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Backpack vs. Upright Vacuum Cleaner Use: Physical Assessment Summary

Two 1998 studies conducted by the Department of Surgery Division of Orthopaedics, Ohio State University and Battelle Memorial Institute provide new data comparing the use of traditional upright vacuum cleaners and backpack vacuum cleaners. These studies determined that backpack vacuum cleaners provide the following advantages over upright vacuum cleaners:

- Using backpack vacuum cleaners results in less body stress than with uprights;
- Backpack vacuum cleaners are more efficient than uprights;
- Backpack vacuum cleaners minimizes the "hunching over" and fatigue often associated with upright vacuum cleaner use;
- Due to the natural walking motion associated with backpack vacuum cleaner use, more carpet is cleaned in a shorter amount of time with less stress to the worker;
- Using backpack vacuum cleaners reduces repetitive motions associated with uprights that can result in long term adverse medical effects;
- Using backpack vacuum cleaners, workers were able to vacuum more than twice the area with similar levels of energy expenditure and perceived effort.

Backpack versus Upright Vacuum Cleaner Use: Biomechanical and Metabolic Assessment

Two 1998 studies conducted by the Department of Surgery Division of Orthopaedics, Ohio State University and Battelle Memorial Institute provide striking evidence comparing the use of traditional upright vacuum cleaners and backpack vacuum cleaners. The biomechanical assessment provides detailed information regarding cleaning rates, musculoskeletal stresses, kinetic measurements, workload and fatigue, repetitive motions and electromyographic activity. The metabolic study analyzes ergonomic efficiencies, metabolic demands, energy exertion and productivity rates. These studies provide data that supports the use of backpack vacuum cleaners as providing less body stress and increasing efficiency as compared to upright vacuum cleaners.

Biomechanical Analysis

The research paper titled *Biomechanical Assessment of an Upright Vacuum Cleaner and Backpack Vacuum Cleaner* (Department of Surgery Division of Orthopaedics, Ohio State University, and Battelle Memorial Institute, Columbus, OH) presents data comparing the stresses and fatigue of custodial managers using upright and backpack vacuum cleaners. Twelve professional cleaners were used in the study (6 men and 6 women; ages 28 - 40 years) under controlled conditions to repetitively clean a test carpet. Motion transmitters were attached to areas of the professional cleaners' bodies (shoulders, elbows, wrists, hips, knees, and ankles). A floor mounted receiver collected data on exact movements while vacuuming. The data provided was analyzed for movements that would lead to stresses and fatigue, including data on repetitive motions that might result in long term adverse medical effects.

The results of this study showed differences related to the length of the vacuum arm and the manner by which each vacuum was used. The distance from the hand to the area of the floor being vacuumed was greater with the backpack than with the upright such that the use of the backpack vacuum minimized the hunching over often associated with upright vacuum cleaner use. Because the upright cleaner was shorter than the wand of the backpack, the test subjects had to reach out further with the upright vacuum leading to both increased fatigue and a slower productivity.

Although using either vacuum cleaner in the forward-backward motion, the area covered per stroke was the same for each type of vacuum cleaner, but with the upright vacuum cleaner the test subjects often switched to a side-to-side motion where they remained in the center of the area vacuumed and swept the vacuum across the entire width to the test area. The total area was vacuumed by proceeding forward using small walking type steps and swinging the floor tool side to side. This motion resulted in both less fatigue to the worker and increased cleaning efficiency. With the use of the backpack vacuum cleaner, more carpet was cleaned in a shorter amount of time with less stress to the worker.

In the trunk and shoulder areas, the repetitive motions and phasic activity of most muscles noted in the front-back vacuuming method could give rise to symptoms of repetitive stress syndrome. However, while using the backpack vacuum cleaner, the workers alternated from front-back motions to side-to-side motions thus lessening the repetitive nature of the motions and decreasing the potential for repetitive stress syndrome.

The biomechanical assessment concluded that the use of backpack vacuum cleaners resulted in less body stress, fatigue and repetition. Specifically, the lower body motions associated with the use of a backpack vacuum were within the limits of average walking, whereas the lower body motions associated with the use of upright vacuum cleaners were more “unnatural” and therefore more stressful on the body. Also, upper body movements were less stressful since the hand to floor distance was longer with the backpack vacuum cleaner than with the upright. This resulted in an increase in the speed in which an area was vacuumed.

Metabolic Assessment

The research paper titled *Comparison of Metabolic Responses During a 1-Hour Vacuuming Task with a Backpack Vacuum Cleaner and An Upright Vacuum Cleaner* (Physical Therapy Division, Ohio State University, and Battelle Memorial Institute, Columbus, OH) presents data regarding ergonomic efficiencies, metabolic demands, energy exertion and productivity rates for custodial managers using upright and backpack vacuum cleaner. As in the previous discussed study, twelve industrial cleaners (six males and six females age 28-39 performed controlled vacuuming tasks. Measurements were made for oxygen uptake, expiratory ventilation, respiratory exchange ration, and ratings of perceived exertion were collected continuously during cleaning tasks.

Previous studies (International Sanitary Supply Association, 1994, etc.) have claimed that industrial backpack vacuum cleaners may be much more efficient in cleaning the same area than industrial upright vacuum cleaners. However, previous

reports lacked information concerning the control of conditions which might affect productivity estimates such as the number, gender, and cleaning experience/instruction of subjects studied, level of exertion during cleaning, consistency of cleaning pace, pattern of movements, and number of trials. Other studies (Service Employees International Union; Dropkin and Buchholz, 1993; HETA, 1994) were skeptical of the backpack vacuum cleaners ergonomic variables such as energy expenditure, noise, heat, vibration, and biomechanical stress.

Since scientific evidence was lacking concerning both the potential positive and negative ergonomic effects of using a backpack vacuum cleaner, rigorous study of the ergonomic effects was needed. The objective of the study was to evaluate the efficiency of a backpack vacuum cleaner as compared to an upright vacuum in terms of cleaning rates and metabolic demands during a simulated industrial vacuum-cleaning task. In an effort to quantitatively resolve these differing views, the 1998 Ohio State University/Battelle Memorial Institute study quantified these conditions and concluded that backpack vacuums were more efficient than upright vacuums at cleaning carpets.

Data showed that average relative energy costs (percent of oxygen uptake peak), expiratory ventilation, respiratory exchange ration, and ratings of perceived exertion were similar between vacuum cleaners, but the percent of oxygen uptake peak and ratings of perceived exertion values differed between genders. The study’s findings conclude that the backpack vacuum cleaner is more efficient than the upright vacuum cleaner as industrial cleaners cleaned with similar levels of energy expenditure and perceived effort.

Using the backpack vacuums, the workers were able to vacuum 2.07 times more area with similar levels of energy expenditure and perceived effort.

The study concluded that the backpack vacuum cleaner was more efficient compared to the upright vacuum cleaner in terms of cleaning rates and metabolic demands during a simulated industrial vacuum cleaning task. Both male and female subjects demonstrated that with the backpack they could clean approximately 2.07 times greater area than with the upright vacuum cleaner, while the metabolic demands remained similar. Furthermore, the subjects did not perceive the effort of work at the

greater cleaning rate with the backpack as different than the effort of work with the upright vacuum cleaner. With similar levels of energy expenditure and perceived effort, industrial cleaners can clean approximately 2.07 times greater area with the backpack vacuums than with upright vacuums.

This review and summary is provided by Robert A. Woellner of QUEST, Inc. (303-935-1573). Interested readers are encouraged to read the full original reports available from either Ohio State University, Battelle Memorial Institute, or Pro-Team, Inc. at 800-541-1456.

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