

# Laboratory Ergonomics: Things You Should Know... Things You Should Do

**C**oncern about Musculoskeletal Disorders (MSDs) has escalated during the last two decades as work cadences, techniques and time pressures have intensified in the life sciences arena.<sup>1,2</sup> Extensive pipetting practices, once on the periphery of ergonomics discussions, now form the core of a hot debate because they are considered a major risk factor that could lead to strain-related injuries, especially in biology research laboratories.<sup>2-5</sup>

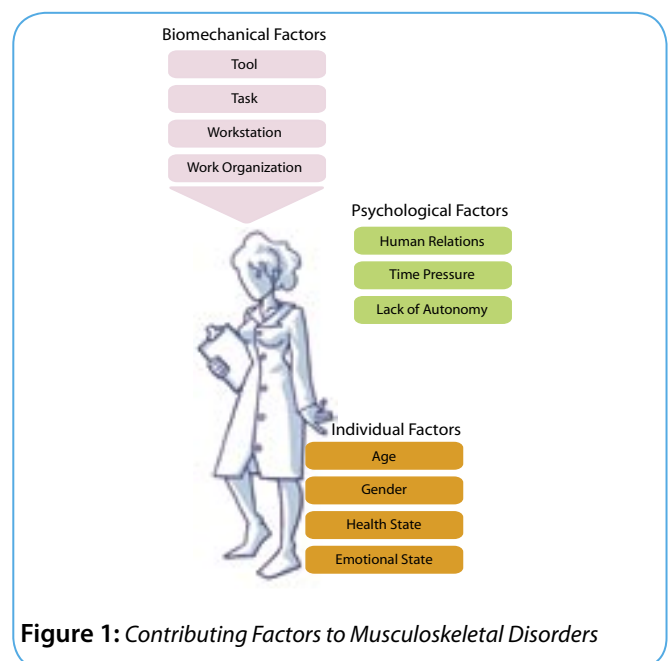
Based on an independent evaluation of the activities performed in a typical cellular biology laboratory and conducted by ergonomics consultants on behalf of Gilson, this article reaches beyond the present-day controversy about pipettes and their relationship to the appearance of MSDs and attempts to re-establish the reality about this indispensable tool. Additionally, we propose general recommendations for improved comfort while performing pipette-oriented tasks and the reduction of risk for developing MSDs in the laboratory.

## Musculoskeletal Disorders — Repetitive Strain Injuries

MSDs are disorders of the osteo-articular and muscular systems involved in movement. Their severity and the physiological regions affected may vary. MSDs result from an imbalance between biomechanical demands and an individual's functional capacities. Their precise developmental mechanism is not fully known, although some studies have identified contributing factors. Inadequate circulation due to static contractions, highly repetitive work and selective muscular activation over a long period of time are believed to be major factors in the development of muscle, tendon, cartilage and bone lesions. Canadian ergonomists have suggested the name of repetitive strain injuries (RSIs) as a subcategory of MSDs attributable to repetitive work.<sup>6</sup> Carpal tunnel syndrome (CTS), the most widely recognized RSI, is identified by the swelling of the membrane linings and surrounding tendons in the base of the palm. Its symptoms include pain or numbness in the wrist, thumb and first three fingers and loss of strength or dexterity in the hand. Musculoskeletal disorders have multiple origins. Most authorities agree that MSDs are the result of different factors acting simultaneously, and their severity and individual impact are impossible to foresee. The three main categories of factors associated with the appearance of MSDs are biomechanical, psychosocial and individual (Figure 1).

## Ergonomics Study in a Research Laboratory

The ergonomics study sought to determine the relationship between the risk of the appearance of MSDs and the activities involving the use of pipettes and other common tools within a research laboratory specializing in cellular biology. The consultants noted distinct differences in the study participants' operating modes, primarily because of the high variability of tasks but also because of their individual differences in aptitude, skills and morphology. Lab scientists perform multiple tasks—pipetting, centrifugation, microscopy, calculations, etc.—all of which are governed by time, precision and safety constraints (Figure 2). The



**Figure 1:** Contributing Factors to Musculoskeletal Disorders

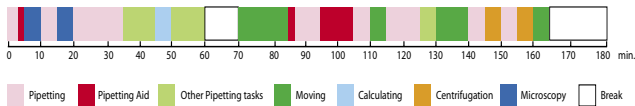
study results indicated that from 57 to 88% of a scientist's time spent working in the lab involves the use of pipettes. Except for work breaks, which range from 0 to 14% per work period, the remainder of the scientist's day, between 9 and 22% of their time, is devoted to operations such as centrifugation, microscopy and calculations. The study also reported there were intense repetitive movements, ranging from 59 to 89 per minute, maintained over prolonged periods. Cramped rooms, poorly adapted laboratory furniture (sadly commonplace in laboratories), disorganized workstations, and stress resulting from the acoustical assault of droning apparatus all contribute to a greater probability of the appearance of MSDs.

The use of pipettes requires dexterity that is often complicated by tasks that force the operator to adopt awkward postures (Figure 3).



**Figure 3: Awkward and Static Postures Lead to Muscular Fatigue**

For example, manual gel loading demands the technician’s full attention as each sample is transferred into a separate well. Maintaining a reasonable distance can only be theoretical. Likewise to work under the fume hood, one must maintain a non-physiological alignment of the shoulder, wrist and finger joints. Accelerations of the heart rate were observed during these tasks, owing to the emotional strain that probably originates with the responsibility for errors and their heavy consequences. Bench work causes difficulties linked with work table dimensions, which are adapted neither to the sitting nor standing position. The table is either too high, so pipetting gestures are conducted with exaggerated flexion of the shoulder, or too low for techniques requiring a short eye-task distance. Other commonly used laboratory apparatus such as safety screens or microscopes force researchers to assume a boxer’s dodge stance, with arms outstretched in an elevated position for the entire duration of a manipulation. A prolonged static position can generate muscular fatigue of the neck region, leading to pain.



**Figure 2: Distribution of Tasks of One Operator (Cell Cloning)**

### Ergonomics Recommendations

Pipette users acknowledge the transformative effect the RSI debate has imposed on pipette manufacturers, who now develop product plans based on the principles of ergonomics. Pipettes now require less force to operate, and motorized electronic versions drastically reduce hand pain related to prolonged repetitive pipetting. Pipettes aside, there are universal recommendations for improving one’s comfort level in the laboratory<sup>7,8</sup> (Table 1). The study revealed that the risk associated with an extended use of pipettes not only depends on the ergonomics of the pipettes, other laboratory devices and furniture but also on factors such as an individual’s physical characteristics, work rhythm, postural constraints and environmental conditions. Choosing the appropriate tools and organizing a work space in a more ergonomic manner can enable one to work smarter and greatly reduce strain-related injuries.

**Table 1: General Ergonomics Recommendations**

Target	Recommendation	Reference
Physical Premises	<ul style="list-style-type: none"> <li>Minimal space requirement per person &gt;10m<sup>2</sup></li> <li>Minimal width for passageways (1 person: 60 cm, 2 persons: 80 cm)</li> </ul>	NF X35-102 ISO 557
Furniture and Apparatus	<ul style="list-style-type: none"> <li>Use adjustable tables and seats</li> <li>Opt for a fume hood with easy access and comfortable seating</li> <li>Place frequently used devices in logical locations</li> </ul>	NF X35-104 and X35-105 ISO 9241-5 Ref. 9
Manual Devices	<ul style="list-style-type: none"> <li>Choose a pipette adapted to the task</li> <li>Prefer tips recommended by the pipette manufacturer</li> <li>Use multichannel pipettes for 96-well plate applications</li> <li>Opt for motorized pipettes for repetitive and mixing tasks</li> </ul>	ISO 8655
Work Organization	<ul style="list-style-type: none"> <li>Do not exceed a gesture frequency of 30 gestures/minute</li> <li>Take frequent, short breaks</li> <li>Take a mandatory pause after each sequence of repetitive work</li> <li>Vary tasks (work with different muscles)</li> </ul>	NF EN 1005-5
Work Conditions	<ul style="list-style-type: none"> <li>Noise &lt; 55 dB(A)</li> <li>Maintain a comfortable ambient temperature</li> <li>Ensure the workstation is sufficiently lit (300 to 600 lux)</li> <li>Eliminate dazzling sources of light</li> <li>Eliminate glare and reflections from computer screens</li> </ul>	ISO 9241-6 ISO 7730 NF X35-103

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[www.gilson.com](http://www.gilson.com) | [sales@gilson.com](mailto:sales@gilson.com) | [service@gilson.com](mailto:service@gilson.com) | [training@gilson.com](mailto:training@gilson.com)

**Gilson, Inc. World Headquarters** | 3000 Parmenter Street | P.O. Box 620027 | Middleton, WI 53562-0027 USA  
Tel: (1) 800-445-7661 or (1) 608-836-1551 | Fax: (1) 608-831-4451

**Gilson S.A.S.** | 19, avenue des Entrepreneurs | BP 145, F-95400 Villiers-le-Bel, France  
Tel: (33-1) 34 29 50 00 | Fax: (33-1) 34 29 50 20



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