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# Ergonomic Assessment of Cleaning Spray Bottles for Hotel Housekeeping Use

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## 1. Background

The housekeeping cleaning occupation represented 24% of the employment in the hospitality sector and was reported to have the highest rate of musculoskeletal disorders (MSDs) in this sector in 2015 (BLS, 2016). Housekeepers perform a variety of cleaning activities, such as vacuuming, mopping, and dusting requiring the use of different tools. Spray bottles containing cleaning product are commonly used during these tasks. The use of spray bottles demands repetitive motion, forceful exertions and awkward posture of wrist and hands. These conditions have been identified as potential risk factors for MSDs, specifically carpal tunnel syndrome (CTS). In 2015, the incidence rate of CTS in housekeeping cleaners was 0.7 per 10,000 full-time workers ranking among the top of the hospitality sector (BLS, 2017). The overall objective was to quantify the muscle activity for four commonly used muscles in the wrist area (flexor and extensor muscles) while using three different spray bottles to clean a shower glass door. The findings will be a step toward proposing recommendations to eliminate related MSDs among hotel housekeepers.

## 2. Methods

Seven female housekeepers from a local hotel were recruited for this study. The average age of the participants was 23.5 years (SD = 6.6). The primary inclusion criteria required participants be free from any type of musculoskeletal, degenerative or neurological disorders and to have had no history of upper extremities, neck, back, and shoulder injury or notable pain. First, participants were provided with a description of the research and its objectives and then asked to sign the consent form approved by Indiana University of Pennsylvania Institutional Review Board prior to any data collection. The Electromyography (EMG) wrist muscles activity was measured using Trigno™ Wireless EMG system (Delsys Inc., Boston, USA). EMG muscle activity was collected from two wrist flexor muscles (*Flexor Carpi Ulnaris* (*FCU*) and *Flexor Carpi Radialis* (*FCR*)), and two wrist extensor muscles (E*xtensor Carpi Ulnaris* (*ECU*) and E*xtensor Carpi Radialis* (*ECR*)).

*Data Collection Procedure:* The Maximum Voluntary Contraction (MVC) of participants was measured first in order to obtain a baseline maximum effort for EMG normalization purposes. To test maximal voluntary contractions of the wrist flexor/extensor muscles, participants while seated and at 90 degrees elbow flexion were asked to flex/extend their wrists maximally while pressing against a dynamometer (Fagarasanu, M., Kumar, S., & Narayan, Y., 2004). This procedure was repeated three times with a 20-second rest period between the trials. Then, the EMG data were analyzed to measure muscle activity during Maximum Voluntary Exertion (MVE). Surface mounted electrodes were placed on wrist flexors and extensors following the procedures described by Roman-Liu and Bartuzi (2013). The participants' skin was prepared for surface mounted electrode placement by cleaning the skin with alcohol applied with a textile towel.

*Experimental Procedure:* after completing the MVC procedures, participants were asked to perform bathtub glass door cleaning task in the same manner they do on a daily basis. Accordingly, Participants were asked to clean each side of a bathtub glass door from top to bottom and from right to left. This task was repeated three times using the three different bottles. Participants were given a minimum of five minute rest between trials. At the end, participants were also asked to complete a questionnaire to collect their demographic data and to rate each bottle based on ease of use, comfort, efficiency, and overall preference.

*Data analysis:* EMG raw data was demeaned and normalized by the peak MVC values using the EMGWorks software program provided by Delsys Inc. The raw EMG data was also transformed from time domain to frequency domain to calculate the median frequency (MDF) as indicator of fatigue. The MDF was calculated using the EMGWorks software program.
Experimentally, the independent variables were the muscle type and bottle type. The dependent variables were the average %MVC and the average MDF over the entire experiment period. For the subjective data, independent variable were the ease of use, comfort, efficiency, and overall preference. Participants' rating on a scale of 5 was the dependent variables. A repeated measure ANOVA was used to test for the main effects and interaction effect of muscle and bottle types. Tukey's HSD tests were used in post-hoc comparisons where appropriate. Analysis was completed using SPSS version 24, and all results were considered significant at an alpha level of .05.

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## 3. Findings

Based on the %MVC data, muscle, bottle type and their interaction were all found significant (p-value < .05), see Figure 1. Accordingly, the motorized spray bottle was found to significantly generate the lowest muscle activity (%MVC) across all muscles except for the ECR. Among participants, the motorized spray bottle was rated the best in each investigated category. However, the median frequency data (MDF) did not show any significant differences between bottles across all muscles and this could be related to the low %MVCs required to complete this task and the small sample size, see Figure 2.

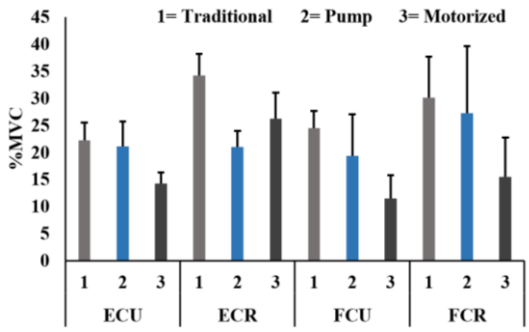


**Figure 1. %MVC for muscle by bottle type**

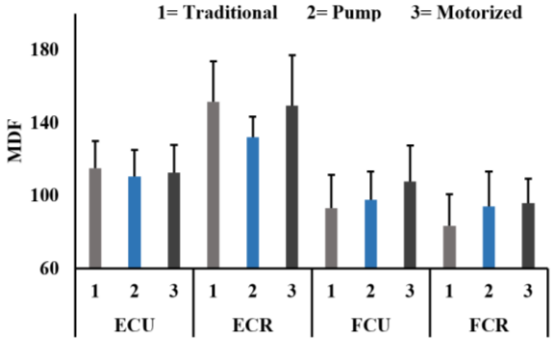


**Figure 2. MDF for Muscle by bottle type**

## 4. Discussion

Findings from this study indicated that the motorized spray bottle would be expected to reduce exposure to occupational risk factors for hotel housekeepers in comparison to the traditional spray bottles used in the sector. The used of motorized spray bottle may have implications for productivity which should be also examined.

## 5. References

U.S. Bureau of Labor Statistics. *Occupational Employment and Wages, May 2015*. From: https://www.bls.gov/oes/current/oes372012.htm. Accessed March 26, 2017.

U.S. Bureau of Labor Statistics. Table 7. Incidence rates for nonfatal occupational injuries and illnesses involving days away from work per 10,000 full-time workers by selected worker occupation and nature of injury or illness, all ownerships, 2015. From: https://www.bls.gov/news.release/osh2.t07.htm. Accessed March 26, 2017

Fagarasanu, M., Kumar, S., & Narayan, Y. (2004). Measurement of angular wrist neutral zone and forearm muscle activity. *Clinical Biomechanics*, *19*(7), 671-677.

Roman-Liu, D., & Bartuzi, P. (2013). The influence of wrist posture on the time and frequency EMG signal measures of forearm muscles. Gait & posture, 37(3), 340-344.

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