail processing facility.** Job tasks were those involved with **feeding mail** to several automated mail processing machines and **removing such mail once it has been sorted.**	Limited to study of ergonomic risk factors in job tasks.	Frequent stooping to retrieve mail trays for feeding the machines, extended reach, and trunk flexion in sweeping and stacking sorted mail. High volume capacity of sorting machines makes these actions more repetitive.	Automated options for relieving manual operations with the processing machines need consideration. Examples would be a weight sensitive stacker bin that would eject its contents into a container either below or beside the bin where a moving conveyor could carry the mail away. Another would be spring-controlled leveling systems that raise the feeder trays as others are removed. Other measures would be to limit the time spent on these machine tasks or to provide added breaks.	HETA 92–0073–2337 NTIS order no. PB–94–133–824

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
4311 Public utilities (Postal service)	**Mail processing** facility with workers engaged in **loading mail into automated sorting machines and transferring the sorted mail once it is collected in bins.**	Limited to an assessment of ergonomic risk factors in job tasks.	Prolonged standing postures and walking on hard floor surfaces.	Provide for a sit/stand option for those operating the loader and furnish foot rests to rest one leg while standing. Install cushioned mats to run the length and width of the loading and sweeping areas. Mats should have a beveled edge to reduce a tripping hazard and should be kept in place by velcro or some other method.	HETA 92–019–2188 NTIS order no. PB-92-193-887
4441 Transportation (Water)	**Operation, repair and maintenance** tasks at **river locks and dams.**	None reported	Repetitive and forceful exertions, awkward postures, heavy lifting, vibration	The major recommendation is to develop an ergonomics program. Three jobs were analyzed, yet these represent only a fraction of the jobs performed at the various sites. Specific engineering control recommendations for the jobs studied include adjustable workstations, use of hoists and lifts for shop work and extending the height of rope tie-off posts for lock operation work.	HETA 90-385-2173 NTIS order no. PB-92-176-809
4510 Transportation (Air)	**Key entry** at computer workstations at a central **airline reservation** office.	Posture, muscular discomfort	Cramped work areas, noise interference, poor lighting, heat	Suggested engineering controls included improved workstations and lighting. Suggested administrative control included 15-min breaks every 2 hours for workers.	HETA 78-134-630 NTIS order no. PB 80 193 030

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
4813 Public utilities (Communi-cators)	**Telecommunications** work setting; **directory assistance operators, using VDTs.**	Upper extremities (hand/wrist, elbow, shoulder, and neck).	Use of bifocal glasses were associated with neck disorders. Work organization and psychosocial factors (e.g., fear of being replaced by computers, lack of supervisor support, and increasing work pressure) linked with musculo-skeletal disorders. Workstation and postural measurements were taken but not analyzed due to methodologic limitations.	Continue joint ergonomics committee and consider equipment purchases based on their recommendations. Conduct visual testing of employees to ensure adequate corrected vision. Address concerns of job security and provide job diversity. Reduce information processing loads. Require prompt examinations of employees with musculoskeletal symptoms.	HETA 89–299–2230 NTIS order no. PB–93–119–329
5411 Retail trade (Food stores)	**Grocery store cashiers** working at express **checkout stands** that involved **frequent reaching, scanning, and keying tasks.**	Neck, upper back, shoulder, lower back, buttocks, and legs.	Repetition, awkward postures, excessive reach, and trunk flexion.	Changes made included adding a barrier at the far corner of the checkstand to reduce excessive reach and trunk flexion and providing an adjustable keyboard to relieve other postural stress. Videotape training was provided. Follow up showed a decrease in some symptoms after implementing these changes based in part on employee input. Other checkstand modifications recommended.	HETA 88–345–2031 NTIS order no. PB–91–117–234

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
5411 Wholesale trade (Food stores)	**Grocery warehouse** setting with jobs involving **order selecting (i.e., locating orders for selection, manual handling, and loading of orders for delivery).**	Back injuries and back pain.	Repeated lifting of heavy loads requiring extended reach. Need to meet incentive standards. Thermal stress further aggravated problems.	Design of storage racks and physical layout should be rearranged to allow ready access to orders, and the grocery items (cases) should be restricted in size to ease handling. Performance standards should be reexamined or worker rotation and restrictions on overtime provisions to minimize risks of overexertion. Measures to reduce heat stress should be considered (e.g., cooling fans, ample, easily accessible cool drinking water, and increasing rest breaks in cool locations).	HETA 91–405–2340 NTIS order no. PB–94–131–638
5411 Trade (Food stores)	**Check-out tasks** at a **grocery store.**	Ergonomics evaluation only	Repetitive and forceful exertions, awkward postures	The major recommendation was to eliminate the practice of having the checker unload the grocery cart by proposing design changes to facilitate customer unloading of the grocery cart in checkout. In the interim, other engineering and work practice recommendations were made ranging from improving the mating between the grocery cart and the checkout counter by changing the height of checkout counters or grocery carts to discourage customers from placing items on the bottom shelf of the cart. Improved training of cashiers was recommended.	HETA 92–294–2301 NTIS order no. PB–94–110 376

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
5712 Wholesale Trade (Furniture)	**Wood kitchen cabinet manufacturer**. Jobs include **sanding, planing, painting, packing, shipping** and **lifting, pushing and pulling** tasks.	Upper limb, neck, back, and lower limb	Repetitive, static, and forceful exertions, awkward postures, and heavy lifting	Numerous specific engineering control recommendations were made to minimize or eliminate risk factors associated with sustained postures, lifting and carrying, and repetitive exertions. In addition, it was recommended that new employees start at slower rates so they can be conditioned and that frequent rest breaks be allowed.	HETA 88–384–2062 NTIS order no. PB–91–152–082
7349 Services (Business services)	Janitorial employees **using a back-pack vacuum cleaner in typical office cleaning** work.	Shoulder, back, and neck discomfort.	Increased muscle force and disc compression owing to weight of unit and typical forward leaning postures assumed when working with the vacuum unit.	Train the workers in proper use of the vacuum unit, and periodically monitor its use and fit and any complaints. Allow the workers some flexibility in choice of equipment for a cleaning task. Use of the unit can prove difficult in a confined space. An upright unit can resolve such problems.	HETA 93–0805–2387 NTIS order no. PB–94–176–450
7699 Services (Repair)	Missile and aircraft **guidance system maintenance and repair** work conducted using low power microscopes at an Air Force facility.	Upper limb and neck, back	Awkward postures	Engineering controls recommended included using improved adjustable chairs, tables, and work jigs. Work practice suggestions included better microscope use techniques such as more frequent lens cleaning and looking away from the lens frequently. Reducing the time spent at the microscope each day by job enlargement and work practices training were suggested as administrative controls.	HETA 84–082–1713 NTIS order no. PB–87–114–682

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
8351 Services (Child care)	Caring for children at a **day care facility**. Tasks involve **lifting** children and frequent **kneeling and squatting**.	Upper limb, neck, back, and lower limb	Repetitive exertions, static exertions, awkward postures, and heavy lifting	Suggested engineering controls were to provide furniture and fixtures at appropriate adult heights. Proposed administrative and work practices controls included use of lifting techniques to minimize back stresses.	HETA 93–0995–2442 NTIS order no. PB 95 129 235
8731 Services (Biological research)	**Research laboratory** conducting anticancer research. **Numerous laboratory tasks.**	Upper extremities	Sustained awkward and static postures of the hand/arm, repetition, use of pinch grips, contact with sharp edges of workstations.	Engineering controls included retrofitting pipettes with finger trigger strips and pipette foot switches and modifying biosafety cabinets (e.g., padding sharp edges, providing height-adjustable turntable for easier access). Administrative controls were changing job protocols to reduce repetitions, job rotation, and frequent micro-breaks.	HETA 95 0294 2594 NTIS order no. (in process)
9190 Services (Government)	**Data entry** and other tasks involving video-display units at a Federal government **office.**	Upper limb and neck, back, eyestrain	Repetitive exertions, awkward postures, glare and poor illumination	Various recommendations were made to improve lighting and reduce glare and to improve workstation design (keyboard height, viewing distance and angle, chair features, wrist rests, detachable keyboards). A visual testing program and a rest-break schedule were recommended.	HETA 83 463 1642 NTIS order no. PB 86 206 059

Tray 1–A. NIOSH Investigations of WMSDs in Work Settings (Continued).

Standard industrial classification (SIC)	Work setting and tasks	Work-related musculoskeletal problems found	Ergonomic risk factors found	Recommendations	HETA/NTIS reference no.
9999 Non-classifiable	**Sign language interpreters for the deaf.**	Upper extremities (e.g., shoulder, elbow, fingers, neck, and hand) disorders and back problems.	Repetition and awkward and static postures.	Include rest breaks in interpreting sessions. Maintain signing motions between the shoulders and within the area bounded by the chest and waist. Avoid forceful contacts between the hands.	HETA 92–0268–2447 NTIS order no. PB–95–219–465

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