

# **CHILDREN AND COMPUTERS: ERGONOMIC OPPORTUNITIES**

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## **ABSTRACT**

The field of ergonomics faced many challenges with the widespread introduction of computers in the workplace during the 1980's. Today, the use of computers by children creates an even more complex problem. Students as computer users have unique needs. Ergonomic intervention is necessary to avoid musculoskeletal disorders (MSDs). The National Occupational Research Agenda recognizes the priority areas of "special populations", such as children, as well as "musculoskeletal disorders." School computer labs cater to children between 5 and 13 years old, where there is a large variability in growth stages and anthropometry. Often, school computers are simply deposited into classrooms and set-up on activity tables and student desks without consideration of the child-workstation interface. The infusion of computers into primary educational institutions has occurred at such a rapid rate that the issues of student-computer interface and appropriate ergonomic strategies have been largely overlooked. The implementation of adjustable tables and ergonomic chairs, appropriately sized keyboards, ergonomic education for students and teachers, and general workstation guidelines would be ideal in the prevention of MSDs. Unfortunately, economic constraints have prevented most public schools from implementing such preventive measures. However, there are many simple low cost modifications that could be made to current computer workstations in schools. Another problem facing children is the increased use of computers for entertainment in the home environment. Children and adolescents use computers for homework, playing games, and instant messaging online, making their average usage time far greater than it was just five years ago. While the current strategy is reactive, long-term solutions require a proactive approach, including an increased reliance on ergonomists and an ergonomics education program for administrators, teachers, and students.

## **INTRODUCTION**

Ergonomics faced many challenges in the 1980's when computers were introduced into the workplace. At that time, computers were simply "thrown" into offices, not giving employees adequate time to adapt to using them on a daily basis. Today, the use of computers by children creates even more complex problems. Variability in growth stages is just one of the issues that make ergonomically correct computer use by children extremely complicated. The child-workstation interface is often ignored by schools where computers are deposited into classrooms that are ill-equipped to handle such additions. Prevention of musculoskeletal disorders (MSDs)

for children in classrooms can be costly and time consuming, often requiring many diverse resources. Children and adolescents also use computers for entertainment at home in addition to using them during the day at school. Ergonomic intervention is necessary for this unique group of users, requiring a proactive strategy involving a closely networked team of teachers, administrators, parents, ergonomists, and students. Perhaps with preventive interventions musculoskeletal disorders may be much less prevalent in the adults of the future than they are today.

## **Purpose**

Musculoskeletal Disorders and Special Populations are the National Occupational Research Agenda (NORA) priorities addressed in this paper. According to the NORA website, “Occupational hazards are known to be distributed differentially, and workers with specific biologic, social, and/or economic characteristics are more likely to have increased risks of work-related diseases and injuries” (NORA homepage, 2003). Children have vastly different physical characteristics, and, therefore, vastly different needs than the adult population. Additionally, musculoskeletal disorders are developing in people earlier in life, which can be partially attributed to the introduction of computers into this population. The purpose of this paper is to illustrate the complex issue of a younger population using computers and the changes needed to avoid future health problems caused by the introduction of computers.

## **COMPUTERS AND CHILDREN: THE CURRENT SITUATION**

### **Developments in Design**

Dr. Leon Straker, a world-renowned lecturer and researcher in the field of ergonomics, and its applicability to children, suggests that the major musculoskeletal problem that faces humans in the 21<sup>st</sup> century is the seated operation of computers (Straker, 2000). Computers were introduced to the workplace in the 1970s, and were on nearly every desktop by the 1980’s. Because of the emphasis put on computer usage, school administrators decided to introduce computers to children with the expectation that they would be better adapted to the requirements of their future workplace. Straker (2000) goes on to suggest that, “it may be a mistake to assume that technology derived in the 20<sup>th</sup> century for office workers will apply to children using computers today.” Since technology has changed, many of the standards that were created in the former century are now obsolete. For example, new computers today have flat panel monitors, which reduces glare, a cause of eye strain. Design of computer cases (the hard shell surrounding the computer components) has been extensively modified recently. Today’s computer cases are much smaller and tend to fit under the desk, not under the monitor as was the case in earlier models. This allows for more adjustability of computer setups because furniture does not have to compensate for cumbersome computer design. Due to these advances, the problems faced in the 1980s are much different than the problems facing children today.

### **Design of Computer Labs**

Children have unique characteristics that make preventing MSDs much more difficult than what ergonomists dealt with when computers were introduced to adults more than 20 years ago. The computer-student interface is complicated due to the variability in childhood development stages

and the rapid advancement of technology (Straker, 2003). Schools are forced to accommodate the anthropometric ideals of the 5<sup>th</sup> to 95<sup>th</sup> percentile, which is difficult due to height variability. School computer labs are designed for children between the ages of 5 and 13. Height variability can be three feet in the extremes. Since the furniture in most schools is not adjustable, it is often designed to simply fit the 50<sup>th</sup> percentile. Even with adjustable furniture designed to fit ninety-percent of the population, ten-percent of students are still forced to adapt to furniture that is ill suited for them. In addition to height, children have an increasing variability in weight or mass. As American children become more obese, computer labs will be forced to accommodate an even greater variability among students. School computer lab designs are a problem for today's students; compounding the issue is the increased use of computers in the home for both homework and entertainment.

### **Alternate Uses of Computers**

For many students in the 21<sup>st</sup> century, the computer is the new telephone, video game system, and television all in one. United States census data figures indicate that 71% of USA households with children 8-17 had a computer at home in 1999 (Straker, 2003). This percentage has increased in the past five years. In addition, 2-17 year olds with access to a computer at home spent an average of 97 minutes per day on computer related activities (Turrow, 2000). Today, children are often required to have some or all of their homework prepared on a computer. Use of a word processor is often required in the preparation of reports and papers, requiring the student to spend more time in front of a computer. An additional activity that has increased children's reliance on the computer is the introduction of instant messaging. Children can now talk to their friends online while doing homework or playing video games. This new technology has a major implication on the amount of time children spend outside doing physical activities. Even the short walk to a neighbor's house has been eliminated because children can network to play video games without ever leaving their room. In addition, the emergence of wireless networking has made it possible to take the computer anywhere. Businesses are offering wireless service allowing students to use their computers in places that are not designed for computer users. These can be the most detrimental areas for child computer use, where surfaces are designed for adults and may not have been intended for computer use. Computers are increasingly becoming an integral part of the lives of American school children both as an aid for learning and as a form of entertainment. Problems posed by the integration of computers into children's lives can have an adverse effect on the health and wellbeing of American children.

### **Childhood Musculoskeletal Disorders**

Repetitive Stress Injuries, or RSIs, occur when repeated stress occurs to the upper limbs and sufficient time is not given for the injury to heal before aggravating the area again (Bradley Royster, 2002). According to an article in *Kids Health*, RSIs are generally caused when too much stress is put on a joint, pulling on the tendons and muscles around the joint. Consequently, the repetitive nature of these injuries indicates that these stress-points are not allowed to fully heal, (i.e. the body has insufficient time to regenerate and is thus re-injured). The body's response to this irritation is to increase the production of fluid in the area, thus reducing the stress. RSIs are an outcome of children using computers in an incorrect setting. Common conditions of RSIs include:

- **Carpal tunnel syndrome:** swelling inside a narrow "tunnel" formed by bone and ligament in the wrist; the tunnel surrounds nerves that conduct sensory and motor impulses to and from the hand; swelling can lead to pain, tingling, and numbness
- **Ganglion cyst:** swelling or lump in the wrist resulting from jelly-like substance that has leaked from a joint or tendon sheath
- **Reflex sympathetic dystrophy:** rare, serious condition characterized by dry, swollen hands and loss of muscle control; consistently painful
- **Tendonitis:** tearing and inflammation of tendons connecting bones to muscles

These are not the only injuries that can result from improper posture or prolonged computer use. Problems can also include MSDs and vision problems, or may also be cognitive or social risks such as aversion to computers, and decreased competency as society becomes more dependent on computers (Straker, 2003). In addition, the increased use of computers reduces the amount of time children spend in physical activities, which may lead to a lack of development in their cardiovascular and neurological systems (Straker, 2003). Despite the risks of these injuries and disorders, little is being done in either schools or homes to prevent their occurrence, mostly due to lack of information on proper ergonomic practices.

### **Ergonomic Computer Set-up**

There are several key requirements needed for a computer workstation in order to reduce the occurrence of MSDs (Cornell, 2003). These requirements include the following:

- Back supported by chair: the back should be resting, well supported, against the back of the chair at an angle greater than 90 degrees. Ideally this angle should be at or around 110 degrees.
- Chair seat pan should not touch the back of the knees: this can be the most difficult criteria for school computer labs to meet due to the large variability in the body size of students. Adjustable seat pans in ergonomic chairs do exist, but can be cost prohibitive.
- Feet firmly on a solid surface for support: this could be either a footrest or the floor.
- Head balanced on neck: MSDs often occur when the neck is tilted too far forward or too far backward.
- Angle behind the knees should be greater than ninety degrees, meaning the legs should hang slightly over the edge of the seat pan.
- Upper arms should be positioned close to the body and relaxed.
- Elbow angle is greater than 90 degrees.
- Wrists are in a neutral position and level with the forearms.

These criteria are necessary for an ergonomically correct computer workstation set-up. While some of the criteria are harder to meet, all are equally important for the health and well being of children.

### **ECONOMICALLY FEASIBLE SOLUTIONS**

Classrooms originally set up for traditional learning, may not adequately allow for computer equipment at every desk (Straker, 2003). Today, computers are haphazardly "thrown" into already crowded classrooms, often placed on teacher's desks or classroom tables. Schools today are facing a crisis with respect to obtaining adequate funding for proper furniture for students. There are, however, some economically feasible solutions that can be introduced when adequate

funding is unavailable. Simple solutions include using a chair that is height adjustable, which can be found at almost any store and are generally reasonably priced. Putting a pillow behind the child's back, and placing a stool or stack of books under the feet can make additional modifications to prevent the legs from hanging. A keyboard tray can be added to the bottom of the table, allowing the hands to reach the keyboard. In addition, this allows for adequate distance between the child's eyes and the computer screen. Ideally, the chair should have adjustable arm rests, where the child could have their forearms, wrists, and hands in a straight line. Lighting may also cause a glare problem on computer screens, which leads to increased vision problems (Straker, 2003). Poor lighting can be eliminated when additional lamps are placed in the room that limit or eliminate glare. Monitor position is critical to the avoidance of upper neck pain in children. Monitors should be positioned forward, facing and level with the top of the table. Neck cramps can be a result of the child constantly moving his or her head to look at other documents. This can be alleviated with the purchase of a document holder. These simple modifications would benefit children using a computer at home, however, they are much less feasible for a school computer lab.

### **COMPUTER LABS OF THE FUTURE**

Perhaps the most ergonomically effective way to prevent MSDs in school aged children with respect to computer usage is to create a computer lab for the school with furniture designed for children in various stages of development. Adjustable furniture allows for anthropometric variability among students (Harris, 2000). In addition, these workstations would allow for students of different sizes to work in different positions, maximizing variability in postures. Ideally, there would be several key components for a computer lab, including:

- Well-designed, good quality chair: the chair should have adjustable back angle, height and arms. Additionally, the chair should be on a five pedestal base and on wheels. This increases both the mobility and the variety of positions children can sit in while working in a computer lab.
- Adjustable height desks or tables: each workstation in the computer lab should have an electronically adjustable table or desk that the student can customize to fit his or her exact height.
- Keyboards on a tray attached to the underside of the desk or table. The design of the tray should allow the student to pull the keyboard out from under the desk and position it at a height that feels comfortable.
- A trackball mouse (a mouse that moves by a movement of the thumb as opposed to the whole arm) to replace the traditional mouse.

Adjustable furniture was introduced to students by Dr. Osmo Hanninen, who conducted a study of students who were given tables and chairs that were individually adjusted to their specific needs. The students were also given chairs that were on wheels, which Hanninen hoped would promote dynamic movement. This group was compared to a control group with non-adjustable chairs and non-adjustable desks. The study showed that scoliosis was reduced in the group with adjustable furniture, as well as improvement in both sitting and standing posture. Many other studies concur: another recent study stated that when an adjustable keyboard was introduced to a traditional desktop computer workstation, significant improvement in posture was noted when the keyboard was adjusted to meet the anthropometric needs of the student (Leaser et al, 1998).

While research suggests that an adjustable computer lab is the ideal solution for a school computer lab, they do come at a high cost.

## CONCLUSION

American school districts are facing a financial crisis. Teachers are being laid off and programs are being cut. Despite this monetary turmoil, it is imperative that ergonomic issues in schools are addressed. Monetary problems notwithstanding, an ergonomics program is very important to the health and wellbeing of American children. The cost of injuries almost always far exceeds the cost of prevention. Because children may be the best indicator of how, as adults, they will use computers in the future, it is necessary that they be taught how to properly use them to prevent injuries.

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