RISK FACTORS ASSOCIATED WITH TRUNK WORK-RELATED MUSCULOSKELETAL DISORDERS IN FEMALE FLIGHT ATTENDANTS

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Have no anxiety about anything, but in everything by prayer and supplication with thanksgiving let your requests be made known to God. And the peace of God, which passes all understanding, will keep your hearts and your minds in Christ Jesus (Philippians 4:6-7)

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LIST OF ABBREVIATIONS

AFA-CWA	Association of Flight Attendants-Communications Workers of America
OSH Act	Occupational Safety and Health Act
ASHSD	Air Safety, Health and Security Department
BLS	Bureau of Labor Statistics
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control and Prevention
CPR	Cardio Pulmonary Resuscitation
FAA	Federal Aviation Administration
FTW	Full-Time Workers
ISO	International Standard Organization
JCQ	Job Content Questionnaire
NIOSH	National Institute for Occupational Safety and Health
NMQ	Nordic Musculoskeletal Questionnaire
NORA	National Occupational Research Agenda
OSHA	Occupational Safety and Health Administration
PASS	Power Analysis and Sample Size
PINS	Pain Intensity Number Scale
PTSD	Posttraumatic Stress Disorders
RSI	Repetitive Strain Injury
SOC	Standard Occupational Classification
USDOL	U.S. Department of Labor
USQES	Quality of Employment Survey
WBV	Whole Body Vibration
WHO	World Health Organization
WMSD	Work-related Musculoskeletal Disorders

SUMMARY

Work-related musculoskeletal disorders (WMSDs) of the trunk (neck, shoulders, upper-back, and lower-back) are among the major occupational injuries and illnesses among U.S. flight attendants. The high incidence of trunk WMSDs among female flight attendants could be explained by the physical load associated with job tasks and the work organization and environment, but there have been few studies about these risk factors for potentially preventable disorders among female flight attendants.

A cross-sectional, mailed-survey design was used to examine the relationships between risk factors (physical load, work organization, and physical and external environment) and the occurrence of trunk WMSDs in female flight attendants on long-haul international flights. A total of 185 out of 420 female flight attendants randomly selected from the union membership list responded to the questionnaire, yielding a response rate of 63%. One postcard reminder and two follow-up mailings were sent. Test-retest reliability for selected subscales of the survey was examined. The survey instrument included 6 parts: physical load, work organization, physical environment, external environment, personal factors, and WMSD symptoms. Descriptive statistics and logistic regression were used.

The results of the study revealed that a large percentage of the flight attendants had WMSDs of the trunk, especially the lower-back region. Physical load factors were found to be the strongest risk factors for trunk WMSDs. Low social support increased the risk of upper-back WMSDs, and high job insecurity increased the risk of lower-back WMSDs. Uncomfortable physical environments in the cabin related to air quality and noise were frequently reported. Uncontrollable external environmental factors, such as turbulence, terrorism threats, air rage, and aircraft malfunction, were also matters of much concern in this study population. Personal

factors, such as long duration of employment as flight attendants and increased age, were important background information and played a role in interpreting the relationship between other risk factors and WMSDs and in providing suggestions for future studies. Integration of these multiple dimensions is the strength of this study, which can provide a better understanding of the multifaceted nature of WMSDs.

I. INTRODUCTION

A. Background

1. Work-related musculoskeletal disorders (WMSDs)

Work-related musculoskeletal disorders (WMSDs) are a subset of musculoskeletal disorders, which are disorders involving the soft tissues (e.g., nerves, tendons, muscles, and supporting tissues). WMSD is not a diagnosis but rather refers to a group of disorders with similar characteristics. According to the Occupational Safety and Health Administration ([OSHA], 2000), these disorders may include muscle strains and tears, ligament sprains, joint and tendon inflammation, pinched nerves, spinal disk degeneration, and medical conditions (e.g., low back pain, tension neck syndrome, epicondylitis, and tendonitis). The characteristics of WMSDs include: mechanical and physiological processes; work-related intensity and duration; either gradual or chronic development; poorly localized, nonspecific, and episodic symptoms; often unreported symptoms; and multifactorial etiology (Armstrong, 2002; Cohen, Gjessing, Fine, Bernard, & McGlothlin, 1997). WMSDs are defined succinctly as "musculoskeletal disorders to which the work environment and the performance of work contribute significantly" or "musculoskeletal disorders that are made worse or longer lasting by work conditions" (Cohen et al., p.1, 1997).

The definitions of WMSDs reflect the philosophy of workers' compensation laws in most western countries (Armstrong, 2002), but different terms have been used for the phenomenon of WMSDs (Armstrong et al., 1993; Cohen et al., 1997;Yassi, 2000). The preferred terms vary from country to country (e.g., cumulative trauma disorder in the U.S., repetitive strain injuries [RSI] in Canada and the United Kingdom, both RSI and overuse syndrome in Australia, and cervicobrachial syndrome in Japan and Sweden) (Yassi, 1997). In particular, the term has often

been used interchangeably with the term occupational musculoskeletal diseases. However, these other terms do not sufficiently reflect the nature of WMSDs. As defined by World Health Organization ([WHO], 1993), occupational diseases have a direct casual relationship between a single risk factor and a disease and have been fully established and controlled (e.g., silica dust-silicosis and asbestos-asbestosis), while work-related diseases have complex and multiple etiologies. In addition, the use of term "disease" is appropriate when the health outcome has a clear pathogenesis. However, when the health outcomes do not have obvious pathogenesis or have symptoms without clinical signs, the term "disorder" is more accurate (Wells, 1997). Therefore, the term WMSD seems to be an appropriate umbrella term for the multi factorial-disorder it is used for.

WMSD alone has been the largest category of work-related injuries and illnesses in the U.S. (Punnett & Wegman, 2004). According to the Bureau of Labor Statistics (BLS) (U.S. Department of Labor [USDOL], 2003), during 2000, U.S. private industries reported 1.7 million lost workdays for injuries or illnesses. Of these, more than one-third of the reported injuries and illnesses resulted from WMSDs. The cases were more common in female workers, who represented 39% of the reported lost workdays for work-related injuries and illnesses: Male workers accounted for 33% (USDOL, 2003). The disorders are also a major component of work-related injury and illness costs. The annual U.S. WMSD-related direct costs were estimated to be $13 billion (National Research Council [NRC] and Institute of Medicine [IOM], 2001). According to the Washington State Department of Labor and Industries (2004), between 1994 and 2002, WMSDs accounted for 27% of the total costs and the average costs per WMSD case were $3,000 higher than those for other injuries. As shown in the Liberty Mutual Workplace Index (Liberty Mutual, 2004), WMSDs including over exertion (injuries caused from

excessive lifting, pushing, pulling, or carrying) and repetition were the top reasons for workers' compensation accounting for one-third of the total costs between 1998 and 2002. The cost in 2002 was $16 billion. These analyses did not include indirect costs, such as lost productivity and lost tax revenues. When indirect costs are added, the figures are much higher (NRC & IOM, 2001).

WMSDs are caused by multiple risk factors, including workplace exposures and personal, environmental, and socio-cultural factors (Armstrong et al., 1993; Cohen et al., 1997; Lemasters & Atterbury, 1996; WHO, 1985). It is widely recognized that the WMSD risk factors include job task factors resulting in physical load (e.g., movement, posture, force), work organizational factors (e.g., decision latitude, social support), and physical environmental factors (e.g., vibration, noise) (Armstrong et al., 1993; Bernard, 1997; Lemasters & Atterbury, 1996; NRC & IOM, 2001). In addition, external environmental factors that are uncontrollable (e.g., emergency situations, weather) may contribute to the occurrence of musculoskeletal problems (Conrad, Balch, Reichelt, Muran, & Oh, 1994).

2. Flight Attendant Job and Working Environment

The job of a flight attendant is a personal care and service occupation according to the Standard Occupational Classification (SOC) (USDOL, 2005). As a certified safety professional by Federal Aviation Administration [FAA] (Golombek, 2004), the primary responsibility of the flight attendants is to ensure passenger safety as performing various tasks: ensuring that passengers fasten seatbelts and place tray tables and seats in an upright position; giving instructions on emergency equipment (e.g., oxygen masks, lifejackets) and procedures (e.g., emergency exits, lights, slides); and performing first aid procedures, including cardio pulmonary resuscitation (CPR), in medical emergencies. Flight attendants' secondary

responsibility is for passengers' comfort and for this they are engaged in a number of tasks, for example, serving meals, blankets, and reading materials; assisting disabled or elderly passengers; checking supplies such as food and drinks prior to passengers' boarding; and taking inventory of headsets, alcoholic beverages, and money (USDOL, 2005).

The flight attendants' work is rarely viewed as dangerous, but the unique environment encompasses various physical, chemical, and psychosocial risk factors, such as unfavorable cabin conditions, disruption of circadian rhythm by irregular work schedules and transmeridian flights, high physical demands, and high psychological demands (Daniell, Vaughan, & Millies, 1990; Pieren, 1997). Although the concerns have been raised about the unique work (cabin) environment and flight attendants' health problems, flight attendants have not even received OSHA protection because of the exclusive jurisdiction of FAA for flight attendants. To date, the FAA has failed to protect flight attendants from a variety of safety and health hazards (Association of Flight Attendants-Communications Workers of America [AFA-CWA], 2004a). In fact, OSHA has given most workers in the U.S. occupational safety and health protection since the 1970 Occupational Safety and Health Act (OSH Act), which is to assure workers' safe and healthy working conditions (OSHA, 1970). For the majority of workers, their workplace safety and health conditions have improved significantly (Salazar, 1997). For example, incidence rates of occupational injuries and illnesses for overall U.S. private industry dropped dramatically, 11 per 100 full-time workers (FTW) in 1973 to 5.0/100 FTW in 2003 (USDOL, 2005). However, the air transportation industry has remained hazardous, with a high incidence of non-fatal occupational injuries and illnesses. The rate in 2003 was 11.0 per 100 FTW, and this was several times higher than mining (3.3/100 FTW) and construction (6.8/ 100 FTW) (USDOL, 2005).

Flight attendants belong to a female-dominated occupation at high risk for occupational injuries and illnesses with similar incidence rates to those for all workers in the air transportation industry (Mokadam, 2003). In 1991, 76% of a total of 5,659 flight attendants who responded to a mail survey reported illnesses that resulted in medical consultation (Cone & Millar, 1993). According to the AFA-CWA review of injury and illness logs at the 11 U.S. airlines, in 1998, 10% of 31,024 flight attendants reported injuries and illnesses that required follow-up medical attention or caused them to lose work days (American Association of Occupational Health Nurses [AAOHN], 2001). Recently the issues regarding flight attendants' health problems have received increased interest among occupational health and safety professionals. In 2004, the NIOSH (2004) established the flight attendant research program to identify hazardous elements in work environment and examine the impact on flight attendants' health problems (e.g., cancer, reproductive health, respiratory symptoms, job stress).

B. Statement of the Problem and Significance

In recent years, one of the major health concerns among flight attendants has been WMSDs. Among the U.S. flight attendant population of about 100,000, a total of 5, 670 non-fatal occupational injuries and illnesses that caused flight attendants to lose workdays were reported in 2003 (USDOL, 2005). Of these, WMSDs accounted for about 32%. The median number of days that flight attendants lost workdays as a result of WMSDs were 22 in 2003; this exceeded those for the two other female-dominated occupations with the greatest number of WMSDs (registered nurses and nursing aides), who had a rate of only 6 days off for WMSDs (USDOL, 2005).

While few studies have been conducted, the trunk, which includes the back, neck, and shoulders, was reported to be the body region with the most frequently reported WMSDs among flight attendants, with percentages of symptom presence ranging from 34-59% (Haugli, Skogstad, & Helleoy, 1994; Iglesias, Gonzalez, & Morales, 1989; Logie, VanDerDoe, & Ryan, 1998). According to the compensation claim data of Air British Columbia, problems with the trunk also accounted for the highest average compensation costs (Logie et al., 1998).

The high prevalence of trunk WMSDs among female flight attendants could be primarily explained by individual physical load. This is determined by their job tasks including manual material handling (e.g., lifting, pushing) and work postures (e.g., bending, twist), which are consistently found in a variety of occupations (Bernard, 1997; NRC & IOM, 2001). Specific job tasks leading to the occurrence of musculoskeletal injuries were related to overhead bin (45%), carts (31%), and passenger baggage (31%) (Logie et al., 1998). Further, flight attendants' job tasks require frequent pushing or pulling heavy carts, lifting or carrying heavy objects, prolonged standing, and frequent bending (United Airlines, 2001). Lifting and pushing were commonly reported safety hazards by the 1995 AFA member survey (AFA-CWA, n.d.).

In addition, recent studies have focused attention on exposure to high work organizational stress and adverse physical environmental factors surrounding flight attendants (Han, 2003; MacDonald, Deddens, Grajewski, Whelan, & Hurrell, 2003; Morley-Kirk, & Griffiths, 2003). Studies from the psychosocial perspective cite its important influences on the occurrence of work-related diseases such as cardiovascular disease (Karasek, Schwartz, & Pieper, 1983) and these social environmental contexts (e.g., social support from coworkers, job insecurity) have gained a greater importance in helping to explain WMSDs in the past decade (Bongers, De Winter, Kompier, & Hildebrandt, 1993; Messing, 1997). Also, unfavorable cabin

environment (e.g., noise, cold temperature, vibration) and external environmental factors that are uncontrollable (e.g., turbulence, terrorism threats) may place flight attendants at risk for WMSDs, but little is known about the potential associations between these environmental factors and trunk WMSDs. The National Occupational Research Agenda (NORA) for WMSDs maintains that research into WMSD risk factors needs to integrate all of these factors (NIOSH, 2003). What is currently known about risk factors for WMSDs among flight attendants is very little and to date, none of studies examined the influence of physical and external environmental factors on WMSDs.

WMSD is one of the 21 priority research areas identified by NIOSH and the identification of risk factors was listed as a high priority research problem for WMSDs by the NORA research teams (NIOSH, 2001). In spite of the increased interest and efforts to decrease the risk for WMSDs in many U.S. industries, little attention has been given to flight attendants. This was the first study that investigated multiple risk factors, including actual job tasks and work environment, for trunk WMSDs among female flight attendants in the U.S. In addition, a job task measure with actual task-specific items that was developed for this study might strengthen the validity of this study. The knowledge gained by this study can make an important contribution to better understanding job tasks and work environmental influences that may place female flight attendants at risk for trunk WMSDs. The findings might suggest ideas for making changes in safety policies to facilitate effective workplace WMSD surveillance for female flight attendants. In particular, it would facilitate the planning of efficient and effective preventive strategies by establishing a focus on the main contributing risk factors. It will also contribute to future ergonomic research targeted at interventions to decrease the female flight attendants' risk for WMSDs.

C. Purpose of the Study

The purpose of this study was to examine the relationships between workplace (physical load, work organization, and physical environment), external environmental (e.g., turbulence, terrorism threats), and personal (e.g., age, height, body mass index [BMI], years of employment) risk factors, and the occurrence of trunk WMSDs in female flight attendants. The aims of the study were:

1. To identify what trunk WMSDs (frequency, duration, and intensity) are experienced by female flight attendants.
2. To identify the relationships between workplace (physical load, work organization, and physical environment), external environmental (e.g., turbulence, terrorism threats), and personal (e.g., age, height, BMI, and years of employment) risk factors and the occurrence of trunk WMSDs in female flight attendants.

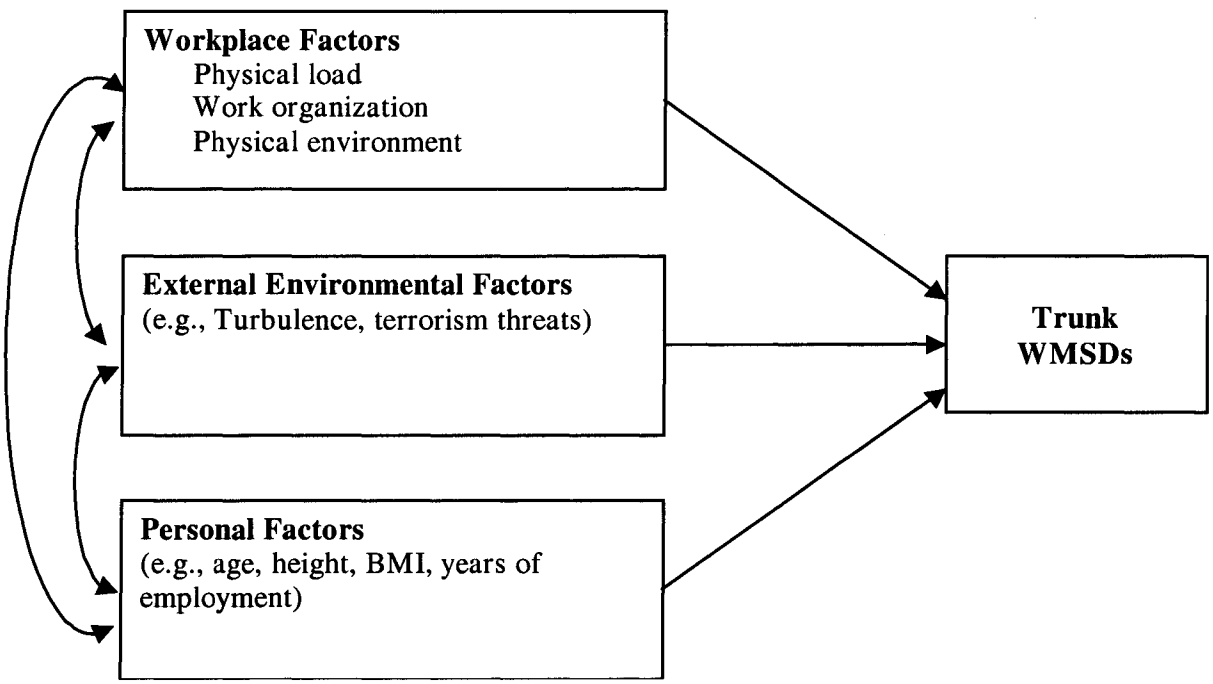
II. CONCEPTUAL FRAMEWORK AND RELATED LITERATURE

A. Conceptual Framework

An ecological model of trunk WMSDs in female flight attendants guided this study (Figure 1). Ecological perspectives assume that an individual's health is influenced by environmental factors as well as personal factors, and it is assumed the factors interact. In addition, environmental factors are assumed to be multidimensional (e.g., social environment and physical environment) and multilevel (e.g., organization and community) and to directly influence health outcomes (Stokols, 1992). In particular, the social ecological perspective views the workplace as a complex system that comprises multiple social and physical environmental factors (Stokols, Pelletier, & Fielding, 1996). Social environmental contexts in the workplace have been cited as having an important influence on the occurrence of work-related diseases (McLeory, Bibeau, Steckler, & Glanz, 1988; WHO, 1993) and have gained a greater importance in helping to explain the occurrence of WMSDs in the recent decade (Amick, Swanson, and Chang, 1999; Bongers,Winter, Kompier, & Hildebrandt, 1993; NRC & IOM, 2001; Stokols, Pelletier, & Fielding, 1996). There is a need, however, for an ecological model that includes personal, workplace, and physical environmental factors that influence health outcomes (Moos, 1979; Sallis & Owen, 1996; Stokols, 1992). In view of WMSD's multifactorial nature, an ecological model that integrates these multiple factors is well suited for guiding an examination of the relationships between risk factors and the occurrence of trunk WMSDs in female flight attendants.

Conrad and her colleagues (1994) were the first to develop an ecological model that considered the influence of the social and physical workplace environment on WMSDs. Based on firefighter focus group interviews, the model posits that personal factors, workplace factors

Figure 1. Ecological Model of Trunk WMSDs in Female Flight Attendants



including social and physical environmental factors, and external environmental factors are interrelated and together influence the risk of WMSDs among firefighters. Although personal and workplace factors were emphasized as points of intervention, external environmental factors, which are defined in the model as uncontrollable situations such as emergency situations and extreme weather, were also considered to be important factors in the occurrence of WMSDs among firefighters. These assumptions and the major concepts of the model are adapted in this study as the ecological model of trunk WMSDs in female flight attendants. Within the ecological model of trunk WMSDs in female flight attendants, workplace factors, external environmental factors, and personal factors, served as independent variables, and trunk WMSD as the dependent variables. The ecological model was also used as an organizational framework to guide a literature review. Because of limited studies of flight attendants, the literature review was expanded to all female worker populations. Selected studies included both cross-sectional and longitudinal studies that examined the relationship between risk factors and WMSDs of the neck, shoulder, or back, and published in English from 1990 to 2005.

B. Review of Related Literature

1. Workplace factors

The workplace is viewed as a complex system comprised of multiple social and physical environmental factors (Stokols, Pelletier, & Fielding, 1996), which themselves are multifactorial (Bernard, 1997; NRC & IOM, 2001). Among the complicated structure/system, factors related to trunk WMSDs include physical load factors, work organizational factors, and physical environmental factors.

a. Physical load

Physical load is defined as biomechanical forces occurring in the body (NRC & IOM, 2001; Winkel & Mathiassen, 1994). This definition of physical load indicates that the full working environment such as the work organization and physical environment at the workplace is not considered (Winkel & Mathiassen, 1994). The physical load results from individuals' job tasks, which are defined as "a unit of activity conducted by one or more individuals" (Gramopadhye & Thaker, 1999, pp. 301-302). The job tasks lead individuals to specific movement, force, and postures comprising a certain level of physical load on musculoskeletal structures (Westgaard & Winkel, 1996), which may result in musculoskeletal symptoms. In critical reviews performed by Bernard (1997) and the NRC and IOM (2001), specific job tasks including manual material handling and work postures were most commonly found to be associated with neck, shoulders, and back musculoskeletal symptoms among adult workers.

Manual material handling is defined as work activities such as moving or bringing something from a lower to a higher level (lifting/carrying), and forceful movement (pulling/pushing) (Bernard, 1997). Manual material handling activities including lifting, carrying, pushing, and pulling have been found to be risk factors for WMSDs in many studies of female workers. In a recent study by Chee and Rampal (2004), the long duration (4 or more hours/shift) of lifting and pushing/pulling increased the risk of neck/shoulder symptoms among semiconductor female workers in Malaysia. Manually lifting materials heavier than 10kg increased the risk of back symptoms in a variety of workers including female clerks, managers, trading workers, and manual handling workers (Alcouffe, Manillier, Brehier, Fabin, & Faupin,

1999; Macfarlane, Thomas, Papageorgiou, Croft, Malcolm, & Silman, 1997) and the magnitude of associations was increased by the frequency of lifting (Alcouffe et al., 1999).

Positive associations between manual material handling tasks and WMSDs were consistently found among nursing personnel. Estryn-Behar and colleagues (1990) reported a positive association between back symptoms and a lifting index that was calculated by the total number of four lifting activities (lifting materials heavier than 15 kg a day, lifting adult patients more than five times a day, pushing beds or trolleys more than 10 minutes a day, and frequent bed making as required by the occupation). Another study by Smedley, Egger, Cooper, and Coggon (1995) showed that frequent lifting tasks (e.g., manually lifting a patient up from the floor) significantly increased the risk of back problems. In a separate study, three patient-handling tasks that involved pushing and pulling (moving patients around in a wheelchair, bed, or trolley, washing/dressing patients, and helping patients to mobilize using walking aids) significantly increased the risk of neck/shoulder symptoms (Smedley et al., 2003). Consistently, frequent lifting of materials heavier than 5 kg was associated with neck, shoulder, and back symptoms among Greek nursing personnel (Alexopoulos, Burdorf, & Kalokerinou, 2003).

Conversely, Barnekow-Bergkvist and colleagues (1998) found that neck/shoulders musculoskeletal symptoms decreased with frequent lifting of heavy materials among Swedish female manual workers, salaried employees, professionals, and managers. Different studies, however, reported no associations between neck/shoulder symptoms and carrying materials weighing more than 20 kg (Gunnarsdottir, Rafnsdottir, Helgadottir, & Tomasson, 2003) or lifting efforts (Brulin, Gerdle, Granlund, Hoog, Knutson, & Sundelin, 1998; Malchaire, Roquelaure, Cock, Piette, Vergracht, & Chiron, 2001).

In a descriptive study by Bjorksten and colleagues (1996), unskilled female workers with a high prevalence of neck/shoulders and back symptoms in metal or food processing industries reported pushing/pulling as one of the most frequently work activities. Likewise, Chavalitsakulchai and Shahnavaz (1993), in their observational study of work activities among Thai female textile workers who had a high prevalence of lower-back problems (95%), found that pushing and pulling heavy steel beams to connect them with weaving machines was a frequent task (8-10 times per shift).

Flight attendants' job tasks require manually handling materials of a variety of weights. It includes different types of fully loaded carts such as liquor cart (230 lbs), duty-free cart (216 lbs), entrée cart (187 lbs), and meal cart (182 lbs). Other materials flight attendants handle are a bin of 6 bottles of champagne (24 lbs), a bin of 25 cans of soda (23 lbs), an oxygen cylinder (15 lbs), and a coffee pot (4 lbs) (United, 2003). Among Canadian flight attendants with a high prevalence of work-related juries (48%), including the trunk body region, pushing/pulling was frequently observed (34-66% of the time per shift). The task of pushing and pulling the fully-loaded meal carts required high force up to 26 kg, which exceeds the recommended limits for females (Snook & Ciriello, 1991). The frequency of the task was greater in a medium-sized aircraft (BAe-146) with 70-112 seats than small aircrafts (Dash 100 & 300) with 37-50 seats. In a recent study of Korean flight attendants (Han, 2003), handling materials heavier than 5 kg was positively associated with the occurrence of lower-back pain, and the risk estimate for materials heavier than 20 kg was highest. These findings suggest that for flight attendants, performing manual material handling activities is likely to increase the risk of trunk musculoskeletal symptoms.

Work postures include awkward postures or static postures. Awkward postures are non-neutral postures in extreme positions or at extreme angles (e.g., back bending, twisting, neck flexion). Static postures are isometric positions in which very little movement occurs (e.g. prolonged standing or sitting) (Bernard, 1997). The specific types of work postures were found as risk factors for trunk WMSDs in female workers in a variety of occupations.

Barnekow-Bergkvist and colleagues (1998) found that adverse work postures were positively associated with neck/shoulder symptoms in Swedish female manual workers, salaried employees, professionals, and managers. Squatting down and reaching arms above the head were two work postures positively associated with neck/shoulder symptoms among women working in nursing homes and geriatric hospital wards, but other postures, including bending, twisting, and kneeling were not related to neck/shoulder symptoms (Gunnarsdottir et al., 2003). A recent study found that twisting and bending four or more hours per shift increased the risk of neck/shoulder symptoms in Malaysian semiconductor workers (Chee & Rampal, 2004). In a longitudinal study, Smedley and colleagues (2003) showed that both reaching and bending while handling patients (e.g., washing/dressing a patient who is on a chair/commode) increased the risk of neck/shoulder pain among English hospital nurses.

Macfarlane and colleagues (2001) found that prolonged standing, that is, standing more than two hours per shift, was an important predictor of back symptoms among female workers who were initially free of back symptoms. The risk was increased with longer employment. Among Swedish home care workers, standing in forward-bent and twisted postures was positively associated with neck/shoulder symptoms after adjusting for age, work hours, and workplaces (Brulin et al., 1998). In a separate study, although no association with neck/shoulder pain was found, prolonged standing was strongly associated with lower extremity pain among

Malaysian women working in semiconductor industries (Chee & Rampal, 2004). In the same study, Chee and Rampal found that prolonged sitting, for four or more hours per shift, increased the risk of neck/shoulder pain. However, sitting in various positions, for example, sitting leaning forward, in twisted postures, or with hands at or above shoulder height, were not associated with the symptoms (Brulin et al., 1998).

Work postures were examined in groups of women with a high prevalence of neck, shoulder, and back problems. Bjorksten and colleagues (1996) found that awkward and static work postures measured by self-reported questionnaires were among the wok activities most frequently reported by unskilled female workers in metal-or food-processing companies. In a study of Swedish female workers in a variety of occupations, Barnekow-Bergkvist and colleagues (1998) also found that work postures including fixed, adverse, and repetitive postures increased the risk of neck/shoulder symptoms. In another study, Chavalitsakulchai and Shahnavaz (1993) reported that the most frequently observed harmful work postures among Thai female industry workers were bending the back, neck flexion, and arm positions at or over shoulder level.

Self-reported back bending greater than 20 degrees was found to be positively associated with the occurrence of low-back pain among Korean flight attendants (Han, 2003). This awkward posture was frequently observed during beverage and food preparation and service among Canadian flight attendants (Logie et al., 2003). Four types of work postures, bending, stooping, neck postures (flexion, extension, and rotation), and reaching above or below shoulder level, were frequently observed during 34-66% of the shift. In particular, it was observed that flight attendants consistently stood more than 66% of the shift. These findings imply that the

exposure to certain awkward or static work postures in these flight attendant populations may increase the risk of trunk musculoskeletal symptoms.

Issues related to measuring physical load. The physical load induced while individuals are performing their job tasks can be estimated in terms of three components: frequency (repetitiveness), duration (length of time), and intensity (magnitude or level) (Westgaard & Winkel, 1996). There are subjective (self-reports and expert judgments) and objective (observation and direct measures) methods to assess physical load factors (van der Beek & Frings-Dresen, 1998). Observations (such as on-site observations or retrospective video observations) and direct measures (such as electromyography and lumbar motion monitor) are more accurate than self-reports. But these are complicated and time-consuming when large groups of workers are involved, and skilled analysts are needed for reliable measurements (van der Beek & Frings-Dresen, 1998). Self-reported measures, therefore, have been commonly used because of their capacity, versatility, and generality: they are relatively simple and less expensive, and thus, make it possible to study a large population; it is possible to collect information about various exposure variables; and it is also possible to collect information about different factors that generally occur, while direct measures collect exposure information about the recording period only (Burdorf, 1992). However, the usefulness of self-reported measures is quite questionable, as existing self-reported measures for physical load have been found to have low reliability and validity.

Several studies examined psychometric properties of self-reported physical load measures. In a test-retest reliability study over a two-week interval (Wiktorin, Hjelm, Winkel, & Koster, 1996), the self-reported measures for movements (trunk rotation, neck rotation, lifting, and pushing) failed to establish good reliability. The authors concluded that it was quite difficult

for subjects to estimate frequencies (e.g., 1-10 times/hour in times per hour) and duration in proportions of typical working shift (e.g., ¼ of the time) of any given job task. Likewise, the validity of the self-reported physical load measures was questionable. Researchers addressed that the self-reported measures might not replace other methods such as interviews (Burdorf & Laan, 1991) and observations (Leijon, Wiktorin, Harenstam, & Karlqvist, 2002; Viikari-Juntura et al., 1996). Self-reported measures with response categories indicating duration in hours were less valid for estimating work posture and movement than observation data (Viikari-Juntura et al., 1996). The self-reported measures underestimated average duration of time spent in lifting/carrying, bending, and standing. They also overestimated average frequency of lifting and bending compared with the observational method (Burdorf & Laan, 1991). In a separate study, the criterion validity was not established as there was low agreement between the self-reported measure and interview data, specifically bending and repetitive movement (Leijon, et al., 2002).

We do not really know if the previously used measures are adequate for risk estimates for the occurrence of WMSDs. To date, there is no general agreement on how best to measure the physical load factors by frequency, level, and duration. Thus, it is a challenge to select appropriate measures for estimating flight attendants' physical load in their job tasks. Using inadequate measures of physical load will lead to underestimating or overestimating the impact of the physical load on the occurrence of WMSD.

Flight attendants' job tasks vary, depending on flight schedules, passengers' needs, types of aircrafts, and types of service sections. Unlike cyclical work such as a machine-paced assembly line, it is difficult to observe flight attendants' representative job tasks during any given time period. It is not very feasible to use direct measures such as biomechanical parameters in their actual work environment (i.e., working in a moving aircraft). Therefore,

there is a need to use simple methods to assess physical load induced by the job tasks that may place flight attendants at risk for trunk WMSDs.

Both level and time (frequency and duration) dimension of job tasks (NRC & IOM, 2001) should be considered to estimate physical load caused by flight attendants' job tasks. As previously stated, measures for frequency and duration using response categories such as the number of a job task performed per shift and the duration of time spent on a certain job task are not suitable for occupations with highly variable work schedules and job tasks.

It would also be difficult to measure the intensity of physical load by self-estimated weight of materials handled during lifting/carrying or force applied during pushing/pulling. Rather, subjective estimation of physical load by psychophysical methods (e.g., perceived exertion, strenuousness, difficulty, fatigue) is deemed the most appropriate for this occupational group (Capodaglio, 2002). The method has been often used in ergonomic studies since rating how heavy and strenuous a physical task is an important indicator of real physical load involved in a specific task (Borg, 1998; NRC & IOM, 2001). In a study by Conrad, Lavender, Reichelt, and Meyer (2000), combined with the self-reported frequency of specific job tasks, the degree of physical strenuousness, which was defined as subsequent fatigue or soreness, was used as an indicator of job tasks putting firefighters at risk for WMSDs. To date, studies that have examined job tasks have not asked the participants if they experienced symptoms (pain, ache, or discomfort) while performing the tasks and the degree of symptoms. We are lacking of using the intensity of symptoms perceived during performing tasks as an indicator of physical load.

Importantly, self-reported measures structured with task-specific items will allow occupational health nurses and ergonomic teams to prioritize specific tasks for intervention. To date, the content of the existing self-reported measure for flight attendants' job tasks, however, is

general (e.g., lifting, pushing, and bending) and not tied to a specific task. Thus, there is a need for contextual understanding of flight attendant job tasks and valid task-specific items that flight attendants consider physically strenuous for inclusion in a self-reported job task measure.

b. Work organization

Increasingly, attention has turned to the influence of work organizational factors on WMSDs. Work organization refers to the work process (the way jobs are designed and performed), the organizational practices (management and production methods and accompanying human resource policies that influence work process), and the external context (legal, economical, and technical factors that influence organizational practices) (NIOSH, 2002). These factors are considered to be important potential risk factors for work-related diseases (WHO, 1993) and may be more important for female workers than male workers (Messing, 1997; Ursin, Endresen, & Ursin, 1988). Among these many aspects of work organization, this study focuses on the work process context, such as job task attributes (e.g., complexity of tasks, skills required, and degree of worker control), interpersonal aspects of work (e.g., social support from coworkers and supervisors), and career concerns (e.g., job security). These work organizational factors have been often called "work-related psychosocial factors" or "job stressors," which are defined as the perceptions or beliefs that workers have about the way their work is organized (Amick, Swanson, & Chang, 1999; Buckle & Devereux, 2002). In addition, another important aspect of work organization is the scheduling of work (e.g., hours of work, work-rest schedules) (NIOSH, 2002).

1) Psychosocial factors

The associations between work-related psychosocial factors and WMSDs might be explained by the following pathways. First, work-related psychosocial factors

directly affect the physical load by changing work activities and in turn, produce muscle tension and biomechanical strain. For example, time pressure may lead workers to perform the tasks in a hurry with high accelerations or poor posture (Bongers, Winter, Kompier, & Hilderbrant, 1993; Sauter & Swanson, 1996). Flight attendants feel the time pressure of tight in-flight service schedules. As a result, they overload the service carts and shorten meal breaks (Edwards, 1991). Second, work-related psychological factors cause psychological strain that links to physiological mechanism (e.g., prolonged muscle activity, changed cortisol and catecholamine levels). (Bongers et al., 1993; Lundberg, 1999; Warren, 2001). Third, psychosocial factors may moderate the relationship between physical load and symptoms by means of perception, attribution, and appraisal of symptoms, without directly affecting physical pathology (Bongers et al.; Sauter & Swanson, 1996). Fourth, initial episodes of symptoms may result in chronic nervous system dysfunction, both physiological and psychological, which perpetuates a chronic pain process (Bernard, 1997). Lastly, changes in the work organization may be associated with changes in the level of exposure to psychological factors. Increased working hours and decreased breaks might place workers at increased probability to risks for WMSDs and thus associations between psychosocial factors and WMSDs occur through either a causal or effect-modifying relationship (NIOSH, 2002).

Among several different models of work-related psychosocial factors, the model proposed by Karasek (1979) has dominated research into job stress. The model reflects both social and psychological nature. That is, it presumes that individual well-being and behavior are affected by social institutional settings (e.g., workplace) as well as individual cognitive interpretation of the person-environment relationship. It postulates that four work organizational factors (high psychological job demands, low decision latitude, low social support, and job

insecurity) increase psychological strain, which results in increased risk of stress-related health problems. These relationships were originally validated in studies of cardiovascular diseases (Karasek, Schwartz, & Pieper, 1983) and since then have been found in other health problems (e.g., WMSDs, diabetes, cancer) (Kristensen, 1995). Karasek (1985) created the Job Content Questionnaire, which comprises those four factors, and has been commonly used to measure the psychosocial structure of the work organization as presented in the extended review of WMSD studies (Bernard, 1997; Bongers et al., 1993; NRC & IOM, 2001). These factors have been found to be important factors related to trunk WMSDs in a variety of female occupational groups.

Psychological job demands are defined as the effort required to carry out work (Karasek, Schwartz, & Pieper, 1983). It includes mental workload (e.g., how hard workers work); organizational constraints on task completion (e.g., insufficient time to complete work); and conflicting demands (Karasek, 1985).

Positive associations have been found between high psychological job demands and back symptoms among Swedish female hospital nurses (Ahlberg-Hulten et al., 1995) and Canadian blue- and white-collar female workers (Cole et al., 2001). Consistently, high psychological demand was positively associated with neck/shoulder symptoms among female workers in geriatric care (Gunnarsdottir et al., 2003) and hospital nursing personnel (Lagerstrom et al., 1995).

Logie and colleagues (1998) reported that Canadian flight attendants who had a high prevalence of neck, shoulder, and back symptoms had high psychological job demands (e.g., deadline pressures, attention to detail) during the majority of their work shift. Consistently, flight attendants from two commercial airlines in the U.S. experienced high psychological job demand: for example, their job required working very fast, required giving long periods of

intense concentration, and the tasks were often interrupted and therefore required attention at a later time (MacDonald et al., 2003). As presented in the Italian flight attendant study (Ballard et al., 2004), their psychological job demand may be increased because of difficulties in balancing work and family due to frequent absences from home, working with new colleagues on each flight, and dealing with angry passengers in case of flight delays. In this study, flight attendants participated in a focus group that addressed the fact that reduced staffing left remaining staff to face increased psychological job demands as well as increased physical load. These findings give important insights into the potential influence of psychological job demand on flight attendants' WMSDs.

Decision latitude is defined as the individual's potential control over the performance of his or her own job. It includes two concepts: decision authority (authority for workers to make decisions about their work) and skill discretion (the level of intellectual skills and creativity required on the job) (Karasek, Schwartz, & Pieper, 1983).

A positive association was found between low decision latitude and neck/shoulder symptoms among Swedish female manual workers, salaried employees, professionals, and managers (Barnekow-Bergkvist et al., 1998). Female hospital nurses in Sweden who had little scope for decision authority and skill utilization showed a high prevalence of back symptoms (Ahlberg-Hulten et al., 1995). Other studies of female workers in geriatric care (Gunnarsdottir et al., 2003) and hospital nursing personnel (Lagerstrom et al., 1995) found positive associations between decision latitude and neck/shoulder symptoms. In contrast to the findings of Karasek's model (1979), which was initially constructed for men, female workers who had more decision autonomy at work were more likely to report neck/shoulder symptoms but not back symptoms. The investigators speculated that women might be more stressed than men by the responsibilities

of high decision latitude at work (Barnekow-Bergkvist et al., 1998). In addition, inconsistent or contradictory associations between neck/shoulder and back symptoms might imply different effects by different body regions.

In a large survey (Morley-Kirk, & Griffiths, 2003) of flight attendants, those who had low job control were twice more likely to experience musculoskeletal problems in any body regions during the past 6 months and 5 times more likely to have job dissatisfaction. In a separate study, which did not include musculoskeletal problems, MacDonald and colleagues (2003) found that low decision latitude was significantly associated with high psychological distress (depression) and job dissatisfaction among flight attendants with two American commercial airlines. This further suggests that flight attendants may be at risk for WMSDs from the stressors.

Social support at work is defined as instrumental and socio-emotional support from co-workers and supervisors (e.g., co-workers helping to get a job done, supervisor's paying attention to what is being said) (Karasek, Schwartz, & Pieper, 1983). It compasses difficult human relations at work (Ando et al., 2000); feelings of isolation (Josephson et al., 2003); and conflicts with others, and stress in one's work team (Ahlberg-Hulten et al., 1995). Positive associations between social support and trunk WMSDs were found in many studies of female workers. Low social support from superiors was positively associated with neck/shoulder symptoms among healthcare providers (Ahlberg-Hulten et al., 1995; Gunnarsdottir et al., 2003; Lagerstrom et al., 1995). Solitary work also increased the risk of neck/shoulder symptoms among female workers in a variety of occupations (Josephson et al., 2003). Positive associations between social support and back symptoms were supported among Swedish nursing personnel (Ahlberg-Hulten et al., 1995; Lagerstrom et al., 1995.) and Japanese teachers for the handicapped

and kindergarteners (Tsuboi et al., 2003). In a longitudinal study by Bigos and colleagues (1991), the findings showed a significant association between the incidence of back pain and social relationships at work (e.g., communication with coworkers, support by coworkers, get along with supervisor).

Flight attendants reported that the relationships with their coworkers and superiors were overall good (Ballard et al., 2002). In the study by MacDonald and colleagues (2003), social support from supervisors decreased psychological distress (anxiety, fatigue, and fatigue) and job dissatisfaction while social support from coworkers decreased perceived stress in female flight attendants. Flight attendants supported by their superiors were less likely to have back pain in Korean flight attendants (Han, 2003). Although these findings provide limited evidence of the influence of social support on WMSDs, they do seem to influence the effect of stress.

Job insecurity is defined as threat or reality of job termination or layoff faced by workers (Davy, Kinicki, & Scheck, 1997; Heaney, Israel, & House, 1994; Karasek, Schwartz, & Pieper, 1983). A review of studies for job insecurity and its consequences (Sverke, Hellgren, & Naswall, 2002) found that job insecurity was related to organizational (e.g., performance, organizational commitment) and health outcomes (e.g., stress symptoms). Importantly, while a few studies were conducted, job insecurity was found to be associated with an increased risk of WMSDs.

Fear of being replaced by computers increased the risk of shoulder problems among telecommunication workers (Hales et al., 1994), and fear of losing their jobs increased the risk of upper extremity problems among female office workers (Marcus & Gerr, 1996). A longitudinal study (Heaney, Israel, & House, 1994) reported that chronic high job insecurity was related to increases in physical symptoms, including musculoskeletal symptom, among automobile

workers. In a study of job insecurity in Canadian female blue- and white-collar workers, that is, the degree to which workers agreed that their jobs were insecure, was not associated with back symptoms. In same study, however, job insecurity was positively associated with activity restrictions from back problems (Cole et al., 2001). This indicates that discrimination because of a disability might give rise to fears of job insecurity.

Airlines have been cutting back a number of flight attendants to reduce operating cost since the late 1990s. Thus, remaining flight attendants may not feel that their jobs are secure because of current undesirable situations such as airline bankruptcy and restructuring (Whitelegg, 2004). In a study of 73 female flight attendants (MacDonald et al., 2003), 27% reported that their job security was not good, and this feeling of job insecurity was significantly associated with job dissatisfaction. This indicates the potential influence of perceived job insecurity on the occurrence of WMSDs in this population, and there is a need further investigation of the relationship.

2) Scheduling factors

The scheduling of work such as hours of work and Length and timing of shifts has been found to be associated with work-related diseases (NIOSH, 2002). The change of the aspects of work schedules may influence the level of exposure to risk factors of WMSDs. For example, working long hours and irregular schedules increase the physical demands on workers who attempt to maintain performance levels in the face of increasing fatigue. It may also increase the time that workers are exposed to other workplace risk factors (Daniels & Guppy, 1995; NIOSH).

Alcouffe and colleagues (1999), however, found no association between the number of work hours and back symptoms among female clerks, managers, trading workers, manual

handling workers, and health care staffs in Paris. Likewise, overtime work (45 or more hours per week) failed to support a positive association with both neck/shoulder and back symptoms in Swedish female manual workers, salaried employees, professionals, and managers (Barnekow-Bergkvist, 1998).

Flight attendants usually fly 65-85 hours a month and work about 50 hours a month on ground preparing in-flight services and writing reports. The length of each segment, which is an individual nonstop flight between two cities, is up to 14 hours (BLS, 2005). The average flight hours per month were not associated with back pain in the Han's study (2003).

More important, long-haul international flights have been considered to be contributors to adverse physical and psychological health in flight attendants. Circadian-rhythm disruption from crossing different time zones during international flights result in jet lag, which is characterized by sleep disturbances, fatigue, behavioral symptoms, headaches, and gastrointestinal disturbances (Shiota, Sudou, & Ohshima, 1996). The influence on flight attendants' work performance might manifest itself as decreased attention span, short-term memory loss, and poor decision-making (Sharma & Shrivastava, 2004). In fact, flight attendants with long-haul international flights showed lower cognitive performance (memory and reaction time) than ground workers. However, flight attendants who had sufficient time to allow the circadian rhythm to recover (> 14 days) between long-haul international flights did not show memory deficit (Cho, Ennaceur, Cole, & Suh, 2000). In a survey (Criglington, 1998) of New Zealand based flight attendants flying to Asia, the U.S., and Europe, 96% of the 228 flight attendants suffered from jet lag. The most commonly reported symptoms were lack of energy and motivation (94%), sleep disturbance after arrival (93%), and tiredness over the first five days after arrival (90%). A similar result was found in the Air India flight attendant survey (Sharma

& Shrivastava, 2004) with 91% of 462 respondents reported symptoms of jet-lag to some degree Ono and colleagues (1991) found that international flights of 9 or longer were related to work stress and fatigue-related symptoms including lower-back pain in Japanese flight attendants. The level of perceived fatigue increased after the second meal service (7 to 10 hour after taking off). Consistently, Norwegian flight attendants who had long-haul flights reported more neck/shoulder and back symptoms than those had shorter flights (Haugli, Skogstad, & Helleoy, 1994). As the airlines have restructured, flight attendants are experiencing poorly scheduled duty time and lengthened duty days (American Federation of Labor and Congress of Industrial Organizations [AFL-CIO] Department of Occupational Safety and Health, 2005). There is a need for further exploration of the effects of the changes in flight schedules on WMSDs.

Other scheduling related factors, such as types of job responsibilities on flights, service sections (first, business, and economy), and aircraft assigned, were considered to be contributors of WMSDs. In a flight attendant job, pursers were less likely to have back pain than general flight attendants (Han, 2003). On the other hand, their psychological job demands related to supervisory responsibilities were higher than other flight attendants (Logie et al., 1998). Flight attendants working in an economy class showed a higher prevalence of back pain than those who working in a first or business class (Han, 2003). These finding suggest that the physical load or psychological strain related to one's position and service session may influence the occurrence of WMSDs. In Haugli and colleagues' (1994) study of Scandinavian Airline System (SAS) in Norway, flight attendants working in the DC-10, which is a large aircraft covering long distances at the time of the study, reported higher frequency of pain in neck, shoulder, and lower-back. This indicates that the layout/design of the aircraft might increase their physical load.

c. Physical environment

Physical environmental factors at the workplace, including noise, whole body vibration, dryness, cold, and ventilation, indicated the potential influence of physical environmental factors on musculoskeletal symptoms among female workers with a high prevalence of neck/shoulder and back symptoms (Bjorksten et al., 1996; Chavalitsakulchai & Shahnavaz, 1993; Logie et al., 1998). While few studies have been conducted, the relationship between physical environmental factors and WMSDs has been examined in several studies. Among automobile-repair garage workers, perceived poor physical environment (e.g., noise, lighting, and chemical products) predicted the occurrence of back pain 1 year later (Torp, Riise, & Moen, 2001). In a separate study, both male and female German workers exposed to a poor physical environment (noise, dust, fumes, gases, and poor air quality) showed a higher prevalence of back pain than those not exposed to these factors (Schneider, Schmitt, Zoller, & Schiltenwolf, 2005). Perceived stress from physical environmental factors such as noise, vibration, and heat were important predictors of neck/shoulder and upper/lower-back symptoms among Chinese male offshore workers (Chen, Yu, & Wong, 2005). Exposure to hot working conditions predicted new onset of lower-back pain among newly employed workers, including police officers, forestry workers, and podiatrists, but other physical environmental factors such as cold and humidity, were not found to predict lower-back pain (Harkness, Macfarlane, Nahit, Silman, & McBeth, 2003).

The influence of WBV on WMSDs has been found in earlier studies. In a large population study, low back pain appeared to be more occurring in female workers who had higher personal vibration dose values than the limit of the health guidance caution zone suggested in International Standard Organization guideline (ISO) 2631 (Palmer, Griffin, Syddall,

Pannett, Cooper, & Coggon, 2003). Johanning and colleagues (1991) found that subway operators have been exposed to longer duration of WBV than the fatigue-decreased-proficiency limit in the ISO guideline, suggesting that the high exposure of WBV may contribute to high prevalence of trunk WMSDs, especially of lower-back body region (73%). In addition, when workers worked with WBV and noise, their perceived annoyance and task difficulty were higher than with a single exposure to WBV or noise (Ljungberg, Neely, & Lundstrom, 2004). On the other hand, both these single or combined effects of WBV on WMSDs have not yet been studied with flight attendant population.

Flight attendants are exposed to a variety of unfavorable cabin environments, such as low humidity, temperature discomfort, excessive noise, poor illumination, poor air quality, and vibration (Lindgren, Norback, Andersson, & Dammstrom, 2000; Nagda & Koontz, 2003; Pieren, 1997). Canadian flight attendants who had a high prevalence of WMSDs constantly reported WBV from aircrafts (Logie et al., 1998). Haugli and colleagues (1994) have noted the same link in flight attendants' WMSDs that Johanning and colleagues (1991) have suggested the potential effect of noise and WBV on WMSDs. As addressed by Vieilefond, Fourn, and Auffret (1977), the physical environment in the cabin might explain some of the fatigue that flight attendants experience on long-haul flights. Further, this observation is likely to provide insights into the potential associations between physical environmental factors and WMSDs among female flight attendants.

2. External Environmental Factors.

External environmental factors, that is uncontrollable environmental factors such as turbulence, terrorism threats, air rage, and catastrophic equipment malfunctions, also need to be considered to be potential contributors to the occurrence of WMSDs. The expectation of

these uncontrollable environmental factors might lead to psychological strain resulting in WMSDs.

Turbulence was one commonly reported safety hazard among flight attendants (AFA-CWA, n.d.), and was the top reason listed for back and neck injuries on flight attendants' compensation claims for musculoskeletal injuries (Logie et al., 1998). Flight attendants are also more likely than those in other occupations to be exposed to safety threats, such as the threat of terrorism. This is a new set of workplace safety and security issues that have emerged since the event of the 9/11 terrorist attack. A recent national survey reported the effect of the events of the September 11, 2001, terrorist attack: 44% of the U.S. population had one or more substantial stress symptoms (Schuster et al., 2001), and 11% of residents in the New York city metropolitan area was determined to be experiencing clinically significant distress, that is posttraumatic stress disorders (PTSD) (Schlenger et al., 2002). It is important to note that flight attendants are at higher risk for PTSD after the 9/11 event than the general population. In a study (Lating, Sherman, Lowry, Everly, & Peragine, 2004) conducted 9 months after the attack, more than half of the 2,050 American Airlines flight attendants experienced one or more significant psychological symptom. The percentage of flight attendants who had PTSD was higher (18.2%) than the general population of Schuster's study, and their levels of depression and sleep disturbance were higher than those who did not have PTSD.

In addition, flight attendants reported that dealing with violent or aggressive passengers added to their job stress (MacDonald et al., 2003). Flight attendants are required to create a friendly and kind atmosphere for even such offensive passengers, which may cause them to feel greater pressure (Ballard, 2002). Flight attendants have also concerned about mechanical failure in flights (MacDonald et al., 2003). Air safety and health experts have also pointed out the

potentially catastrophic equipment malfunctions in the aircraft (e.g., smoke, fire, engine or flight control system failure, and rapid decompression) (D. Mokadam, personal communication, November, 15, 2004). The findings suggest the need for further examination of the influence of flight attendants' unique uncontrollable environmental factors on WMSDs.

3. Personal factors

Personal factors usually play a role as risk factors in work-related diseases (WHO, 1993). They can be independent risk factors of WMSDs or confounders with other risk factors. These include age, years of employment, height, weight, body mass index (BMI), sleep quality, and fatigue.

Age was found to be associated with increased trunk WMSDs in female workers, but the findings on the influence of age on WMSDs are conflicting. The probability of neck symptoms decreased with age among women working in various manufacturing jobs in Belgium (Malchaire et al., 2001). The highest number of musculoskeletal injuries appeared to be in the younger group (26-30) of Canadian flight attendants who filed work compensation claims (Logie et al., 1998). A separate study found that the risk of low back pain was higher among younger female workers (18-44 years) than in the older age group (45-75 years) (Macfarlane et al., 1997). Conversely, the occurrence of neck, shoulder, or back problems increased with age (Alcouffe et al., 1999; Cole et al., 2001; Lagerström et al., 1995). On the other hand, in an earlier study, the effects of age on WMSDs were different depending on jobs (De Zwart et al., 1997). In that study, neck WMSDs were positively associated with an older age group (45–54) among workers with mentally/physically demanding jobs (e.g., nurses, truck drivers), whereas they were associated with the youngest age group (16–24) among those with heavy physical demands (e.g., construction workers, agricultural workers). In addition, individuals with long length of

employment had a higher probability of WMSDs. In previous studies, female workers who had a longer length of employment tended to have more back symptoms (Harlow et al., 1999; Macfarlane, 1997), but in the same study by Macfarlane, the risk was less in those had the longest experience (more than 17 years). Recently, Chee and colleagues (2004) found that the results differed according to body regions: there was a positive association between longer employment and back symptoms but a negative association with neck/shoulder symptoms.

Anthropometric factors including height and BMI have been identified in prior studies as potential risk factors for WMSDs (Bernard, 1997). These are also important factors to be considered in the designing equipment, tools, and workstations for preventing WMSDs (Lu, 2003). In female office workers, height was negatively associated with neck/shoulder symptoms and weight was positively associated with lower-back pain (Westgaard, Jensen, & Hansen, 1993). In a study analyzed the data from the Australian National Health Survey (Kortt & Baldry, 2002), BMI significantly increased the occurrence of at least one musculoskeletal symptom. In recent studies of female workers, however, no significant associations were found between trunk WMSDs and height (Ando et al., 2000) or BMI (Alcouffe et al., 1999; Estryn-Behar et al., 1990). However, it is worth noting that more extended reaching by shorter flight attendants and more bending movements by taller flight attendants were observed (Logie et al., 1998), indicating a potential influence of height on increased physical demand while performing some job tasks. Interestingly, treatment and sick-leave for back pain were more frequent among those with at least 20% excess weight (Estryn-Behar et al., 1990). In a 7-year longitudinal study, sleep and fatigue in adolescence predicted the occurrence of neck/shoulder pain in adulthood (Siivola et al., 2004) and poor sleep quality increased the risk of long-term work disability (>8 weeks)

(Natvig, Eriksen, & Bruusgaard, 2002). The link of these factors to the occurrence of WMSDs needs to be further investigated in flight attendants.

In summary, positive associations between workplace factors (physical load induced by job tasks including manual material handling activities and awkward/static work postures and work organizational factors) and trunk WMSDs found in various female occupations suggest that the exposure to these risk factors is likely to increase the risk of trunk WMSDs in female flight attendants. Potential influence of physical and external environmental factors surrounding female flight attendants on their trunk WMSDs are suggested. Personal factors would be important variables to be included in a study of female flight attendants. Studies show that individual influence of these factors on WMSDs, but to date more have examined the relevance of all these factors. For explaining the multifactorial nature of WMSDs in female flight attendants, there is a need for studies that examine not only the individual but also the combined influence of the personal, workplace, and external environmental factors on WMSDs.

III. METHODOLOGY

A. Preliminary work

A series of preliminary steps were undertaken in preparation of this study. These steps included a review of relevant WMSD studies and measures; meetings with the flight attendant union management and air safety and health experts; personal conversations with current flight attendants; and a focus group. The investigator's previous experiences as an airline occupational health nurse and medical attendant, including observation of flight attendants' tasks and the cabin environment, as well as case management of those who had WMSDs, also contributed to the initial phase of survey preparation.

In particular, this study was conducted in collaboration with the AFA-CWA Air Safety, Health and Security Department (ASHSD). Since the first contact with the union in June 23, 2003, specific details about the study were consistently communicated with the union from the stage of proposal development to study completion. Mr. Dinkar Mokadam, an industrial hygienist and OSHA specialist in the ASHSD, served as a liaison between the union ASHSD and the investigator. After a number of e-mail and phone communications with the liaison, the first meeting with a dissertation chair, two dissertation committee members, and two union staff members in ASHSD through teleconference was held on February 13, 2004. At the meeting, the union staff provided overall feedback regarding the proposal draft, including a scope of the survey, study population, and WMSD risk factors to focus on. The union support for recruiting focus group participants was promised at the meeting and a local union committee chair at Chicago was assigned to help coordinate the focus group study. The second meeting was held in the union headquarters in Washington, D.C. on March 16, 2004. The meeting consisted of the investigator, the dissertation chair, and five union staff members: the vice president of the

international AFA-CWA, a representative from the membership department, a director of the ASHSD, a coordinator and flight attendant in ASHSD, and an industrial hygienist and OSHA specialist in ASHSD. Based on the revised research protocol with a survey questionnaire, details about the sample eligibility criteria, a focus group discussion guide, survey items, mailing list, and survey administration were discussed, and the union management provided their final support for conducting this study. A support letter indicating collaboration work with the union ASHSD from the director of ASHSD was given to the investigator. It was followed by a focus group study with flight attendants from target population for the survey.

1. Focus group

a. Aims

The aims of the focus group study were to: (1) expand on a previously developed list of 2 flight attendant job specific task items by identifying specific job tasks associated with a list of 11 general work activity items (e.g., manual handling and postures); and (2) assess the clarity, appropriateness, and applicability of self-reported measures for other WMSD risk factors (work organization, physical environment, and external environment) and symptoms to be used in the survey.

b. Methods

Subjects. One focus group was conducted with six female flight attendants who have had at least one long haul international flight in prior 3 months and worked at least 75 hours in prior month. Prior to starting recruitment, the investigator met with the union headquarters' Health and Safety Department staff for their support, and also communicated with two key informants who were committee members of the local union at Chicago to help identify participants. Flight attendants were recruited by e-mail notices to the local union membership

(about 2,800), by solicitation through word of mouth by the key informants, and by flyers posted on the bulletin board in the local union office. During a two-week recruitment period, 22 women responded—10 by phone and 12 by e-mail—expressing interest in participating in the study. Of the 22 women, 16 were contacted by phone, given further explanation of the study, and screened for eligibility; the others could not be reached during the recruitment period. Two of the women screened were not eligible because their work hours totaled less than 75 hours in the prior month. Six of the eligible women were not able to confirm their availability, leaving eight women who were scheduled for the focus group on July 7, 2004. Finally, six women participated in the focus group, with one last-minute cancellation and one no-show.

Measures. The investigator drafted a survey questionnaire including an initial set of work activity items and parts of five self-reported WMSD risk factor measures (work organization, physical environment, external environment, personal factors, and WMSDs). A list of 11 work activity items and 2 specific job task items were drafted based on a literature review including two job analyses of flight attendants (Logie et al., 1998; United Airlines, 2001). The work activity items included: 2 manual handling activities (lifting/carrying and pushing/pulling) with specific examples by weight levels (lifting/carrying <= 10 lbs [a liquor miniature tray=9 lbs, a pot of coffee full-loaded= 4 lbs]); and 9 work postures (standing, sitting, bending, twisting, kneeling, squatting, stooping, reaching, and neck postures [flexion, extension, and rotation]), with the definition of each within the questions stem (e.g., kneeling [bending legs at the knees to come to rest on knee or knees]). The list also included two specific job task items performed by flight attendants (lifting/carrying passengers' baggage to stow in overhead compartments and pushing/ pulling service carts).

Work organization measure includes four subscales (psychological job demand, decision latitude, social support, and job insecurity) of the Job Content Questionnaire (Karasek, 1985). The Motion Survey Questionnaire designed by Communications Workers of America (2003, unpublished data) was modified to address the physical environment of the cabin. The Behavioral Risk Factor Surveillance System terrorism module (Centers for Disease Control and Prevention, 2002) was modified to reflect external environment relative to flight attendants.

Procedure. A trained and experienced moderator led a two-hour discussion, and a research assistant took notes on posters displayed on the walls so that participants could review what they were discussing. The investigator took field notes, operated two tape recorders, and monitored environmental conditions. Before the focus-group discussion, the flight attendants signed consent forms agreeing to participate in the meeting and to be tape-recorded. According to the focus-group discussion guide, which was developed based on the process presented by Krueger (1994): introduction including a welcome and ground rules; topic questions and probes; and summary and conclusions. The participants were asked to discuss physically strenuous job tasks that they performed during a long-haul international flight from the time they entered the cabin until they left. The time periods discussed was segmented into pre-passenger boarding, passenger boarding, in flight, and after landing. After the main discussion, self-reported WMSD risk factor and symptom measures were distributed to the participants and they were asked to review them and to discuss the appropriateness and applicability of the measures for use with female flight attendants. At the end of the focus-group session, the participants were asked to fill out the brief background questionnaire.

Analysis. A transcript-based analysis was conducted. The tapes were fully transcribed by a transcriber, which took about five hours for one hour of discussion. Based on transcripts, job

tasks were listed from the time the flight attendants entered the cabin until they left. Information written on the posters and the observer's field notes were also used to supplement the transcripts. Five physically strenuous job task categories and one other category were identified by the investigator and a research assistant, and then each individually sorted the job task into the categories on the basis of similarity. Then the two lists were compared until there was agreement between the investigator and the research assistant. The job tasks were reviewed to see if they captured the 11 general work activity items.

c. Results

The participants felt that work in the following five categories was physically strenuous: handling carry-on baggage, handling carts (beverage, meal, and duty free), galley work, service (beverage, meal, and duty free), and safety checks. In addition, two items, "sleeping in passenger seats in economy section" or "awkward postures when sleeping in cramped bunk beds", which previously came up at the meeting with the union staff prior to the focus group, were confirmed by the participants and were sorted to the "other" category. Within these five categories and the "other" category, a list of 41 physically strenuous job task items (Table I) was generated and it was reviewed and agreed upon by an air safety and health professional in AFA-CWA and two current flight attendants with international flights.

In addition, the focus group participants were asked what made it difficult to respond to the self-reported measures for WMSD risk factors (work organization, physical environment, and external environment) and symptoms. The participants explained problems (vague words, inappropriate response categories, etc.) they had in answering some of the self-reported measures, and made suggestions for modifying or adding questions providing examples to be added to the measures. The participants suggested changing the wordings of the social support

TABLE I

FORTY-ONE PHYSICALLY STRENUOUS JOB TASKS

Carry-on baggage handling
1. Carrying passengers' bags
2. Carrying crew bags while walking up and down stairs
3. Lifting and reaching to stow passengers' bags in overhead bins
4. Lifting and reaching to stow crew bags in overhead bins
5. Reaching, pulling, and pushing bags to reposition in overhead bins
6. Reaching and pushing to close overhead bins
Cart handling
7. Pulling and pushing beverage carts with hands while walking on an incline
8. Pulling and pushing meal carts with hands while walking on an incline
9. Pulling and pushing duty free carts with hands while on an incline
10. Pushing against the cart with knees and hips
11. Pushing and pulling to steer the cart away from passengers
12. Pushing and pulling carts to reposition in the galley
13. Pushing and pulling carts to move to/from upstairs by an elevator
Galley work
14. Lifting bins out of carts over your head into galley
15. Reaching to reposition galley bins in higher levels
16. Reaching, bending, and squatting to reposition galley bins in lower levels
17. Reaching to latch galley bins in higher levels
18. Reaching, bending, and squatting to latch galley bins in lower levels
19. Reaching, bending, and squatting to take the lids off food in carts
20. Reaching for the supplies in higher galley bins
21. Reaching, bending, and squatting for supplies in lower galley bins
22. Lifting food load in the ovens to cook and pulling it out of the ovens
Service (beverage, meal, & duty-free)
23. Hand carrying the coffee pot
24. Rotating wrist to pour coffee and beverages
25. Reaching to serve passengers
26. Pinching tongs to hold service items
27. Reaching and bending to serve the passengers at the window seat
28. Reaching for items while kneeling
29. Squatting to take meal trays in/out of carts
30. Lifting and carrying heavy duty-free sale items
31. Squatting and pulling bottom bins with heavy items
Safety check
32. Reaching, bending, and squatting to read pressure gauges
33. Pushing aisle seats into upright positions
34. Reaching and pushing window and center seats into upright positions
35. Pushing with feet to restore footrests to proper positions
Other
36. Arming/ disarming door
37. Standing for a long time
38. Walking for a long time
39. Lifting or physically assisting disabled or elderly passengers
40. Sleeping in passenger seat in economy section
41. Awkward postures when sleeping in cramped bunk beds

measure from supervisor" to "purser" or "lead" because they rely on each other rather than being supervised. In response to one of the job security items, "How steady is your work?" participants reported that their jobs had been under seasonal and frequent layoffs and also suggested adding "furloughs-off" to response categories. In another job-security item, "How likely is it that during the next couple of years you will lose your present job with your employer?" the participants thought that they might lose their jobs because of their own abilities in addition to company situation. Response options of the job task measures (frequency, strenuousness, and symptom intensity) were all acceptable to the flight attendants except one response category of the frequency measure. Among four response categories ("not done", "occasionally", "frequently", and "constantly"), the participants suggested changing the highest response category from "constantly" to " almost always". For the question wording about the frequency of job tasks, "On average, how often did you do each of following tasks per shift?" the participants suggested using the terminology of "segment" or "leg" instead of "shift".

d. Conclusions

The job tasks within each of six physically strenuous job categories reflected the 11 general work activities. The focus group discussion provided contextual understanding for job tasks and made the work activities task-specific (e.g., squatting and pulling bottom bins with heavy items, carrying crew bags while walking up and down stairs). Also, the self-reported measures were modified for use with flight attendants in terms of content, wording, and phrasing.

B. Design

This study was conducted using a cross-sectional, mailed-survey design to examine the relationships between risk factors and the occurrence of trunk WMSDs in female flight attendants who flew long-haul international flights.

C. Subjects and Setting

To be included in the study, flight attendants had to meet the following criteria: (a) be female; (b) flew at least one long-haul international flight (flights that include meal services and duty- free sales) in the prior 3 months; (c) worked at least a 75-hour schedule in the prior month; and (d) were based in the U.S. On average, flight attendants fly 75 hours a month (USDOL, 2005) and a duration of 6 hours or more per segment is generally considered a long-haul flight among flight attendants (Lapostolle et al., 2001; Whitaker, Soong, Terzis, & Yeh, 2005). The influence of long-haul international flights on flight attendants' physical and psychological health including musculoskeletal symptoms has been found to be more significant than domestic flights (Criglington, 1998; Haugli et al., 1994; Ono et al., 1991).

The AFA-CWA is the largest flight attendant union representing over 46,000 flight attendants from the 26 airlines in the U.S. The union serves as a voice for flight attendants at their workplace, in the industry, in the media and on Capitol Hill for maintaining and improving wages, benefits, working conditions and work rules at their airlines, and their safety on the job (AFA-CWA, 2004b). Of the six airlines with long-haul international flights that are represented by the AFA-CWA, United Airlines has the largest number of long-haul international flights serving multiple destinations in Europe, Asia, and Australia. The other five airlines have only a small number of long-haul international flights with a limited number of destinations or irregular flights such as military charters. In addition, United Airline is the only member of the union with

information on which flight attendants work on international flights. Other major airlines with a large number of international flights (American, Continental, Delta, and Northwest) were not members of the AFA-CWA at the time of the study. The United Airlines is one of U.S. major airlines with flights to over 800 destinations in the world and operating revenues of more than $ 1 billion (Department of Transportation, 2004). The airline had approximately 13,500 flight attendants with AFA-CWA membership at the time of the study, which is about 10 % of the total flight attendant population in the U.S. The majority (85%) of the flight attendants were female and resided in 12 domestic and 5 international bases. International flight attendants, who resided in five international base cities (London, Frankfurt, Paris, Hong Kong, and Narita), however, were excluded from the study because of the prohibitive cost, time requirements of international mailings, and low contact rates due to incorrect address information. Of the 12 domestic bases 8 have international flights (Chicago, Los Angeles, San Francisco, Washington, D.C., Denver, New York City, Seattle, and Honolulu). Therefore, the flight attendants were selected from the AFA-CWA membership list of one airline located at 8 domestic bases with international flights.

1. Sample Size

PASS, which is a power analysis and sample size software (NCSS Statistical Software, 2003), was used to calculate sample size for the logistic regression. Three components (baseline probability for the outcome in non-exposure group [X=0], % of total N with X=1, and odds ratios [ORs]) used in the PASS program were estimated from the findings in previous studies that examined similar risk factors to this study: psychological distress (OR=2.7) (Estryn-Behar et al., 1990); and standing/walking > 2hrs (OR=2.9) and lifting/moving > 25 lb (OR=2.8) (Macfarlane et al., 1997). A logistic regression to achieve 80% power at a 0.05 significance

level to detect odds ratio of 2.8 needs a sample size of 201 (of which 65% are in the group X=0 and 35% are in the group X=1).

Working sample size was calculated using four components: eligible rate, contact rate, response rate, and desired number of completed cases (n=201). A contact rate of 0.8 was estimated based on 20% of annual residence change of U.S. population (Putnam, 1996). An eligibility rate was calculated based on two eligibility criteria: work schedules with at least one long-haul flight in the prior 3 months and a 75 hours or greater flight time in the prior month. Based on average flight hours (75-85 hours a month) of U.S. flight attendant population (USDOL, 2005) and the discussion with the union staff, it was assumed that most flight attendants who are in the sampling frame (flight attendants who scheduled for any international flights in a given month) would have 75 or greater flight hours including at least one long-haul flight. Thus, the proportion of flight attendants who met these criteria was approximated at 90% each and an eligibility rate of 0.8 was calculated by multiplying these two estimates. A response rate of 0.75 was estimated assuming that the response to the first mailing is 50% conservatively and an additional 25% after the second and third questionnaire mailings, overall, it was estimated that the working sample size for the first mailing should be 420:

$$\mathbf{n} = \frac{\text{Desired Number of Completed Cases (n=201)}}{\text{Contact Rate (0.8) x Eligible Rate (0.9. x 0.9) x Response Rate (0.75)}} = 420$$

2. Sampling

A systematic random sampling method was used, in which each sample unit was chosen from the population list at a regular interval. The sampling method approximates random sampling sufficiently and has been in widespread use for surveys because of its simplicity and efficiency (LoBiondo-Wood & Haber, 1998).

The sampling frame, which is the list from which a sample is to be drawn, was created from the union membership, which was alphabetized by last name. However, the membership list did not pertain the information on the eligibility criteria at the phase of constructing the sampling frame. Through the discussion with the union staff, it was decided to ask the union scheduling committee at 8 base cities to generate a list of flight attendants' names scheduled for any international flights in October, 2004. Although it was possible to include those who were not in the study population (e.g., those on short-haul international flights or part-time attendants), this was the most accessible data about the target population. After excluding male flight attendants (about 15%), a total of 2,754 female flight attendants remained in the sampling frame. The systematic selection interval was calculated by dividing the target population (n=2,754) by the size of the desired working sample (n=420). Using the sampling interval of 6, which was rounded down, a total of 459 cases were selected from the sampling frame. To obtain the final sample size of 420, extra cases (n=39) were eliminated using the same procedure. Although the sample was drawn from the list of flight attendants with international flights for only one month, it would represent flight attendants working on international flights because of their stable work schedules. More favorable working condition on international flight schedules (e.g., oversea travels, higher pay than domestic flights), would lead them to continually choose international flights.

D. Data Collection Procedure

The research protocol was approved by the Institutional Review Board at the University of Illinois at Chicago. The mailing protocol was designed with modifications as outlined by Dillman (2000). The protocol delineated survey implementation procedures to maximize response rates including multiple contacts, the contents of the letters, number of mailing times

and the interval between mailings. The protocol called for a total of four mailings sent by first-class (Figure 2). To examine test-retest reliability, reliability questionnaires were sent to the first 30 women who returned their questionnaires and agreed to participate. Each mailing was color coded.

All mailings prepared by the investigator had an ID on the questionnaire and on the envelope to be mailed to the subject. These were sent to the AFL-CWA union membership department in Washington D.C. via U.S. Postal Service. The union staff had a list of all subject names and addresses with a corresponding ID number. A union staff member affixed a flight attendant mailing label on the outer envelope checking carefully to see that the subject ID corresponded to the one on the envelope and questionnaire. This was mailed to subjects with a sender's address label for the union office so that any survey packets delivered to wrong addresses were expected to return to the union office. On the participants' enclosed return envelopes, the investigator's address was stamped as both sender and recipient. On the cover letter, potential participants were informed that they should return the completed survey questionnaires directly to the investigator. Thus, the data were protected from the union. They were also asked that they should not write their names on the questionnaires so that the investigator was not able to identify subject ID and corresponding name. Once the questionnaires were returned to the investigator, the IDs were reported to the union in order to exclude them from the follow-up mailing list. Also, the ID numbers printed on the questionnaire were removed from the questionnaires and then new data-entry numbers were given to the questionnaires. The test-retest participants were assigned the same ID numbers on both questionnaires.

1. **First mailing**

The first mailing included a cover letter, a letter of support from the union president, an eligibility screening questionnaire (Appendix A), a survey questionnaire with a request to participate in the test-retest reliability questionnaire (Appendix B), and a pre-paid return addressed envelope. The cover letters informed potential participants that participation in the survey was voluntary and confidential. In addition, they were told the purpose of the study, benefits, and that it would take approximately 30 minutes to complete. Completing and returning the questionnaires implied consent to participate in the study. The letter of support from the union president stated the importance of the study and encouraged potential participants to participate in the study. The president also addressed that individuals' responses would help develop a thorough, scientific understanding of how the flight attendants' work environment influences WMSDs and might suggest specific recommendations for changes to equipment and safety policies that might reduce ergonomic hazards and facilitate effective surveillance and intervention programs.

The screening questionnaire was attached to the front of the survey. It consisted of three questions confirming the study inclusion criteria: (1) be female; (2) flew at least one long haul international flight in the prior 3 months; and (3) worked at least 75 flight hours in the prior month. Those who answered "no" to each question were asked to skip to the next question and to follow a directional arrow toward the instruction box at the bottom of the questionnaire. It noted appreciation for agreeing to participate and asked them to return the blank questionnaires to the investigator. Flight attendants who were eligible were instructed to continue to the next page.

At the end of the questionnaire, it was briefly described why a test-retest reliability survey was needed. Subjects were asked if they were willing to answer a short-version questionnaire, excluding some of items they answered before, one more time. The first mailing was done to 420 randomly selected flight attendants (Figure 2). Of the 420 subjects, 171 returned questionnaires. A total of 116 were eligible, 50 were not eligible, and 5 refused.

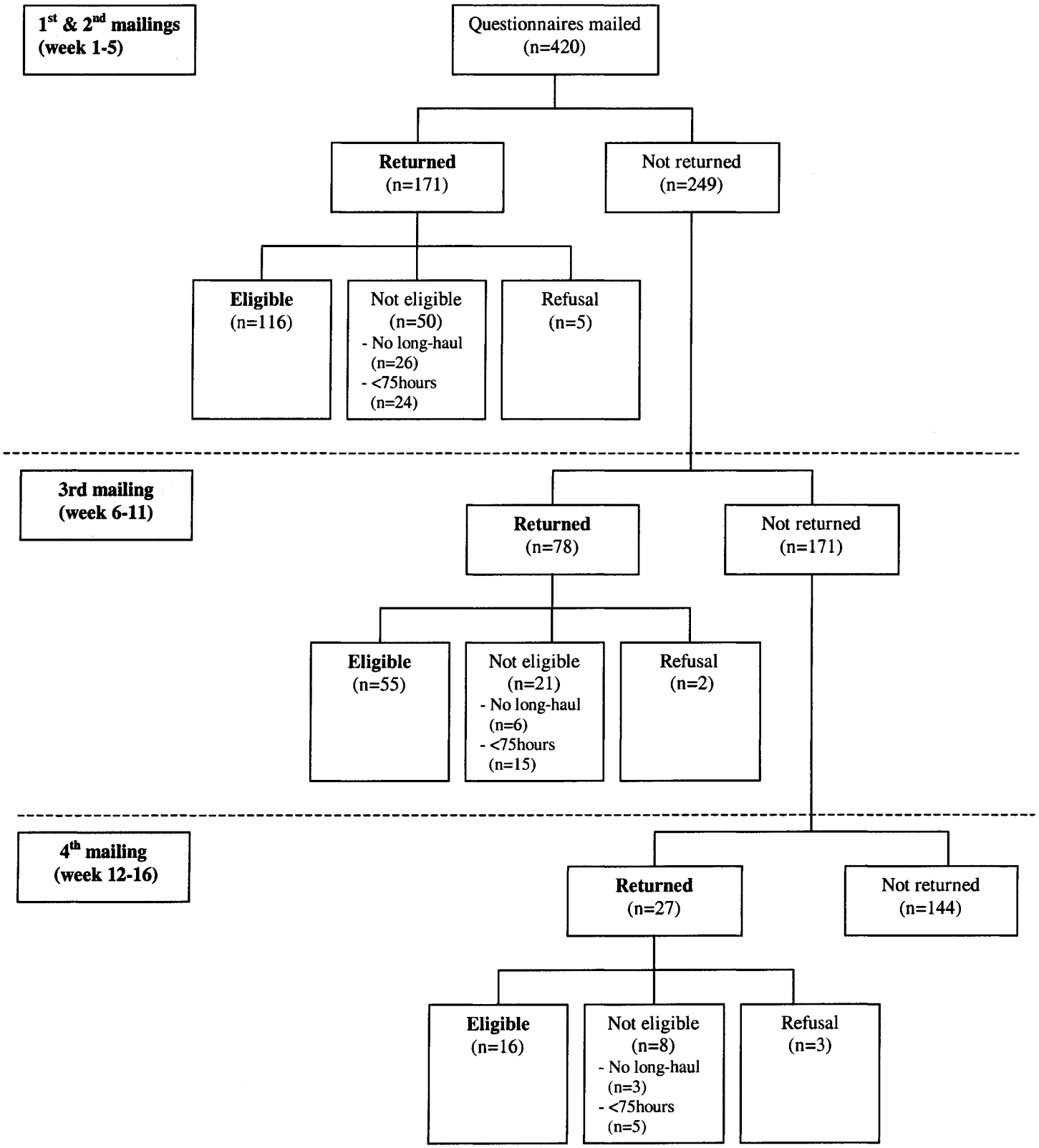
2. Second mailing

Two weeks after the first mailing, a follow-up postcard was sent to all subjects. The postcard stated that a questionnaire was mailed to the subject two weeks ago and emphasized the importance of each subject's response to the success of the study. It contained an expression of appreciation to those who had already returned the questionnaires and a courteous reminder for those who had not.

3. Third and fourth mailings

Two follow-up mailings were done 5 weeks and 11 weeks after the first mailing. The survey packet in both included a cover letter, a letter of support from the union president, a screening questionnaire, a survey questionnaire, and a pre-paid return addressed envelope. Each of the third and fourth mailings was planned for 4 weeks (at week 5) and 8 weeks (at week 9) after the first mailing, but due to staffing issues it was delayed 1 to 3 weeks from the expected week of mailing. The follow-up cover letters for the third and fourth contacts stated that the subject's completed questionnaire had not been returned and reemphasized each respondent's importance once more but with slightly different wording from the first mailing. The third and fourth cover letters were each printed on a different attractive colored paper to draw attention to them. Of the 249 flight attendants who received the third mailing, a total of 78 flight attendants returned the questionnaires (55 were eligible, 21 were not eligible, and 2 refused) (Figure 2).

Figure 2. Four Stage Recruitment Mailings



After the fourth mailing to 171 non-respondents, additional 27 returned questionnaires (16 were eligible, 8 were not eligible, and 3 refused).

In summary, of the 420 questionnaires distributed, 276 were returned, yielding an overall return rate of 66%. A total of 10 refused, 79 were ineligible, and 187 were eligible. There were no undelivered questionnaires returned to the union office because of a change of residency suggesting that all questionnaires reached their destination. Of the 187 eligible questionnaires, two were excluded due to missing the last 2 pages including demographic and musculoskeletal symptom questions. A total of 185 completed questionnaires, the 152 that had less than 30% item non responses out of 195 items, remained in the final analyses.

A response rate was estimated in two ways. First, assuming all non-respondents were eligible for the study, a response rate was conservatively estimated at 54% by dividing the number of completed questionnaires (n=185) by the number of eligible sample members (n=187+154=341). Second, assuming the same eligibility rate of 70% (187/266) among the non-respondents (n=154), the response rate was estimated at 63% (185/[187+108]).

The 185 respondents and 156 non-respondents (flight attendants who did not complete questionnaires [n=154] or returned incomplete questionnaires [n=2]) were compared in terms of personal characteristics. The personal factors that were available from the AFA-CWA membership list were age, years of employment, and base city. The respondents and non-respondents had comparable age (54.4 vs. 54.2 years, t=.19, df=339, p=0.85), years of employment (30.2 vs. 30.0 years, t=.27, df=339, p=0.79), and base city (χ^2=8.8, df=7, p=0.27) distribution. In addition, the flight attendants with 1% or fewer item non-responses (n=54) and those who had item non-responses greater than 1% (n=131) were compared in terms of age (53.8 vs. 54.2 years, t=-.22, df=183, p=0.83), years of employment (31.2 vs. 30.4 years, t=.59, df=183,

p=0.56), and WMSDs (χ^2=0.51-3.05, df=1, p=0.08-0.48). These indicate the absence of serious non-respondent bias. On the other hand, it was not valid to compare available personal characteristics of the 185 respondents with the entire sampling frame because the sampling frame included persons who were not eligible for this study.

4. Test-retest reliability questionnaire mailing

Two weeks after receiving a completed initial questionnaire, a test-retest reliability questionnaire with a cover letter and a prepaid, addressed envelope was mailed to the flight attendants who agreed to participate in the reliability test. The reliability questionnaire consisted of three measures (physical load, physical environment, and external environment) that did not have prior reliability testing by others. A reminder/thank-you postcard was mailed one week later.

A total of 121 eligible participants responded to the request of participation in the test-retest reliability survey. Of these, 101(83%) agreed to participate in the test-retest study. Of the 101, the reliability questionnaire was mailed to the first 30 respondents 1 or 2 weeks after receiving the initial questionnaires. Of the 30, 23(77%) returned their completed questionnaires between 2 and 7 weeks after the reliability questionnaire mailing.

E. Measures

Conceptual framework components, variables, and measures are summarized in Table II. A survey questionnaire titled "Flight Attendant Work-related Musculoskeletal Symptom Survey" consisted of 6 parts: physical load, work organization, physical environment, external environment, personal factors, and WMSD symptoms (Appendix B).

The test-retest reliabilities for selected measures (physical load, physical environment, and external environment) were estimated as the bivariate correlation coefficient between the

TABLE II

CONCEPTUAL FRAMEWORK COMPONENTS, VARIABLES, AND MEASURES

Conceptual framework components	Variables		Measures
Workplace factors	Physical load	Frequency of job task	Physical Demand (USDOL, 1991)
		Strenuousness of job task	Strenuousness scale (Conrad et al., 2000)
		Intensity of symptom	Pain Intensity Number Scale (Wilkie et al., 1990)
		Overall physical load	Sum of frequency, strenuousness, and intensity of symptoms
	Work organization	<u>Psychosocial factors</u> Psychological job demands Decision latitude Social support Job insecurity	Job Content Questionnaire (Karasek et al., 1985)
		<u>Scheduling factors</u> Flight hours/month Flight hours/segment Service section Job responsibilities Types of aircrafts	Flight attendant studies (Logie et al., 1998; Morley-Kirk & Griffiths, 2003)
	Physical environment	Cabin environmental factors	Motion Survey (CWA, 2003)
External environmental factors	External environmental factors (Turbulence, terrorism, air rage, catastrophic equipment malfunctions)		
Personal factors	Age, years of employment, work pattern, height, weight, BMI, sleep, fatigue, uniform comfort, heels of shoes, and base city		
WMSDs	Symptom presence		NMQ (Kuorinka et al., 1987)
	Frequency, duration, intensity, and onset		NIOSH Symptom Survey (Bernard et al., 1994)
	WMSD cases		NIOSH Symptom Survey (Bernard et al., 1994)

total scores of each measure for the first and second administrations of the test-retest reliability questionnaire. In addition, Cronbach's Coefficient Alpha was computed using SPSS reliability analysis to assess the internal consistency of the measures.

1. **Workplace Factors**

   a. **Physical load**

The physical load measure contained the 41 job task items that were performed by female flight attendant on long-haul international flights. The measure consisted of three dimensions: the frequency of job task, the degree to which the job task is considered strenuous, and intensity of symptoms (pain/ache/discomfort) perceived while performing the job task.

The *frequency* of each job task was asked using a question phrased as, "On average, how often did you perform this job task per segment in the past 30 days?" and rated on a 4-point scale (1=not done, 2=occasionally, 3= frequently, and 4= almost always). These response categories were derived from the U.S. DOL physical demand analysis document (USDOL, 1991) and the original descriptors of the lowest and highest response categories ("not present" and "never", respectively) were modified through the focus group. The total score of frequency, which is the mean across all 41job task items, was calculated by dividing the sum of each score by the number of items completed.

The *strenuousness* of each job task was measured using a question phrased as "On average, how physically strenuous is this job task for you?" It was rated on a 4-point scale (1= not strenuous, 2= somewhat strenuous, 3= strenuous, and 4= very strenuous). The scale was developed by Conrad and colleagues (Conrad et al., 2000). A Cronbach's alpha for the measure was 0.94 and the Rasch person reliability was 0.93 (Conrad, Conrad, & Reichelt, 2002). The

individual responses of all 41 job task items were summed and divided by the number of items completed to score the total score of strenuousness.

The *intensity* of symptoms (pain/ache/discomfort) was measured using a question phrased as "How much ache, pain, or discomfort did you experience while performing this job task?" It was measured by the Pain Intensity Number Scale (PINS), which ranged from 0 being "no pain/ache/ discomfort" to 10 being "pain/ache/discomfort as bad as it could be." Concurrent validity was supported with correlation coefficients of 0.77-0.89 between the PINS and Visual Analogue Scale (Wilkie, Lovejoy, Dodd, & Tesler, 1990). The total score of intensity of symptoms was calculated by dividing the sum of each score by the number of items completed.

Finally, *overall physical load* was measured to estimate the degree of overall physical load to which individuals were exposed while performing the job tasks. The scores of intensity of symptoms were adjusted to 4-point scale using the formula: (3 x original score + 10)/10. For example, the response of "0" was converted to "1" and "10" was to "4". Each of total scores of frequency, strenuousness, and intensity of symptoms were summed. Possible scores ranged from 3 to 12. A high score reflected that the respondent was exposed to high physical load.

The content validity of the physical load measure was established by expert opinions and a focus group with members of target population (see preliminary work). The three dimensions had good internal consistency with a Cronbach's alpha of 0.91 for frequency; 0.96 for strenuousness; and 0.98 for intensity of symptoms. Nunnally and Bernstein (1994) noted that the coefficient alpha of 0.7 or above is considered to be an indicator of acceptable reliability. Good test-retest reliabilities of the measures were achieved with a coefficient value of 0.87 for frequency, 0.90 for strenuousness, and 0.67 for intensity of symptoms.

b. Work organization

Four work organizational factors (psychological job demands, decision latitude, social support, and job insecurity) were measured by subscales of the Job Content Questionnaire (JCQ) developed by Karasek and colleagues (1985). This is the most widely used instrument to measure work organizational factors in the world (Shen, Cheng, Tsai, Lee, & Guo, 2005). Additional work organizational factors regarding scheduling were assessed with items derived from two flight attendant studies (Logie et al., 1998; Morley-Kirk & Griffiths, 2003).

Psychological job demands was measured with five items (work fast, work hard, no excessive work, enough time, and no conflicting demands). All items were scored on a four-point scale ranging from 1(strongly disagree) to 4 (strongly agree) and were finally scored by the weighted formula constructed by Karasek and colleagues (1985): [(Q42 + Q43) x 3] + [15-(Q44 + Q45 + Q46)] x 2. Possible total scores ranged from 12 to 48 and higher scores indicated greater psychological demands. Internal consistency reliability was acceptable with a Cronbach's alpha of 0.78 in the study of musculoskeletal symptoms among Swedish postal workers (Wahlstedt, Bjorksten, & Edling, 2001); 0.74 in the Work Site Blood Study among a wide variety of white- and blue-collar workers in New York city (Landsbergis, Schnall, Pickering, & Schwartz, 2002); 0.71 in the study of low back pain among aluminum plant workers in Norway (Morken et al., 2003); and 0.63 in the U.S. Quality of Employment Survey (U.S.QES), including full occupational groups from manager to line workers (Karasek, Brisson, & Kawakami, 1998). Test-retest reliability with a three-year interval was acceptable with a correlation alpha of 0.64 (Landsbergis et al., 2002). In this study, the Cronbach's coefficient was 0.66.

Decision latitude was measured by two subscales: (a) skill discretion measured by six items (learn new things, repetitive work, requires creativity, high skill levels, variety, and

develop own abilities); (b) decision authority measured by three items (allows own decisions, little decision freedom, and has a lot of say). All items were rated on a four-point scale ranging from 1(strongly disagree) to 4 (strongly agree) and scored by the weighted formula constructed by Karasek and colleagues (1985): {[Q47 + Q49 + Q50 + Q51 + Q52 + (5-Q48)] x 2} + {[Q53 + Q55 + (5-Q54)] x 4}. Possible total scores ranged from 24 to 96. Higher scores indicated that the respondent was more likely to have control over the performance of her own job. Good internal consistency reliability was established with a Cronbach's alpha of 0.83 in the U.S. QES (Karasek et al., 1998). In recent studies, good internal consistency reliability was demonstrated by a Cronbach's alpha of 0.83 (Landsbergis et al., 2002); 0.74 (Morken et al., 2003); and 0.70 in the study of flight attendants' job stress (MacDonald et al., 2003). Three-year test-retest reliability was established with a correlation alpha of 0.64 (Landsbergis et al., 2002). In this study, the Cronbach's coefficient was 0.64.

Social support was measured by two subscales: (a) co-worker support measured by four items (competent co-workers, co-workers' interest in me, friendly co-workers, and helpful co-workers); (b) supervisor support measured by four items (concerned about the welfare of those under her, pays attention to what I am saying, helpful in getting the job done, and successful in getting people to work together). All items were rated on a four-point scale ranging from 1 (strongly disagree) to 4 (strongly agree) and were summed across all eight items. Possible total scores ranged from 8 to 32. Higher scores indicated greater instrumental and socio-emotional support from co-workers and supervisors. Good internal consistency reliability was established with a Cronbach's alpha of 0.81 for co-worker support and 0.83 for supervisor support in the U.S.QES (Karasek et al., 1998). Two studies reported good internal consistency reliability with Cronbach alphas ranging from 0.70 to 0.87 (Landsbergis et al., 2002; Morken et al., 2003). In

this study, internal consistency reliability was acceptable with a Cronbach's alpha of 0.86.

Job insecurity was assessed with six items: steady work, job security, future layoff, prospects for career development, valuable job skill, and past job loss faced. They were measured on a four-point scale ranging from 1 (regular and steady, strongly disagree, or not at all likely) to 4 (both seasonal and frequent layoffs, strongly agree, or very likely) or a five-point Likert scale ranging from 1 (never) to 5 (actually layoff or furloughed). All items were finally scored by the weighted formula constructed by Karasek and colleagues (1985): Q67-64+Q68+ Q69-Q65-Q66). Possible total scores ranged from –9 to 10. Higher scores indicated that the respondent perceived the job less secure. Internal consistency reliability for the job insecurity was evaluated and a Cronbach alpha was 0.47 in the U.S.QES, and 0.76 in the U.S. New England Medical Center (U.S.NEMC) sample (Karasek et al., 1998). Cronbach's alpha for the job insecurity measure was 0.63 in this study.

In addition, work organizational factors regarding work schedules were measured by six items including number of work hours per month, number of sectors per week, number of hours per sector, service section, responsibilities on duty, and types of aircraft. These items were derived from the Canadian flight attendant study (Logie et al., 1998) and cabin crew work stress research (Morley-Kirk & Griffiths, 2003).

c. Physical environment

The physical environment measure includes 12 items measuring cabin environmental factors: too little air movement, cold temperature, hot temperature, uncomfortable humidity, stuffy air, unpleasant order in air, excessive noise, lighting too dark, whole body vibration, potentially toxic chemicals (e.g., pesticide, smoke, oil mist), insufficient oxygen due to low cabin pressure, and rapid variations in cabin pressure. The items were constructed based on

a literature review that addressed cabin environments (Nagda & Koontz, 2003; Pieren, 1997) and a motion survey questionnaire designed by the Communications Workers of America (2003, unpublished data). The subjects were asked about how often they were exposed to each of 12 physical environmental conditions while working in the cabin. All items were rated using a four-point scale ranging from 1 (never) to 4 (always). The individuals' overall physical environment score was calculated by dividing the sum of each score by the number of items completed. Possible total scores ranged from 1 to 4 and higher scores reflected greater exposures to physical environmental factors. Good internal consistency (Cronbach's alpha=0.85) and test-retest reliability (Pearson's coefficient=0.84) were established in this study.

2. External environment

The external environment scale contains four items, which were designed by the investigator based on the Behavioral Risk Factor Surveillance System (BRFSS) terrorism module (Centers for Disease Control and Prevention, 2002) and discussion with key informants including current flight attendants and air safety staff in the AFA-CWA. Four questions regarding how concerned flight attendants were about turbulence, the threat of terrorism attacks, air rage or assault by passengers, and catastrophic equipment malfunctions (e.g., fire, engine control system failure) were asked using a four-point scale ranging from 1(never) to 4 (very much). The individuals' overall physical environment score was calculated by dividing the sum of each score by the number of items completed. Possible total scores ranged from 1 to 4 and higher scores indicated greater concern about external environmental factors. Good internal consistency (Cronbach's alpha = 0.82) and test-retest reliability (Pearson's r =0.87) were achieved in this study.

3. Personal factors

Personal factors include age, years of employment, work pattern, weight, height, BMI, sleep quality, fatigue, uniform comfort, heights of heels of shoes, and base city. Age, years of employment, weight, height, and height of heels of shoes were measured at the ratio level of measurement. BMI was calculated by dividing weight by height squared (kg/m^2) and classified to underweight (<18.5), normal weight (18.5-24.9), overweight (25-29.9), and obesity (30 or greater) (National Heart, Lung, and Blood Institute, 1998).

Work patterns since the subjects first became a flight attendant (stable working, double-track, interrupted, and unstable) were measured by one question developed by Nolan (1985). Sleep quality and fatigue were measured using a 10-point scale that was adapted from the Fibromyalgia Survey: the sleep quality scale ranging from 1, " poorest sleep quality" to 10, "best sleep quality"; and the fatigue scale ranging from 1, "minimal fatigue" to 10, "most severe fatigue." The 10-point scale was also used to rate how flight attendants perceive the comfort of their uniform using different descriptors (1, "being least comfortable or most restrictive" and 10, "being most comfortable"). Lastly, the airport code of home base was asked by an open-ended question.

4. Work-related musculoskeletal symptoms and WMSD cases

WMSDs were measured by combining the Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka et al., 1987) and NIOSH Symptom Survey (Bernard, Sauter, Fine, Petersen, & Hales, 1994). The presence of musculoskeletal symptoms was determined by a single question derived from the NMQ. It was phrased as: "Have you at any time during the last 12 months had trouble (ache, pain, or discomfort) that you consider to be related to work in following body regions?" The question included four body regions (neck, shoulders, upper and

lower-back) as shown in a body picture. The wording "to be related to work" was added to the original question of the NMQ to restrict the symptoms to work-relatedness. This item has response categories of "yes" and "no" and a directional arrow was placed by the "yes" category, indicating to continue next questions of further symptom dimensions (frequency, duration, and intensity). Good test-retest reliability of the NMQ was established in prior studies: 85-100% agreement with a 2-3 week interval (Kuorinka et al., 1985); kappa values of 0.73-0.82 with a one week interval (Palmer, Smith, Kellingray, & Cooper, 1999); and kappa values of 0.48-0.82 with a two to five week interval (Rosecrance et al., 2002). Good validity was demonstrated between the NMQ and physical examination for diagnosis: 80-100% agreement (Kuorinka et al., 1985); and the sensitivity of 66-100% and the specificity of 33- 84% (Ohlsson et al., 1994; Palmer et al., 1999).

In the case of symptom presence, frequency, duration, and intensity of the symptoms were asked for WMSD case definition. The questions and criteria used in the NIOSH studies (Bernard et al., 1994) were used. The frequency of the symptoms during the past year was measured using a 5-point scale ranging from "almost never" to "almost always (daily)". The duration of the symptoms was measured using a 7-point scale ranging from usually lasts "less than 1 hr" to "more than 2 months". The intensity of the symptoms on average was measured using a 5-point scale ranging from "none" to "worst ever". In addition, time of first onset (month and year) was asked to examine if the symptoms occurred after the current job was started. In this study, good reliabilities were established with a Cronbach's alpha of 0.72 in the frequency, 0.86 in the duration, and 0.79 in intensity.

Trunk WMSD cases were defined by the following classification criteria, which was developed by an internal NIOSH ergonomics medical team to reduce case misclassification

(Bernard et al., 1994) (Figure 3): (a) no non-work related acute injury (e.g., motor vehicle accident, sports, home accident); (b) symptom began after the current job was started; (c) symptoms occurred at least once a month or lasted at least one week in the past year; and (d) symptoms were reported as at least "moderate" on a five-point intensity scale. In a recent study of nurses (Trinkoff, Lipscomb, Geiger-Brown, & Brady, 2002), the validity of WMSD case definition was demonstrated. In that study, nurses who met the WMSD case definition were more likely to report functional consequences (e.g., seeking health care providers, missing work days, reducing non-work activities, and reducing recreation), medication use, and inadequate sleep than those who did not.

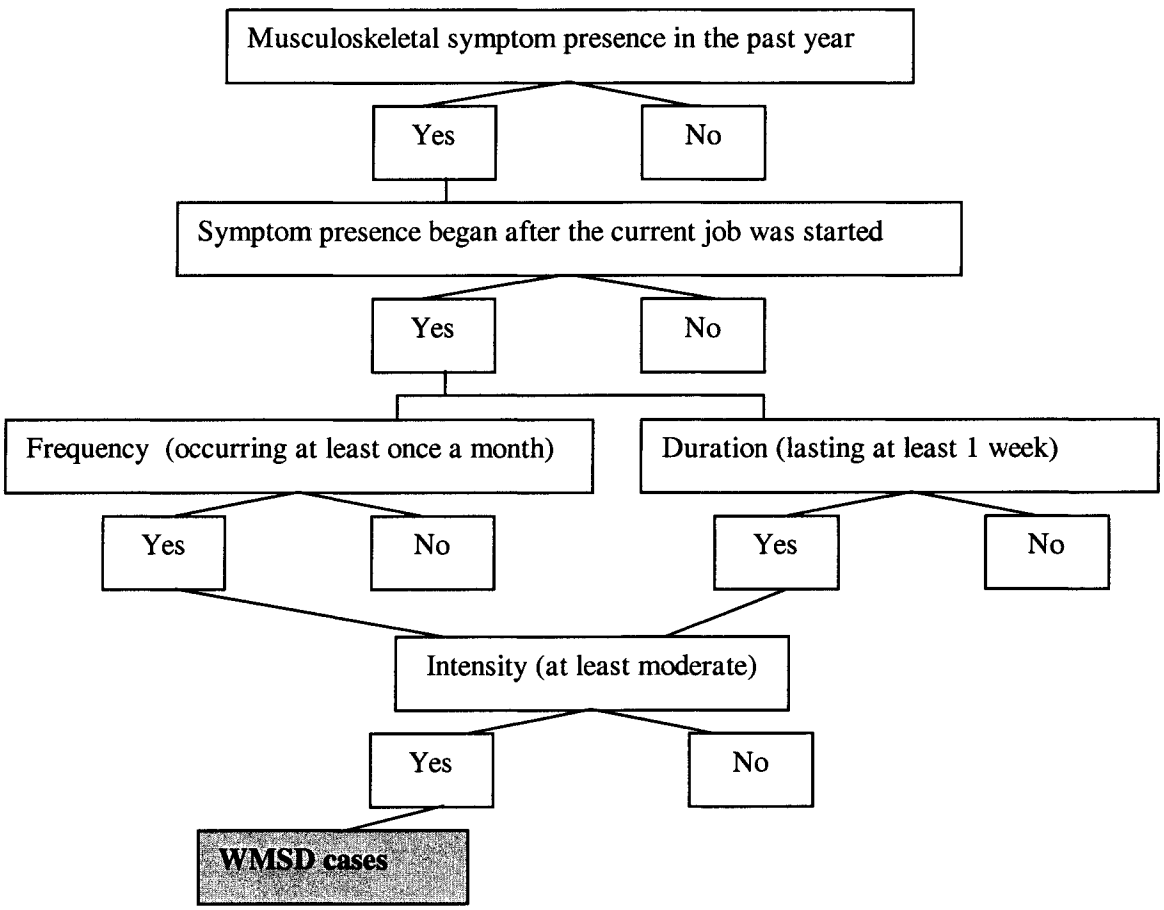
F. Data analysis procedures

In preparation for data analyses, sequential steps including data coding, entering, and screening were undertaken. It is essential to take these steps so that one can correct random (e.g., entering wrong values) and systematic errors (e.g., coding incorrectly) to ensure the validity of the data (Roberts, Anthony, Madigan, Elizabeth, & Chen, 1997). These were followed by a series of steps including reliability test of the questionnaires and both descriptive and inferential statistical analyses matched with the research questions. All analyses were conducted using Statistical Package for the Social Sciences (SPSS) version 12 (SPSS Inc., 2003).

1. Data coding

The data file was constructed using the SPSS 12.0 data editor. The investigator created all items (n=226) to be entered including corresponding variable names, measurement levels, data values, and labels. The orders and codes of almost all variables were constructed in accordance with those on the questionnaires to avoid unnecessary recoding for scoring or errors that might occur while entering data. Then, the codebook was generated by the "Data file

Figure 3. Decision Tree for WMSD Cases



information" of the SPSS data editor. New values obtained for non-numeric response item (base city), were added to the codebook while entering the data and used consistently throughout the data-entry process.

2. Data entering

A separate Excel data file was created to track the questionnaires returned. Once the investigator received either the completed questionnaires or the blank questionnaires, the ID numbers (001-420) for both eligible and ineligible cases were recorded in the tracking file on the computer and the ID numbers were removed from the questionnaires. The raw data on each page of the questionnaires were reviewed for completeness prior to entering the data into the computer data file. Then data-entry numbers starting at 1001 were assigned to all eligible cases. Two cases that were missing substantial parts (personal factors and WMSDs) of the survey were excluded leaving a total of 185 cases in the analysis. All data were entered into the SPSS data by a trained assistant and the investigator. The data file was saved to a hard drive on a personnel computer and a backup file for the raw data was created and stored on a compact disk.

3. Data screening

The data were screened to check data accuracy and missing or non-sensible data. This needs to be sequentially undertaken because the decisions made at one step influence those to be taken at later steps (Tabachnick & Fidell, 1989). The investigator checked for both computed variables and values derived from raw data if there were invalid values. Using the minimum and maximum values on the frequency distribution of each variable, values out of the ranges were checked with the questionnaires and corrected. For checking non-sensible data, cross-tabulation was created for sets of two variables to be examined (e.g., age and years of employment). For the data in a logical order, the consistency was checked among a series of

variables, for example, if the response to the question about symptom presence is "no", the subsequent questions about symptom frequency, duration, and intensity should not have been answered. Several variables were recoded or computed for scoring as addressed in the measure session. The "other" response categories for two variables, types of aircrafts and job responsibilities, were treated as a separate category or added to existing response categories. Responses that were marked on spaces between two response choices were treated as missing values.

Missing data handling. Before the analyses, all missing data were handled in a couple of ways. Nine of 15 single item questions had at least one missing case, ranging from 1 (0.5%) to 3 (1.6%) cases, but these were less than 5% that were used as a rule for their inclusion in the analyses in an earlier study (Zeytinoglu, Denton, Webb, & Lian, 2000). Thus, the missing data were replaced with mean value for continuous variables (working hours, number of hours per segment, fatigue, and height of heels) or mode for categorical variables (service section, job responsibility, and work pattern). Since individuals' weight and height were significantly correlated (Pearson $r=0.22$, $p<0.01$), the missing data of weight were imputed based on a regression of weight on height (weight $=3.49 + 2.11$ x height) from subjects with completed data ($n=181$). In addition, missing data for two variables (years of employment and base city) were replaced with the data from the union membership list.

For multi-item scales (frequency of job task, strenuousness of job task, intensity of symptoms, psychological job demand, decision latitude, social support, job insecurity, physical environment, and external environment), if 50% or fewer items were missing, each scale was scored with the mean score of completed items within subjects. If more than 50% of the items were missing, the cases were excluded from the analyses. This criterion was adapted from

previous studies (Kleinman, Frank, Ciesla, Rupnow, & Brodaty, 2004; Perneger & Burnand, 2005). Some subjects failed to answer at least one of the 41 job task items for each of the three job task measures: frequency of job task (15%), strenuousness of job task (50%), and intensity of symptoms (48%). However, the majority (85%) of respondents missed less than 10 items overall in the job task measure. Only 1 person missed more than 20 or > 50% of the items. Each of the other six scales had few cases with at least one item missing, ranging from 1 (0.5%) to 9 (5%) cases. Most of these missing cases had only one item missing. The number of cases with missing items more than 50% of the items in each scale was only one for psychological job demand, decision latitude, physical environment, and external environment and two for social support. Prior to imputation 63 to 65 cases were entered into separate multiple logistic regression analyses by body regions, including key variables (physical load, psychological job demand, decision latitude, social support, job insecurity, and age), but following imputation this number rose to 161to 164 of the 185 participants. The positive associations between physical load and WMSDs in all four body regions without the imputation (ORs=1.51-2.69, 95% CIs=1.00-4.65) remained significantly after the imputation (ORs=1.54-2.22, 95% CIs=1.19-3.03). The imputation revealed a significant association between social support and upper-back WMSDs while the positive association between job insecurity and upper-back WMSDs appeared prior to the imputation no longer existed after the imputation.

4. Data analyses

The following analyses matched the numbered research questions were conducted using the statistical package SPSS 12.0.

a. Research question 1: What trunk WMSDs (frequency, duration, and intensity) are experienced by female flight attendants?

Descriptive statistics were calculated for any symptom-present cases and WMSD cases in the past year. Each of the symptom dimensions (frequency, duration, and intensity) was reported by the frequency and percentage in each of four body regions (neck, shoulders, upper back, and lower-back).

b. Research question 2: What are the relationships between workplace factors (physical load, work organization, and physical environment), external environmental factors (e.g., turbulence, terrorism threats), and personal factors (e.g., age, height, BMI, and years of employment) and the occurrence of trunk WMSDs in female flight attendants?

First, descriptive statistics were calculated for all risk factor variables. For interval or ratio variables, the means, standard deviations, and ranges were reported while numbers and percentages were reported for categorical variables.

Second, bivariate logistic regression analyses were conducted to examine the relationship between each risk factor and WMSDs. All variables were treated independently using the Enter method in SPSS.

Third, multiple logistic regression analyses were conducted to examine the influence of more than one independent variable on the outcome. Models were derived using a forward stepwise selection procedure in SPSS. At each step, only variables that were statistically significant at the level of 0.05 were selected in a multivariate logistic model. This process was started with no variables and repeated until none of the remaining variables could make a significant contribution to the model. Categorical variables were converted to dummies

automatically by leaving out the first category a reference category. The analyses were conducted separately for neck, shoulders, upper-back, and lower-back.

IV. RESULTS

This chapter presents the cross-sectional mailed-survey results of the risk factors for WMSDs in female flight attendants with long-haul international flights. First, sample characteristics, musculoskeletal symptoms they experienced during the past year, and WMSD cases are described. This is followed by the survey scores of risk factors (workplace, external environmental, and personal factors) and the results of analyses on the relationships between risk factors and WMSDs.

A. Sample Characteristics

The personal characteristics of the sample are presented in Table III. The mean age of the flight attendants was 54.0 (SD=6.2) ranging from 32 to 68 years. The length of employment as a flight attendant varied ranging from 7 to 43 years with a mean of 31 years. The majority (87%) had worked 20 years or more. Over half of the participants (n=104) have worked as flight attendants without interruption, and only a few (n=5) have taken more than five years off from work. The sample consisted of flight attendants who had relatively lengthy experiences as a flight attendants, thus is appropriate for the focus of this study on the associations between work-related risk factor exposures and the occurrence of WMSDs.

Most participants were assigned in four base cities: San Francisco (29.2%), Chicago (27.0%), Los Angeles (15.7%), and Washington, D.C. (12.4%). The average height of the participants was 65 inches (SD=2.3) and the average weight was 141.2 lbs (SD=21.9). The mean BMI was 23.2 (SD=3.6); 21% were overweight (a BMI of 25 and over), and 6% were obese (a BMI of 30 or above). On a 10-point scale ranging from "1"=poorest sleep quality to "10"=best sleep quality, the participants rated their sleep quality as 4.7 (SD=2.4) on average. Flight attendants' fatigue over the past two weeks was scored on a 10-point scale ranging from

TABLE III

SAMPLE CHARACTERISTICS OF FEMALE FLIGHT ATTENDANTS (N=185)

	Mean (SD)	Range	N	%
Age (year)	54.0 (6.2)	32 - 68		
<40			9	4.9
40-49			25	13.5
50-59			131	70.8
>=60			20	10.8
Duration of employment (year)	30. 7 (7.8)	7.4 - 43.0		
<10			2	1.1
10-19			22	11.9
20-29			39	21.1
30-39			117	63.2
>= 40			5	2.7
Work pattern*				
Continued & uninterrupted			104	56.2
1- 5 years off			73	39.5
> 5 years off			5	2.7
Base city				
San Francisco			54	29.2
Chicago			50	27.0
Los Angeles			29	15.7
Washington, D.C.			23	12.4
Honolulu			10	5.4
New York			9	4.9
Seattle			9	4.9
Denver			1	0.5
Height (inch)	65.2 (2.3)	53 - 70		
BMI (kg/m^2)	23.2 (3.6)	16.6 - 38.3		
Sleep quality (10-point scale)	4.7 (2.4)	1 - 10		
Fatigue (10-point scale)	6.2 (2.3)	1 - 10		
Comfort of uniform (10-point scale)	6.1 (2.3)	1-10		
Height of heels (inch)	0.6 (0.6)	0-3		

*Percentages may not add up to 100 due to missing values

"1"=minimal fatigue to "10"=most severe fatigue. The mean score was 6.2 (SD=2.3). On a 10-point scale, the participants rated the comfort of their uniform as 6.1 (SD=2.3) on average. The height of heels of the shoes they wear in the cabin was quite low, 0.6 inches on average (SD=0.6).

B. Work-related Musculoskeletal Symptoms and WMSD Cases

1. Presence of Work-related Musculoskeletal Symptoms and WMSD Cases

About 94% (n=174) of the flight attendants experienced musculoskeletal symptoms in at least one body region during the past year. The majority (85%) of the flight attendants reported musculoskeletal symptoms in more than one body region, indicating that a large proportion of musculoskeletal symptoms overlapped body regions. The presence of muscuoskeletal symptoms (ache, pain, or discomfort) experienced in the past year for each of four body regions (neck, shoulders, upper-back, and lower-back) are shown in Table IV. More flight attendants experienced lower-back symptoms (85.9%) than neck, shoulders, and upper-back (79.5%, 76.2%, and 67%, respectively).

The frequency, duration, and intensity of muscuoskeletal symptoms experienced in the past year are presented in Table V. The majority (81-86%) of the flight attendants experienced musculoskeletal symptoms at least once a month. The highest level of frequency, "almost always (daily)" was more common in the lower-back (32%) than shoulders (30%), neck (29%), and upper-back (17%). Over a quarter (26-35%) of the flight attendants had musculoskeletal symptoms that lasted for one week or longer in each of the body regions. Moore than half (54-66%) of the flight attendants experienced at least moderate intensity of musculoskeletal symptoms during the past year in neck, shoulders, and lower-back while nearly half (48%) of the flight attendants experienced upper-back symptoms a week or longer. The largest percentage

TABLE IV

MUSCULOSKELETAL SYMPTOMS EXPERIENCED IN THE PAST YEAR AND WMSD CASES BY BODY REGION

	Musculoskeletal Symptom[1]		WMSD Case[2]	
	N	%	N	%
Neck	147	79.5	81	43.8
Shoulders	141	76.2	71	38.4
Upper-back	124	67.0	57	30.8
Lower-back	159	85.9	99	53.5
Number of body regions affected				
0	11	5.9	55	29.7
1	16	8.6	35	18.9
2	22	11.9	41	22.2
3	33	17.8	25	13.5
4	103	55.7	29	15.7

[1]: Symptom presence during the past year
[2]: Symptom with a frequency at least monthly or a duration of at least 1 week; with a pain intensity of at least a 3 (moderate) on a 5-point scale (Bernard et al., 1994)

TABLE V

FREQUENCY, DURATION, AND INTENSITYOF MUSCULOSKELETAL SYMPTOMS EXPERIENCED IN THE PAST YEAR

	Neck	Shoulders	Upper-back	Lower-back
	N (%)	N (%)	N (%)	N (%)
Frequency				
Almost never (every 6 months) /rarely (every 2-3 months)	25 (17.0)	21 (14.9)	19 (15.4)	20 (12.6)
Sometimes (monthly)	31 (21.1)	34 (24.1)	31 (25.0)	39 (24.5)
Frequently (weekly)	49 (33.3)	43 (30.5)	49 (39.5)	46 (28.9)
Almost always (daily)	42 (28.6)	42 (29.8)	21 (16.9)	51 (32.1)
Duration				
< 1 day	55 (37.4)	52 (36.9)	45 (36.2)	49 (30.8)
> 1 day to 1 week	39 (26.5)	37 (26.2)	35 (28.2)	48 (30.2)
> 1 week to 3 months	14 (9.6)	15 (10.6)	16 (12.9)	23 (14.5)
> 3 months	31 (21.1)	31 (22.0)	17 (13.7)	32 (20.1)
Intensity				
No pain/mild pain	51 (34.7)	56 (39.7)	52 (41.9)	43 (27.1)
Moderate pain	63 (42.9)	55 (39.0)	52 (41.9)	70 (44.0)
Severe pain/ worst pain ever	23 (15.7)	21 (14.9)	9 (7.2)	35 (22.0)

(22%) of the flight attendants reporting severe or worst pain ever was for the lower-back and the smallest (7%) was for the upper-back.

As shown in the Table IV, a large portion of the flight attendants met the previously mentioned WMSD case criteria. Lower-back WMSDs were the most commonly reported (53.5%), followed by neck, shoulders, and upper back (43.8%, 38.4%, and 30.8%, respectively). Overall, about 70% (n=130) of the flight attendants had WMSDs in at least one body region. About 51% (n=95) of the flight attendants had WMSDs in more than one body region.

2. Relationship among WMSD cases for different body regions

The Phi Correlation Coefficient, which is a measure of the association between two dichotomized variables, was calculated to examine the relationship among WMSD cases for four different body regions (Table VI). There were significant correlations among all of the regional WMSD cases. Increased occurrence of neck WMSDs was strongly associated with an increased occurrence of shoulder WMSDs ($r=0.605$, $p<0.001$). On the other hand, the relationship between lower-back and neck or shoulder was quite weak although it is statistically significant (0.176 and 0.263, respectively, $p<0.05$). For the other body regions, moderate relationships were found (0.310-0.444, $p<0.001$).

C. Description of Workplace and External Environmental Factors

1. Workplace Factors

a. Physical load

1) Frequency of job task

The mean total score (overall mean frequency across 41 job tasks) was 3.10 (SD=0.38) ranging from1.88 to 3.90. The mean scores of each of all 41job tasks were higher than 2.5 except six tasks (Table I, Appendix C), indicating that the majority (85%)

TABLE VI

CORRELATIONS AMONG WMSD CASES FOR DIFERENT BODY REGIONS

	Neck	Shoulder	Upper-back
WMSDs			
Shoulder	0.605**		
Upper-back	0.310**	0.444**	
Lower-back	0.263*	0.176*	0.377**

of the tasks were frequently performed by the flight attendants. Table VII shows the top 10 job tasks most frequently performed by flight attendants. They had means ranging from 3.59 to 3.92 on a 4-point scale with 4 being always. Of the top 10 job tasks, the ones most frequently performed by flight attendants were "standing for a long time", "arming/disarming door", "reaching to serve passengers", and "walking for a long time". Uncomfortable postures such as reaching, bending, and squatting required while performing specific tasks and manual handling materials such as coffee pots, meal trays, bins, and carts were also among the top 10 job tasks flight attendants most frequently performed.

2) Strenuousness of job task

The mean total score (overall mean strenuousness across 41 job tasks) was 2.51 (SD=0.53) ranging from 1.05 to 3.80 on a 4-point scale with 4 being very strenuous. About 60% of the 41 job tasks were found to be strenuous with mean scores higher than 2.5 (Table II, Appendix C). Table VIII shows the top10 job tasks that were perceived as most strenuous by flight attendants. They had means ranging from 2.85 to 3.25. Of overhead bins", "carrying crew bags while walking up and down stairs", and "squatting and

TABLE VII

TOP 10 JOB TASK ITEMS FLIGHT ATTENDANTS MOST FREQUENTLY PREFORMED

Job Task	Mean	SD	Actual Range	Possible Range
Standing for a long time	3.92	0.28	1-4	1-4
Arming/disarming door	3.87	0.42	1-4	1-4
Reaching to serve passengers	3.78	0.44	1-4	1-4
Walking for a long time	3.78	0.49	1-4	1-4
Reaching and bending to serve the passengers at the window seat	3.77	0.43	1-4	1-4
Hand carrying the coffee pot	3.69	0.52	1-4	1-4
Rotating wrist to pour coffee and beverages	3.67	0.58	1-4	1-4
Reaching and pushing to close overhead bins	3.65	0.57	1-4	1-4
Reaching, bending, and squatting to read pressure gauges	3.61	0.68	1-4	1-4
Pushing and pulling carts to reposition in the galley	3.59	0.66	1-4	1-4
Total score	**3.10**	**2.10**	**1.88-3.90**	**1-4**

TABLE VIII

TOP 10 JOB TASK ITEMS FLIGHT ATTENDANTS PERCEIVED AS MOST STRENUOUS

Job Task	Mean	SD	Actual Range	Possible Range
Lifting and reaching to stow crew bags in overhead bins	3.25	0.81	1-4	1-4
Carrying crew bags while walking up and down stairs	3.21	0.80	1-4	1-4
Squatting and pulling bottom bins with heavy items	3.04	0.84	1-4	1-4
Pushing and pulling carts to reposition in the galley	3.03	0.81	1-4	1-4
Reaching and pushing to close overhead bins	2.99	0.95	1-4	1-4
Standing for a long time	2.94	0.88	1-4	1-4
Reaching, pulling, and pushing bags to reposition in overhead bins	2.92	0.84	1-4	1-4
Pushing and pulling to steer the cart away from passengers	2.89	0.80	1-4	1-4
Pulling and pushing beverage carts while walking on an incline	2.87	0.87	1-4	1-4
Lifting and reaching to stow passenger's bags in overhead bins	2.85	0.94	1-4	1-4
Total score	**2.51**	**0.53**	**1.05-3.80**	**1-4**

pulling bottom bins with heavy items". Three of the top 10 job tasks most frequently performed were also found to be among the top 10 strenuous job tasks: "pushing and pulling carts to reposition in the galley"; "reaching and pushing to close overhead bins"; and "standing for a long time".

3) Intensity of symptom

The mean total score (overall mean intensity across 41 job tasks) was 4.13 (SD=2.10) ranging from 0 to 8.7 on a scale with 10 being pain/ache/discomfort as bad as it can get (Table III, Appendix C). Table IX shows the top 10 job tasks in which flight attendants experienced the most severe symptoms. Their means ranged in intensity of symptoms from 4.98 to 5.78. The flight attendants experienced moderate symptoms (mean scores higher than 5.5) while performing only 3 of the 41 job tasks: "lifting and reaching to stow crew bags in overhead bins'; "carrying crew bags while walking up and down stairs"; and "sleeping in passenger seats in economy sections".

4) Overall physical load of each task

The composite score, which was the sum of the total scores of frequency, strenuousness, and intensity of symptom, was calculated to estimate the degree of overall physical load of each task. The mean total score (overall mean composite score across 41 job tasks) was 7.93 (SD=1.33) with the possible range from 3 to 12.

The mean composite score ranged from 6.05 to 9.48 (Table IV, Appendix C). As shown in Table X, the tasks that induced the high physical load was "standing for a long time", "lifting and reaching to stow crew bags in overhead bins", "reaching and pushing to close overhead bins", and "carrying crew bags while walking up and down stairs".

TABLE IX

TOP 10 JOB TASK ITEMS FLIGHT ATTENDANTS EXPERIENCED THE HIGHEST INTENSITY OF SYMPTOMS

Job Task	Mean	SD	Actual Range	Possible Range
Lifting and reaching to stow crew bags in overhead bins	5.78	3.02	0-10	0-10
Carrying crew bags while walking up and down stairs	5.70	2.88	0-10	0-10
Sleeping in passenger seat in economy section	5.54	3.44	0-10	0-10
Standing for a long time	5.40	2.95	0-10	0-10
Squatting and pulling bottom bins with heavy items	5.27	2.96	0-10	0-10
Reaching and pushing to close overhead bins	5.13	3.04	0-10	0-10
Hand carrying the coffee pot	5.11	3.06	0-10	0-10
Rotating wrist to pour coffee and beverages	5.09	3.16	0-10	0-10
Pushing and pulling carts to reposition in the galley	5.06	2.85	0-10	0-10
Reaching, pulling, and pushing bags to reposition in overhead bins	4.98	2.87	0-10	0-10
Total score	**4.13**	**2.10**	**0-8.7**	**0-10**

TABLE X

TOP 10 JOB TASK ITEMS WITH THE HIGHEST OVERALL PHYSICAL LOAD

Job Task	Mean	SD	Actual Range	Possible Range
Standing for a long time	9.48	1.73	6-12	3-12
Lifting and reaching to stow crew bags in overhead bins	9.22	2.04	3-12	3-12
Reaching and pushing to close overhead bins	9.17	1.96	4-12	3-12
Carrying crew bags while walking up and down stairs	9.17	1.92	3-12	3-12
Pushing and pulling carts to reposition in the galley	9.14	1.90	4-12	3-12
Squatting and pulling bottom bins with heavy items	9.04	2.02	3-12	3-12
Rotating wrist to pour coffee and beverages	8.92	1.97	5-12	3-12
Hand carrying the coffee pot	8.89	1.89	5-12	3-12
Reaching and bending to serve the passengers at the window seat	8.88	1.90	5-12	3-12
Squatting to take meal trays in/out of carts	8.79	1.98	3-12	3-12
Total score	**7.93**	**1.33**	**4.51-10.87**	**3-12**

b. Work Organization

Results from the assessment of work organizational factors are presented in Table XI. The psychological job demand mean (e.g., fast or excessive amount of work required or conflicting demands) was 36.0 (SD=5.7) ranging from 24 to 48. The mean score for decision latitude was 60.4 (SD= 9.2) ranging from 36 to 84. The mean score of social support from co-workers and supervisors (pursers) was 23.6 (SD=3.1) ranging from 13 to 32 and each of these two social support dimensions had comparable mean scores (12.0 vs. 11.7, respectively). The job insecurity mean was 1.3 (SD=3.1) ranging from –6 to 9.

The mean flight hours was 87 hours per month and ranged from 65 to 103 hours. On average, the flight hours per segment were 11 hours. Service sections the flight attendants most often worked varied: First class (37.8%), business class (69.2%), economy class (47.6%), both business and economy class (15. 4%), and all classes (14%). Seventy-two percent (n=133) of the flight attendants worked as team members, and about 30% (n=55) were responsible for all flight services. Types of aircrafts the respondents most often worked on were Boeing-747 only (28.6%), Boeing-777 only (27.6%), both Boeing-747 and Boeing-777 (16.2%), and Boeing-767 (13.5%). About 30% of the respondents worked more than one type of aircraft. Few flight attendants worked in Boeing-757 (n=7), Airbus 340 (n=1) or Airbus 320 (n=1).

c. Physical Environment

Physical environmental factors included 12 items related to cabin conditions. Each item was rated on a 4-point scale (1=never, 2=occasionally, 3=often, and 4=always) about how often flight attendants were exposed to the conditions while working in the cabin. The means and standard deviations for each item, and the overall measure are shown in Table XII. Higher scores indicate greater exposure to physical environment risks for WMSDs.

TABLE XI

MEANS, STANDARD DEVIATIONS, RANGES, NUMBERS, AND PERCENTAGES FOR WORK ORGANIZATIONAL FACTORS

Work Organizational Factors	Mean	SD	Actual Range	Possible Range	N	%
Psychosocial factors						
Psychological job demand	36.0	5.7	24-48	12-48		
Decision latitude	60.4	9.2	36-84	24-96		
Social support	23.6	3.1	13-32	8-32		
Co-worker support	12.0	1.6	7-16	4-16		
Supervisor support	11.7	2.1	4-16	4-16		
Job insecurity	1.3	3.1	-6-9	-9-10		
Scheduling factors						
Work hours/month (hour)	87.2	7.3				
Flight hours/segment (hour)	11.0	3.3				
Service section**						
First class					70	38
Business class					128	69
Economy class					88	47.6
Job responsibility*						
Crew/team member					133	71.9
All in-flight service					55	29.7
Types of aircraft**						
B777					99	53.5
B747					89	48.1
B767					46	24.9
Others					9	4.8

* Percentages don't add to 100 because of missing values
** Percentages add to over 100 because of more than one response

TABLE XII

MEANS, STANDARD DEVIATIONS, AND RANGES OF PHYSICAL ENVIRONMENTAL FACTORS

Physical environmental factors	Mean	SD	Possible range
Air is too dry (low humidity)	3.61	0.63	1-4
Stuffy air	3.30	0.74	1-4
Too little air movement	3.12	0.73	1-4
Excessive noise	3.07	0.91	1-4
Air temperature too hot	2.70	0.68	1-4
Unpleasant odor in air	2.61	0.82	1-4
Air temperature too cold	2.59	0.65	1-4
Insufficient oxygen due to low cabin pressure	2.59	0.96	1-4
Potentially toxic chemicals	2.51	0.99	1-4
Cabin lighting too dark	2.34	0.80	1-4
Excessive vibration	2.22	0.87	1-4
Rapid variations in cabin pressure	2.05	0.81	1-4
Physical environment (Overall)	**2.72**	**0.51**	**1-4**

The overall mean score for physical environment was slightly higher than the mid-point of the scale (Mean=2.72, SD=0.51) ranging from 1.18 to 3.92. The mean scores for each of 12 items varied ranging from 2.05 to 3.61. The major problems were "low humidity", "stuffy air", "too little air movement", and "excessive noise". The least commonly reported exposure was "rapid variation in cabin pressure". The reporting being "often" or "always" exposed to the physical environmental factor was combined (Figure 4). Seven of the physical environmental factors related to the cabin air quality and noise were reported as experienced often or always by 50% or more of the flight attendants.

2. External Environmental Factors

The means and standard deviations for external environmental factors are shown in Table XIII. The overall mean score of all respondents' concerns about external environmental factors was 3.01 (SD=0.64) ranging from 1 to 4. The mean scores for each of four factors tended toward higher concerns about the external environmental factors. The highest concern was about the threat of terrorism followed by turbulence, and air rage or assault by passengers. The respondents were also concerned about potentially catastrophic equipment malfunctions such as smoke, fire, engine or flight control system failure, and rapid decompression. Overall, more than half of flight attendants reported that they were "some" or "very much" concerned about all four external environmental factors (Figure 5).

Figure 4. Percentage of Flight Attendants Who Reported Being Often or Always Exposed to Physical Environmental Factors

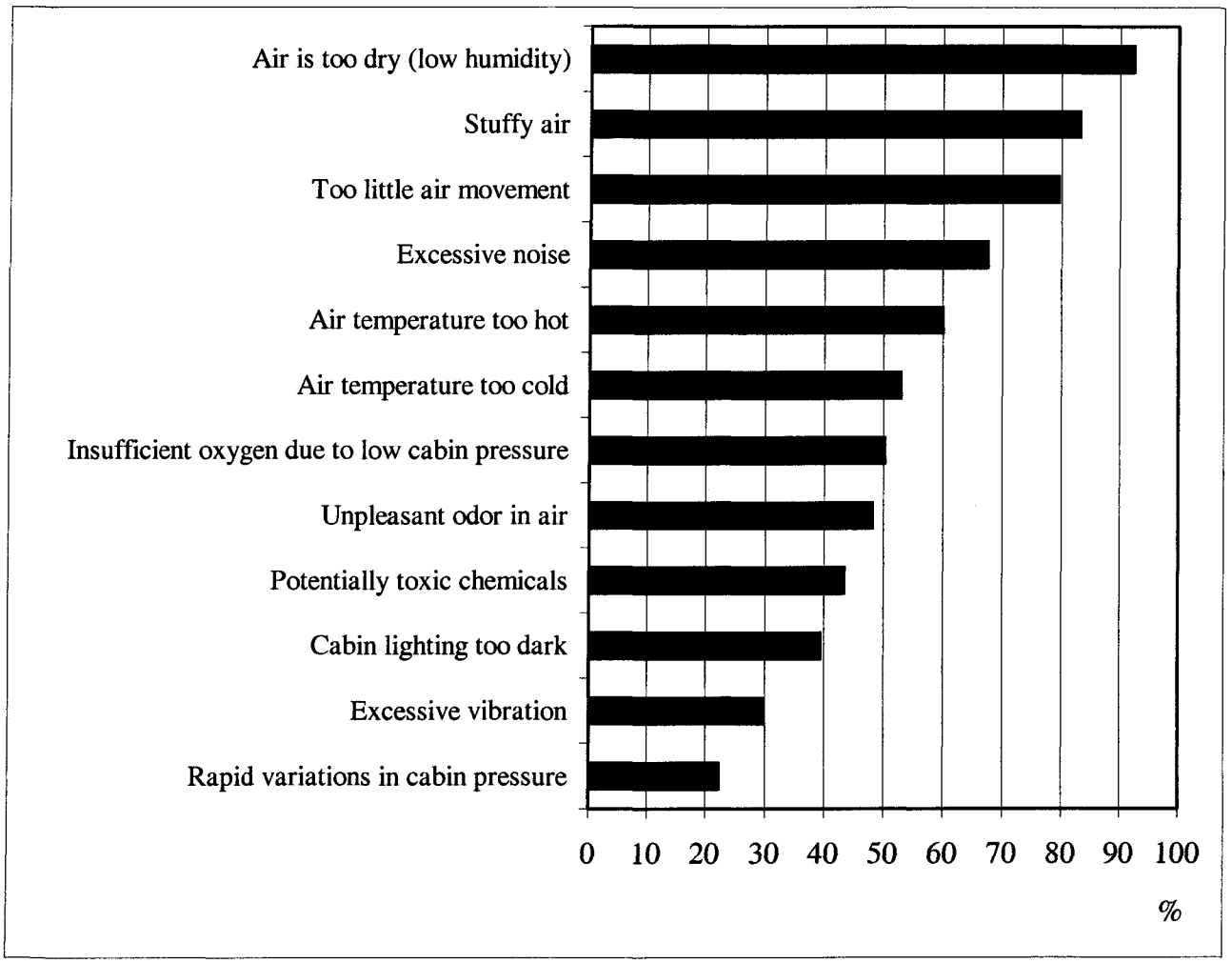
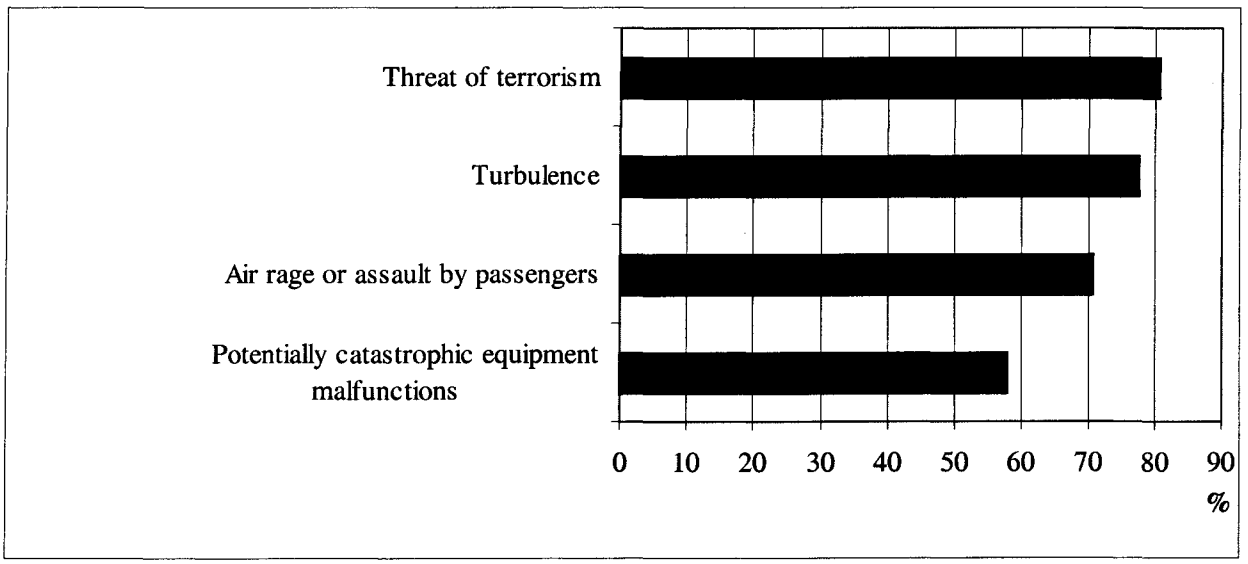


TABLE XIII

MEANS, STANDARD DEVIATIONS, AND RANGES OF EXTERNAL ENVIRONMENTAL FACTORS

External Environmental Factors	Mean	SD	Possible range
Threat of terrorism	3.25	0.78	1-4
Turbulence	3.11	0.79	1-4
Air rage or assault by passengers	2.94	0.80	1-4
Potentially catastrophic equipment malfunctions (e.g., smoke, fire, engine or flight control system failure, and rapid decompression)	2.76	0.82	1-4
External Environment (Overall)	**3.01**	**0.64**	**1-4**

Figure 5. Percentage of Flight Attendants Who Reported Being Exposed Some or Very Much to External Environmental Factors



D. Relationships between Risk Factors and WMSDs

Tables XIV-XVII present the significant associations identified between risk factors and WMSDs in four body regions in bivariate and multiple logistic regression analyses. Several variables were highly correlated with each other indicating that it would be collinear if entered simultaneously in a multiple logistic regression model. Specifically, the frequency, strenuousness, and intensity of job tasks were significantly correlated with each other (r=0.43-0.85, $p<0.001$), thus only overall physical load (a composite score of three dimensions of physical load) was entered in the multiple logistic analyses instead of entering each of the three variables separately. Likewise, age was highly correlated with years of employment (r=0.81, $p<0.001$). Age has been one of the primary personal factors to be considered in the analysis of data as a confounder in WMSD studies (NRC & IOM, 2001) and it is recommended that it be, at least initially, entered into multivariate modeling procedures (Dempsey Burdorf, & Webster, 1997). Thus, the variable of years of employment was excluded from the multiple logistic regression analyses.

1. Neck WMSDs

In the bivariate logistic analyses, the frequency of job task, strenuousness of job task, intensity of symptom, and overall physical load were all positively associated with neck WMSDs (ORs= 2.12-6.45, 95% CIs=1.57-16.84) (Table XIV). The psychological job demand increased the risk of neck WMSDs (ORs= 1.09, CIs=1.03-1.16). The flight attendants who reported being more frequently exposed to unfavorable cabin conditions were almost three times more likely to have neck WMSDs (ORs=2.94, 95% CIs=1.50-5.76). The flight attendants who most often worked in B-777 or both B-747 and B-777 (ORs=0.35, 95% CIs=0.15-0.81 and ORs=0.35, 95% CIs=0.09-1.36) were less likely to have neck WMSDs than those who worked in

TABLE XIV

RISK FACTORS ASSOCIATED WITH NECK WMSDS ANALYZED WITH BIVARIATE AND MULTIPLE LOGISTIC REGRESSION ANALYSES

	Bivariate analyses	Multiple analyses
Risk factors	OR (95% CI)	OR (95% CI)
Physical load		
Frequency of job task	6.45 (2.47-16.84)***	
Strenuousness of job task	4.64 (2.30-9.36)***	
Intensity of task-related symptom	4.62 (2.52-8.44)***	
Overall physical load	2.12 (1.57-2.85)***	2.08 (1.55-2.80)***
Work organization		
Psychosocial factors		
Psychological demand	1.09 (1.03-1.16)**	
Decision latitude	1.01 (0.98-1.05)	
Social support	0.99 (0.89-1.09)	
Job insecurity	1.06 (0.97-1.17)	
Scheduling factors		
Flight hours /month	0.99 (0.95-1.03)	
Flight hours/segment	1.08 (0.98-1.19)	
Service section (Ref-first class only)		
Business class only	0.82 (0.27-2.51)	
Economy class only	0.57 (0.17-1.91)	
Both first and business	0.47 (0.13-1.74)	
Both first and economy	0.65 (0.19-2.24)	
All	0.55 (0.16-1.92)	
Job responsibility (Ref-all in-flight service)		
Crew/team member	1.06 (0.53-2.11)	
Types of aircraft (Ref-B-747 only)		
B-767 only	1.15 (0.41-3.22)	
B-777 only	0.35 (0.15-0.81)*	
Both B-747 and B-777	0.31 (0.12-0.82) *	
Both B-767 and B-777	0.35 (0.09-1.36)	
Others	0.74 (0.20-2.75)	
Physical environment	2.94 (1.50-5.76)**	
External environment	1.18 (0.72-1.91)	
Personal factors		
Age	1.00 (0.95-1.05)	
Years of employment	1.00 (0.96-1.04)	
Height	1.11 (0.96-1.28)	
BMI	0.96 (0.88-1.05)	
Work pattern (Ref-taken >1 year off)		
Continued & uninterrupted	0.72 (0.39-1.33)	
Sleep quality	0.92 (0.81-1.05)	
Fatigue	1.05 (0.92-1.20)	
Uniform comfort	0.93 (0.81-1.07)	
Height of heels	1.31 (0.83-2.08)	

* p<0.05 , **p<0.01, ***p<0.001

B-747 only. Other work organizational factors (decision latitude, social support, job insecurity, and scheduling factors) and external environmental factors showed no significant associations with neck WMSD. All personal factors, including age, years of employment, height, BMI, sleep quality, fatigue, uniform comfort, and height of heels were not significantly associated with neck WMSDs.

In multiple logistic regression analyses, only the overall physical load was significantly associated with neck WMSDs (ORs=2.08, 95% CIs=1.55-2.80). The physical load accounted for a total of 16.6 % of the variance (Cox & Snell R square) in neck WMSDs.

2. Shoulder WMSDs

In the bivariate logistic regression analyses, the frequency of job task, strenuousness of job task, intensity of symptom, and overall physical load were all positively associated with shoulder WMSDs (ORs= 2.23-9.16, 95% CIs=1.63-25.60) (Table XV). The only work organizational factor positively associated with shoulder WMSDs was psychological job demand (ORs= 1.12, 95% CIs=1.05-1.19). Both physical and external environmental factors showed positive associations with shoulder WMSDs (ORs= 2.88, 95% CIs=1.46-5.67 and ORs= 1.68, 95% CIs=1.01-2.80, respectively). Poor sleep quality significantly increased the risk of shoulder WMSDs (ORs= 0.87, 95% CIs=0.76-1.0). None of the other work organizational factors and personal factors were significantly associated with the occurrence of shoulder WMSDs.

In multiple logistic regression analyses, only the overall physical load was significantly associated with shoulder WMSDs (ORs=2.19, 95% CIs=1.61-3.00). The physical load factor accounted for a total of 18 % of the variance (Cox & Snell R square) in shoulder WMSDs.

TABLE XV

RISK FACTORS ASSOCIATED WITH SHOULDER WMSDS ANALYZED WITH BIVARIATE AND MULTIPLE LOGISTIC REGRESSION ANALYSES

	Bivariate analyses	Multiple analyses
Risk factors	OR (95% CI)	OR (95% CI)
Physical load		
Frequency	9.16 (3.28-25.60)***	
Strenuousness	5.41 (2.59-11.31)***	
Intensity	4.06 (2.23-7.38)***	
Overall physical load	2.23 (1.63-3.05)***	2.19 (1.61-3.00)***
Work organization		
Psychosocial factors		
Psychological demand	1.12 (1.05-1.19)**	
Decision latitude	1.01 (0.98-1.05)	
Social support	0.97 (0.88-1.07)	
Job insecurity	1.04 (0.94-1.14)	
Scheduling factors		
Flight hours /month	1.00 (0.96-1.04)	
Flight hours/segment	1.02 (0.92-1.12)	
Service section (Ref-first class only)		
Business class only	1.62 (0.53-4.94)	
Economy class only	1.53 (0.46-5.13)	
Both first and business	0.38 (0.09-1.65)	
Both first and economy	0.67 (0.19-2.42)	
All	1.12 (0.32-3.91)	
Job responsibility (Ref-all in-flight service)		
Crew/team member	1.14 (0.57-2.30)	
Types of aircraft (Ref-B-747 only)		
B-767 only	1.50 (0.55-4.13)	
B-777 only	0.56 (0.24-1.28)	
Both B-747 and B-777	0.65 (0.25-1.70)	
Both B-767 and B-777	0.39 (0.93-1.64)	
Others	0.87 (0.23-3.20)	
Physical environment	2.88 (1.46-5.67)**	
External environment	1.68 (1.01-2.80)*	
Personal factors		
Age	1.01 (0.96-1.07)	
Years of employment	1.00 (0.96-1.04)	
Height	1.07 (0.93-1.22)	
BMI	0.97 (0.89-1.07)	
Work pattern (Ref-taken >1 year off)		
Continued & uninterrupted	0.54 (0.29-1.01)	
Sleep quality	0.87 (0.76-1.00)*	
Fatigue	1.07 (0.93-1.22)	
Uniform comfort	0.92 (0.80-1.06)	
Heels of height	1.41 (0.89-2.25)	

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

3. Upper-back WMSDs

In the bivariate logistic regression analyses, the frequency of job task, strenuousness of job task, intensity of symptom, and overall physical load were all positively associated with upper-back WMSDs (ORs= 1.75-3.59, 95% CIs=1.32-7.55) (Table XVI). High psychological job demand was positively associated with upper-back WMSDs (ORs=1.06, 95% CIs=1.00-1.13). High social support decreased a risk for upper-back WMSDs (ORs=0.83, 95% CIs=0.74-0.94). When the impact of support from co-workers and supervisors (pursers) were examined separately, only supervisor (pursers) support showed a significant association with upper-back WMSDs (ORs=0.79, 95% CIs= 0.67-0.93). Perceived job insecurity increased the risk of upper-back WMSDs (ORs=1.11, 95% CIs=1.01-1.24). The flight attendants who most often worked in B-777 were less likely to have upper back WMSDs than those who worked in B-747 only (ORs=0.30, 95% CIs=0.12-0.76). The physical environment was positively associated with upper-back WMSDs (ORs=2.29, 95% CIs=1.16-4.52). The flight attendants who were comfortable to their uniforms were less likely to experience upper-back WMSDs (OR=0.85, 95% CI 0.73-0.98). None of the remaining personal factors, decision latitude, scheduling factors, and external environmental factors showed significant associations with upper-back WMSDs.

In the multiple logistic regression analyses, the overall physical load was significantly associated with upper-back WMSDs (ORs=1.74, 95% CIs=1.30-2.32). The low social support increased the risk of upper-back WMSDs (ORs=0.85, 95% CIs=0.75-0.97). The physical load factor accounted for a total of 10% of the variance (Cox & Snell R square) in upper-back WMSDs and the addition of the low social support explained another 4% of the variance in upper-back WMSDs.

TABLE XVI

RISK FACTORS ASSOCIATED WITH UPPER-BACK WMSDS ANALYZED WITH BIVARIATE AND MULTIPLE LOGISTIC REGRESSION ANALYSES

	Bivariate analyses	Multiple analyses
Risk factors	OR (95% CI)	OR (95% CI)
Physical load		
Frequency	2.97 (1.17-7.55)*	
Strenuousness	3.59 (1.80-7.14)***	
Intensity	3.19 (1.79-5.67)***	
Overall physical load	1.75 (1.32-2.31)***	1.74 (1.30-2.32)***
Work organization		
Psychosocial factors		
Psychological demand	1.06 (1.00-1.13)*	
Decision latitude	1.00 (0.96-1.03)	
Social support [a]	0.83 (0.74-0.94) **	0.85 (0.75-0.97)*
Job insecurity	1.11 (1.01-1.24)*	
Scheduling factors		
Flight hours /month	1.00 (0.96-1.04)	
Flight hours/segment	1.07 (0.97-1.17)	
Service section (Ref-first class only)		
Business class only	0.81 (0.27-2.47)	
Economy class only	0.67 (0.20-2.30)	
Both first and business	0.66 (0.16-2.68)	
Both first and economy	0.94 (0.27-3.32)	
All	1.05 (0.30-3.62)	
Job responsibility (Ref-all in-flight service)		
Crew/team member	0.65 (0.32-1.34)	
Types of aircraft (Ref-B-747 only)		
B-767 only	0.70 (0.26-1.91)	
B-777 only	0.30 (0.12-0.76)*	
Both B-747 and B-777	0.56 (0.21-1.47)	
Both B-767 and B-777	1.17 (0.26-5.23)	
Others	0.44 (0.10-1.86)	
Physical environment	2.29 (1.16-4.52)**	
External environment	1.02 (0.61-1.71)	
Personal factors		
Age	0.97 (0.92-1.02)	
Years of employment	0.96 (0.92-1.01)	
Height	1.10 (0.95-1.27)	
BMI	1.05 (0.95-1.15)	
Work pattern (Ref-taken >1 year off)		
Continued & uninterrupted	1.14 (0.59-2.19)	
Taken 1 year off	-	
Sleep quality	0.89 (0.78-1.03)	
Fatigue	1.09 (0.95-1.26)	
Uniform comfort	0.85 (0.73-0.98)*	
Height of heels	1.13 (0.70-1.81)	

* p<0.05, **p<0.01, ***p<0.001 [a] Co-worker support (ORs=0.80, 95% CIs=0.64-1.01, p=0.06), supervisor support (ORs=0.79, 95% CIs= 0.67-0.93, p=0.004)

4. Lower-back WMSDs

In the bivariate logistic regression analyses, the strenuousness of job task, intensity of symptom, and overall physical load showed positive associations with lower-back WMSDs (ORs= 1.53-2.79, 95% CIs=0.71-5.11) (Table XVII). However, the frequency of job task was not significantly associated with lower-back WMSDs. High psychological job demand and job insecurity increased the risk of lower-back WMSDs (ORs= 1.06, 95% CIs=1.01-1.13 and ORs=1.15, 95% CIs=1.03-1.27, respectively). None of the other work organizational factors were significantly associated with lower-back WMSDs. Both physical and external environmental factors failed to support the positive associations with lower-back WMSDs. None of the personal factors showed significant associations with lower-back WMSDs.

In the multiple logistic regression analyses, the overall physical load was significantly associated with lower-back WMSDs (ORs=1.47, 95% CIs=1.13-1.91). The high job insecurity increased the risk of lower-back WMSDs (ORs=1.17, 95% CIs=1.02-1.34). The physical load factor accounted for a total of 7% of the variance (Cox & Snell R square) in lower-back WMSDs the addition of the high job insecurity explained another 3% of the variance in lower-back WMSDs.

TABLE XVII

RISK FACTORS ASSOCIATED WITN LOWER-BACK WMSDS ANALYZED WITH BIVARIATE AND MULTIPLE LOGISTIC REGRESSION ANALYSES

	Bivariate analyses	Multiple analyses
Risk factors	OR (95% CI)	OR (95% CI)
Physical load		
Frequency	1.63 (0.71-3.71)	
Strenuousness	2.69 (1.42-5.11)**	
Intensity	2.79 (1.60-4.85)***	
Overall physical load	1.53 (1.19-1.97)***	1.47 (1.13-1.90)**
Work organization		
Psychosocial factors		
Psychological demand	1.06 (1.01-1.13)*	
Decision latitude	1.01 (0.98-1.04)	
Social support	0.96 (0.86-1.06)	
Job insecurity	1.15 (1.03-1.27)**	1.12 (1.01-1.25)*
Scheduling factors		
Flight hours /month	0.97 (0.93-1.02)	
Flight hours/segment	1.08 (0.97-1.20)	
Service section (Ref-first class only)		
Business class only	0.86 (0.29-2.58)	
Economy class only	0.51 (0.16-1.66)	
Both first and business	0.92 (0.24-3.46)	
Both first and economy	2.33 (0.60-9.02)	
All	0.74 (0.22-2.52)	
Job responsibility (Ref-all in-flight service)		
Crew/team member	0.66 (0.32-1.38)	
Types of aircraft (Ref-B-747 only)		
B-767 only	1.39 (0.46-4.21)	
B-777 only	0.71 (0.31-1.62)	
Both B-747 and B-777	0.59 (0.23-1.51)	
Both B-767 and B-777	2.38 (0.46-12.37)	
Others	1.04 (0.27-4.02)	
Physical environment	1.47 (0.78-2.78)	
External environment	1.33 (0.81-2.19)	
Personal factors		
Age	1.00 (0.95-1.05)	
Years of employment	0.98 (0.94-1.02)	
Height	1.10 (0.96-1.27)	
BMI	1.03 (0.94-1.13)	
Work pattern (Ref-taken > 1 year off)		
Continued & uninterrupted	1.05 (0.56-1.98)	
Sleep quality	0.90 (0.79-1.03)	
Fatigue	1.08 (0.95-1.24)	
Uniform comfort	0.89 (0.77-1.03)	
Height of heels	1.27 (0.78-2.05)	

* p<0.05, **p<0.01, ***p<0.001

V. DISCUSSION

A. Work-related Musculoskeletal Symptoms and WMSD Cases

This is the first investigation of work-related musculoskeletal symptoms in U.S. female flight attendants with long-haul international flights. Remarkably, all of the flight attendants in this study, with an exception of 11 flight attendants (6%), experienced some level of work-related musculoskeletal symptoms in the neck, shoulder, upper-back, or lower-back regions during the past year. The percentages of the flight attendants who experienced musculoskeletal symptoms in each of these body regions ranged from 67% to 86%, indicating there was considerable overlap across body regions. These percentages are much higher than the results of studies of female workers in other occupations. In those studies, the prevalence of musculoskeletal symptoms in the neck, shoulders, or back regions during the same time period ranged between 35% and 76% (Alcouffe et al., 1999; Barnekow-Bergkvist et al., 1998; Joksimovic, Starke, Knesebeck, & Siegrist, 2002; Macfarlane et al., 1997; Smedley et al., 1994: Trinkoff et al., 2002). This was also higher than female flight attendants in different airlines, with percentages of symptom presence ranging 34% to 59% (Haugli et al., 1994; Iglesias et al., 1989; Logie et al., 1998).

In addition, a large number (31-54%) of the female flight attendants had somewhat severe musculoskeletal symptoms of the neck, shoulders, upper-back, and lower-back, which were defined as WMSDs in this study: at least moderate intensity of musculoskeletal symptoms that lasted more than one week or occurred at least once a month in the past year. About 70% of the flight attendants had the WMSDs in at least one body region, and more than half of the flight attendants had WMSDs in more than one body region. When compared to other studies that used same case definitions of WMSD, the WMSDs reported in this study population were at

much higher levels than different groups of female dominated occupational groups such as nurses (22-32%) (Trinkoff et al., 2002) and office workers (20%) (Polanyi et al., 1997). The lower-back WMSDs were more severe in terms of frequency, duration, and intensity of musculoskeletal symptoms than injuries to other body regions. This is consistent with the findings from other investigations of flight attendants (Haugli et al., 1994; Iglesias et al., 1989; Logie et al., 1998).

The findings, therefore, suggest that the presence of musculoskeletal symptoms in this study population is higher than in most female occupations, and the lower-back WMSD is more severe than disorders in other trunk regions. This may be explained by the fact that the job of being a flight attendant imposes a more hazardous work environment and job tasks and, thus, a greater risk for the occurrence of WMSDs than the jobs of the workers previously studied. In addition, these flight attendants were older than those in the other studies mentioned above (mean ages of 54 years vs. 33-45 years, respectively) exposure and they also had worked as flight attendants for almost their entire adult lives, with an average of 30 years on the job. Thus, the WMSDs found in this study may have arisen as a consequence of many years of accumulated exposure to potential risk factors for WMSDs.

B. Risk Factors for WMSDs

1. Work place factors

a. Physical load

The physical load of female flight attendants on long-haul international flights was assessed by self-reported job task measures. This was the first study that used this particular measure of flight attendant task-specific items. As expected, the flight attendants' physical load was found to be a significant risk factor of trunk WMSDs in this study, supporting

the findings from extensive reviews of WMSD studies including both male and female workers in a variety of occupations (Bernard, 1997; NRC & IOM, 2000).

In accordance with previous flight attendant studies (Han, 2003; Logie et al., 1998), certain job tasks involving the manual handling of material were found to be high physical-loading tasks in this study. Six out of the 10 job tasks with the highest physical load involved handling materials such as crew bags, carts, bins with heavy items, coffee pots, and meal trays. The mean scores of each of these tasks were 9 or greater out of 12. Although pushing and pulling carts have been most frequently addressed as a hazardous task (AFA-CWA, n.d.; United Airlines, 2001), the perceived physical load induced by the task of handling crew bags was found to be as high as the load for the cart-handling. The flight attendants have been frequently required to "lift and reach to stow crew bags in overhead bins" and "carry crew bags while walking up and down stairs".

The flight attendants also perceived these tasks as strenuous and experienced moderate intensity of symptoms while performing these tasks. This is consistent with an earlier study (Rozmaryn, 1998) that reported that baggage handling (assisting passengers and loading bags overhead) was the most common source of flight attendants' injuries, resulting in 2,704 lost work days during an 18-month period at one U.S. airline. In that study, although the task related to crew-bag handling was not examined separately, the high injury rates among flight attendants might, in part, be a result of handling crew bags. On the other hand, in the current study, flight attendants occasionally handled passengers' baggage, and they perceived strenuousness while lifting and reaching to stow them in overhead bins.

Although the weight of carry-on baggage was not examined in this study, the heavier the baggage, the greater the physical load that is required (Luttmann, Jager, & Griefahn, 2003).

Several airlines (e.g., American, Delta, and Northwestern) have a weight limit of 40 lbs or less for carry-on baggage (Engineered Packaging Solutions, 2005), but the airline studied has no regulation on the weight limit of carry-on passengers' baggage. Today, the popular luggage on wheels makes it possible for passengers to take their heavy baggage aboard the aircraft, and so flight attendants may have more occasions to handle passengers' heavy baggage. They might be asked to carry or lift over-head the heavy bags that exceed the recommended weight limit of 51lbs for females set by the revised NIOSH lifting equation (Waters, Putz-Anderson, & Garg, 1994). Further, handling their own baggage was an important issue raised in this study population. The flight attendants have designated positions in the overhead bin area to stow their baggage, and they lift the bags up and down many times on each flight. Sometimes they have to walk up and down stairs with heavy bags.

In addition to baggage, other materials (carts, bins, meal trays, and coffee pots) were frequently handled by the flight attendants, and they perceived the tasks involving these materials as strenuous. The flight attendants also reported that they experienced moderate intensity of symptoms while performing these tasks. In Han's study (2003), self-reported weight of objects over 11 lbs increased the risk of low-back pain among Korean flight attendants, and the risk estimate increased with weight. In this study, the data on the weight of each material manually handled were not collected, but they are a variety of weights, for example, carts (122-230 lbs), a bin of six bottles of champagne (24 lbs), a bin of 25 cans of soda (23 lbs), meal rack with 10 entrees (14 lbs), and a coffee pot (4 lbs) (United, 2003). The flight attendants reported that pushing and pulling carts to reposition them in the galley and to steer in the aisles were among the top 10 highest physical loading tasks. The initial force (12 lbs [empty cart] and 35 lbs [fully loaded beverage cart]) required for pushing or pulling carts (Han, 2003) exceeded the

acceptable maximum initial forces of push (Snook & Ciriello, 1991). This suggests that the task may be a high risk factor for WMSDs in this study population. In addition, the tasks performed while serving beverage, meals, or duty-free items, for example, carrying coffee pots, squatting to take meal trays in/out of carts, and squatting and pulling bottom bins with heavy items, were found to be high physical loading tasks. Although these materials are not heavy, the finding suggests that when they are frequently handled or involve awkward postures, the physical load induced by the tasks seems to increase.

Flight attendants' work postures that were involved in the top 10 job tasks with the highest physical load included standing, reaching, squatting, bending, and wrist rotating. These were frequently observed during over one-third of the shift for Canadian flight attendants with a high prevalence of WMSDs (Logie et al., 1998). The job task of "standing for a long time" showed the highest physical load among the flight attendants in this study, indicating a high risk for WMSDs as found in other studies (Brulin et al., 1998; Pietri et al., 1992; Xu, Bach, & Orhede, 1997). The flight attendants reported that it was a task that is almost always performed and is physically strenuous, and they perceived symptoms of moderate intensity while standing for a long time. It appears that the majority of tasks were performed on their feet. Standing postures are in low physical loading situations, but maintaining low loads for long periods of time leads to strain in muscle tissues, and slow recovery of the strain that can lead to musculoskeletal symptoms (Ranney, 1997).

In addition to the standing posture, the results of this study showed that certain tasks involving awkward postures ("reaching to close overhead bins," "rotating wrist to pour coffee and beverages," "squatting to take meal trays out of carts and return them," and "reaching and bending to serve the passengers in the window seat") imposed high physical load. This is

consistent with the findings from Canadian flight attendants (Logie et al., 1998). Before take-off, the flight attendants have to close all overhead bins and check whether the overhead bins' latches are secured. While performing this task, they frequently work with their hands above their heads with adequate force to reposition carry-on baggage and to close overhead bins. The force given at the wrist level during pushing or pulling the baggage in combination with the increased distance from the baggage or overhead bins to the body may increase physical load. Repetitive rotation of the wrist to pour coffee and beverages may increase the load on the shoulders and neck because this task requires flexion, or forward reach, of the arm. This leads to increased distance between the body and the object, which results in much greater moment (distance x force). In combination with the weight of the coffee pot one holds, the increased moment results in shoulder muscle fatigue (Marras, 1999). Also, this task requires forward flexion of the neck from the vertical position, resulting in increased activation of the neck musculature and more probability of muscle fatigue because the neck muscles remain in a static posture (Marras, 1999). Squatting and bending may lead to strain, particularly in the back body region. Walking for a long time, frequently on the 5-20 degree slope of a cabin floor (Logie et al., 1998), might require increased physical load. There is a need to further investigate whether there is a positive relationship between these postures and WMSDs.

The overall physical-load score was calculated by summing all three separate dimensions (frequency, strenuousness, and intensity of symptom) of job task measures that combined all the separate 41 tasks. Because the strenuousness and symptom intensity were highly correlated ($r=0.85$, $p<0.05$), the overall physical load score was determined predominantly by these two dimensions. For example, flight attendants did not sleep in passenger seats in the economy section frequently, but it was perceived to be strenuous and the intensity of symptoms was higher

than for most job tasks. Thus, the overall physical load was estimated to be relatively high. Conversely, the very frequently performed tasks ("arming/disarming door" and "pinching tongs to hold service items") were among the 10 lowest physical loading tasks because of the low degree of strenuousness and low intensity of symptoms. Although both strenuous and frequently performed tasks would be a priority for ergonomic intervention, frequently performed tasks such as the aforementioned may be considered risk factors for WMSDs in view of their accumulated effect (Conrad et al., 2000; NRC &IOM, 2001). In planning safety training, therefore, each of the three physical-load dimensions may need to be examined separately to identify job tasks that place flight attendants at risk for WMSD. In addition, there is a need to further examine the risk estimates of physical load by each task in order to prioritize specific job tasks for further ergonomic assessment and intervention.

b. Work organization

In this study, the work organization influencing WMSDs was measured by four work-related psychosocial factors and five scheduling factors. Overall, the flight attendants perceived that their job was psychologically demanding with respect to five characteristics: fast work, hard work, excessive work, insufficient time to complete work, and conflicting demands. In the current study, the mean score of psychological demand on the flight attendants was greater than the results for the U.S. general female work population (36 vs. 30.9, respectively) (Karasek et al., 1998). Another study of flight attendants (Logie et al., 1998) found that flight attendants with a high prevalence of trunk WMSDs frequently reported high psychological demands associated with their work situations (e.g., deadline pressures and attention to detail). In bivariate analyses, the high psychological demand of the job in this study population was significantly associated with increased risks of WMSDs in all four body regions. After

controlling for physical load factors, however, the positive association no longer existed. This may be explained by the indirect effect via the physical load on the occurrence of WMSDs as addressed in extensive reviews of WMSD studies (Bernard, 1997, Bongers et al., 1993). Fowr example, flight attendants feel the time pressure of tight in-flight service schedules. As a result, they overload the service carts and shorten meal breaks (Edwards, 1991), which affect individuals' physical load.

The degree of decision latitude that flight attendants in this study reported was similar to that of the U.S. female-worker population at large (Karasek et al., 1998). It was also similar to that of female flight attendants with two U.S. commercial airlines (MacDonald et al., 2003). An extensive review of WMSD studies (NRC & IOM], 2001) found that low decision latitude was positively associated with an increased risk for trunk WMSDs. Likewise, flight attendants from 35 airlines across countries who had low control in their job were twice as likely to have experiences of musculoskeletal symptoms during the previous six months (Morley-Kirk & Griffiths, 2003). However, the current study failed to support the positive association between low decision latitude and trunk WMSDs. This might be explained by the fact that the flight attendants who participated in two studies had attained different level of seniority. In the Morley-Kirk and Griffiths' study, only two-thirds of the participants had been in the flight attendant job for 8 or more years, whereas almost all flight attendants in this study had been flight attendants for at least about 8 years. Senior flight attendants were more likely to have management positions (purser or lead) in the cabin and more freedom to decide how to work. Also, they might have more freedom to decide their work schedules and position in the cabin because the scheduling is assigned through a bidding system by seniority.

The mean score for social support was slightly less than for the general female work population in the U.S. (Karasek et al., 1998) (23.6 vs. 26.0, respectively). In both bivariate and multiple logistic regression analyses, low social support from supervisors but not co-workers was found to be a risk for WMSDs of the upper-back. Low support from a supervisor (purser or lead) increased the risk of upper-back WMSDs. This is consistent with a study of Korean flight attendants (Han, 2003), in which flight attendants with back pain had significantly less support from their supervisors than those who did not have back pain, but support from co-workers was not significantly different between the two groups. Flight attendants work in a team setting that requires close cooperation with each other (Logie et al., 1998). An earlier study of Italian female flight attendants found that flight attendants generally felt that they were emotionally supportive of each other. For example, they overcame difficult emotional feelings related to their work-related psychological demands by sharing them with their colleagues (Ballart et al., 2004). On the other hand, flight attendants received less support from their supervisors than those in comparable positions (Han, 2003; Mac Donald et al., 2003). In a separate study of flight attendants (Morley-Kirk & Griffiths, 2003), over half of the participants reported low social support from their supervisors, and this was positively associated with increased job stress. It suggests that these work organizational characteristics in the flight attendant job need to be integrated into the planning of intervention programs to reduce WMSDs.

Job insecurity has been considered a risk factor for WMSDs less frequently than the other work-related psychosocial factors that have already been discussed. However, WMSDs related to job insecurity can be prevalent among flight attendants, who work in a rapidly changing organizational environment. Flight attendants might have more psychological burdens from the job insecurity that accompanies organizational restructuring or labor market dynamics than other

occupations. The results of this study clearly demonstrate that the increased need in many airline industries to continue to operate more effectively with fewer resources has left flight attendants contemplating the future of their current jobs with growing uncertainty and ambiguity. The majority (90%) of the flight attendants in this study reported that their jobs were not secure versus 27% in an earlier study (MacDonald et al., 2003). The difference between the two studies can be explained by the different time points studied (1995 vs. 2005). It is true that the airline industry has faced increased economic pressure since the events of September 11, 2001, which is one of the major crises airlines have faced during the past 25 years.

The airline selected for this study has been cutting back on the number of flight attendants to reduce operating costs since it filed for bankruptcy protection in 2002. Remaining flight attendants may not feel that their jobs are secure because of the current undesirable situation, such as airline bankruptcy and restructuring (Whitelegg, 2004). In the bivariate analyses, job insecurity was found to be a risk for both upper- and lower-back WMSDs in this study population. The positive association, however, remained significant only in lower-back WMSDs after controlling for the effects of other factors. Again this supports the direct pathway that high job insecurity triggers lower-back WMSDs, whereas it is probable that the effect of job insecurity on Upper-back WMSDs is mediated by the physical load factors.

In addition, the flight attendants flew 87 hours a month with a length of 11 hours each segment on average. In view of the effect of sustained physical load on WMSDs, the effect of exposures over a long period of time on WMSDs would explain the high percentages of WMSD presence among this study population. A review of WMSD studies showed that prolonged exposures to physical load factors increased the risk of WMSDs (Bernard, 1997). However, this study could not compare the effect s of long working hours on WMSDs because there was no

comparison group. In addition, the flight attendants worked more often in first or business class than economy class. An earlier study (Preston, 1978) presented that the energy expenditure of flight attendants who worked in the economy class was higher than those who worked in the first class. This suggests that the economy class work might require higher physical load than the first class, but the current study revealed no association between service section and WMSDs.

This study population was limited to flight attendants working mostly on international flights, thus, they worked on large aircrafts such as Boeing-747, Boeing-777, and both Boeing-747 and Boeing-777. In bivariate analyses, flight attendants who most often worked in Boeing-747 had more increased risks of neck and upper WMSDs than those who worked in the other aircrafts. The finding may be explained by different layouts of the aircrafts in terms of ergonomic aspects. However, none of these scheduling factors showed significant associations with WMSDs in multiple analyses.

c. Physical environment

Physical-environmental factors in the cabin have long been a concern of flight attendants; to date, however, no studies have investigated the relationship between the cabin's environmental factors and WMSDs. The flight attendants perceived that they had frequently been exposed to uncomfortable air quality, noise, inadequate lighting, and vibration. Most frequently they reported three of the uncomfortable cabin-air qualities: dry air, stuffy air, and too little air movement. This may be due to the fact that the cabin is an enclosed environment and the occupants are totally dependent on the air provided by the environmental-control systems that pressurize the cabin, maintain its temperature, and ventilate the cabin with outside air (NRC, 2002). Also, aircraft noise was frequently reported. Whole body vibrations (WBV), which can come from mechanical and aerodynamic sources of the aircrafts and are

transmitted to the flight attendant through the cabin floor, were less frequently reported, indicating they may not be usually perceived as hazardous. Johanning and colleagues (1991) speculated about the combined influence of WBV and noise on WMSDs. The effects of WBV and noise on WMSDs, however, have not yet been studied with a flight attendant population.

In bivariate analyses, flight attendants who perceived more frequent exposure to uncomfortable cabin environmental factors were 2-3 times more likely to have neck, shoulder, and Upper-back WMSDs. The positive association with lower-back WMSDs, however, was not found in this study, in contrast to earlier studies conducted in different occupations (Chen, Yu, & Wong, 2005; Harkness et al., 2003). The strength of risk estimates was slightly higher in the neck and shoulder region than the upper-back region. The reason for the difference among body regions is unclear. In multiple logistic regression analyses, however, the positive association no longer existed after adjustment for other factors. This may be explained by indirect pathways through psychosocial factors. In earlier studies of various occupations, the risk of WMSDs was increased by physical-environmental factors such as noise and air quality (Schneider et al., 2005), noise, vibration, and heat (Chen, Yu, & Wong, 2005), and hot condition (Harkness et al., 2003). Although these findings relied on self-reported measures without objective measures of the environmental factors, the investigators consistently speculated that workers' perception of the poor environmental factors increased their psychological stress. This may then lead to increased physical load.

The plausible linkage between physical environment and psychosocial factors was supported by a commercial air crew study (Lindgren, Norback, Andersson, & Dammstrom, 2000). In that study, perceived poor cabin environmental conditions (draftiness, too high/low temperature, varying temperature, stuffy air, dry air, unpleasant odor, static electricity, noise,

inadequate illumination, and dust and dirt) were positively associated with psychological demand (excessive work) (ORs 2.35-13.18, 95% CIs 1.02-39.93) among pilots and flight attendants in Scandinavia. In addition, the aircrews who perceived frequent exposure to draftiness, varying or too low temperature, dry air, unpleasant odor, inadequate illumination, and dust and dirt were more likely to have low work control (i.e., little opportunity to influence their working conditions). The results of the current study suggest that physical-environmental factors in the cabin indirectly influence WMSDs through psychosocial factors. In the current study, the influence of each environmental factor in the cabin on WMSDs through this plausible way was not examined separately. However, the cabin environmental factors particularly poor air quality and noise, which were most frequently reported by this study population, may have played a role in this indirect influence.

2. External environmental factors

External environmental factors that may contribute to the occurrence of WMSDs were assessed as the degree of concerns about terrorism threats, turbulence, air rage, and catastrophic equipment malfunctions. In this study, a large portion of the flight attendants reported that they were "some" or "very much" concerned about all of the external environmental factors. The majority (80%) of the flight attendants reported that they had been some or very much concerned about the threat of terrorism. This safety issue might become more important since the event of the 9/11 terrorist attack. Flight attendants are more likely to be exposed to the threats than those in other occupations as shown in previous surveys (Lating et al., 2004; Schuster et al., 2001). Turbulence was one commonly reported safety hazard among flight attendants (AFA-CWA, n.d.) and this study population working on longer flights might have been more exposed to possible turbulence. Possible aircraft malfunction was another concern

among this study population. In bivariate analyses, these uncontrollable external environmental factors were associated with an increased risk of the occurrence of shoulder WMSDs, but remained insignificant after adjusting for other factors. Again, although the independent effects of the external environmental factors on WMSDs were not found in this study, these factors might link to other risk factors such as physical load or psychosocial factors that may lead to the occurrence of WMSDs.

3. Personal factors

Of the personal factors examined in this study, bivariate analyses showed that only work pattern, sleep quality, and uniform comfort were associated with increased risks of shoulder or upper-back WMSDs. After adjustment for other risk factors, however, none of the personal factors were significant. In this study, however, over 80% of the flight attendants were between 50 and 68 years of age with a mean length of employment of over 30 years. The advanced age and increased number of years on the flight attendant job may have contributed to the high percentage of WMSDs. Age may increase the development and severity of WMSDs because of decreased muscle function due to the development of degenerative disorders and decreased tissue strength (Bernard, 1997). The mean muscle strength maximized between the ages of 20 and 30 years gradually decreases over the remaining lifespan and the changes increase after 40 years of age (de Zwart, Frings-Dresen, & van Dijk, 1995). The degeneration of spinal discs with age may have implications in increased risk of back pain that originates from intervertable discs (NRC & IOM, 2001). Both age and length of employment, however, were not associated with increased WMSDs in this population.

Height and BMI failed to support positive or negative associations with the occurrence of WMSDs in this study. An earlier study found that increased BMI was associated with WMSDs

(Kortt & Baldry, 2002). The positive results might be attributable to the inclusion of a broad range of diseases under the category of the International Classification of Diseases 710-739 (diseases of the musculoskeletal system and connective tissue) and all body regions including low-extremity regions. In fact, the presence of arthritis of knee or feet was not examined in this study. Flight attendants on long-haul international flights tend to be in a continuous situation of circadian rhythm disruption that leads to sleep disturbance and consequent fatigue. It is of interest that sleep quality and fatigue were not serious in this study population. This is in contrast to a prior study that showed that over 90% felt fatigued both during and after flights (Smolensky, Lee, Mott, & Colligan, 1982).

C. Strengths and Limitations

It is essential to use precise measures to detect and quantify the contribution of the job tasks to the occurrence of WMSDs. Although direct measures are more valid and reliable than self-reports, it was deemed most appropriate to use self-reported measures because of the variability in flight attendants' job tasks. A strength of this study is that that the job task items created in this study are flight attendant job-specific items unlike other self-reported generic measures. A previous self-reported measure (Han, 2003) to assess flight attendants' job tasks consisted of general work activity items such as "lifting heavy loads", whereas this study consisted of task-specific items such as "lifting and reaching to stow crew bags in overhead bins". In terms of biomechanical loading, the given external load (e.g., weight of object) to the body can generate different amounts of loads on the spine, depending on the other parameters (e.g., distance of the object from the body). Thus, the task specific items provide information about possible loads on the body although measurement of actual biomechanical load was not possible. In addition, the job-specific items were developed integrating the perspectives of flight

attendants from the target population. Thus, the measure fits the population and setting targeted. The measure established good internal consistency and test-retest reliabilities. Also, union air-safety and health experts assisted in establishing the content validity of the measures. Thus, the physical load data on each job task will allow occupational health nurses and ergonomic teams to focus on surveillance and identification of hazardous job tasks and to prioritize job tasks for further task analyses, such as quantifying biomechanical parameters.

However, the time period and the wording of the job task measure might be a source of variability in the estimation of physical load. In this study, muscloskeletal symptoms were estimated by one-year time period following the classification of WMSD cases developed by the NIOSH ergonomic experts (Bernard et al., 1994). The one-year time period is appropriate to assess musculoskeletal symptoms in terms of the characteristics of fluctuating and recurrent diseases and the saliency of the topic (Sudman & Bradburn, 1982). On the other hand, it is difficult for the respondents to remember a low salient topic such as usual job tasks by the one-year time period. Thus a shorter time period of 30 days was used in the question for the frequency of job task measure. Because flight attendants are likely to do the same or similar tasks on all international flights, the physical load estimated during the last 30 days should indicate the physical load on average during the past year. However, the designation of 30 days was only presented for the frequency dimension and no skip pattern was provided for those who indicated they had not performed the job task in the prior 30 days. Thus some flight attendants who had not performed the task responded to the strenuousness and symptom intensity dimensions. This potential response bias may result in low precision of the physical load estimate.

Several limitations of the cross-sectional mailing method used for this survey need to be acknowledged. Non-coverage bias might be possible because the sampling frame excluded some units of the study population. This study targeted those who had worked 75 hours or more in the previous month, with at least one long-haul international flight in the previous 3 months, but it was not possible to obtain data pertaining to the eligibility criteria from the target population at the phase of constructing the sampling frame. The most accessible data about the target population were a list of the flight attendants who had worked on any international flights in a given month (October 2004). Although it was possible to include those who were not in the study population (e.g., those on short-haul international flights or part-time attendants), after discussion with the union staff it was decided that this list would represent the target population more closely than would the entire membership list. However, it is possible to exclude those who took vacation, filed sick leave, or were scheduled for domestic flights during the designated time period. It is also possible to include some flight attendants who should not be in the sampling frame. Because the initial mailing was started in January, right after holidays, it is possible that the actual flight hours might be different between in October and December. Flight attendants on long-haul international flights tend to be seniors, thus they have priority in choosing flight schedules. Although they worked on a full-time base, it is probable that they took some vacation days during the holiday seasons. On the screening questionnaires returned, four of the ineligible flight attendants provided such information on the question about flight hours during the previous month. Because of the probability of this non-coverage, it might be difficult to conclude that the relationship between risk factors and WMSDs would not be systematically different in the sample than it would be for the target population as a whole. Thus, the results of this study may be less generalizable to the target population of interest.

The study achieved a response rate of 63%. One would have expected it to be higher than earlier flight attendant surveys (Cone & Millar, 1993; Han, 2003) because this study administrated one postcard reminder and additional two follow-up mailings. However, the response rate was similar to those studies (63% and 58%, respectively) with only one mailing. This may be explained by the fact that this study only targeted flight attendants on international flights, who frequently are away from home and therefore are more difficult to contact. The analysis of the data using the Chi-square and independent t-test showed that there were no significant differences between respondents and unit non-respondents regarding age, years of employment as a flight attendant, and base city. Therefore, it is unlikely that there is serious unit non-respondent bias in this study.

There is cause for concern that self-selection bias in this study may lead to overestimation of risk factors, WMSD symptoms, or both. Flight attendants who had WMSDs may be more likely to participate in the study, and the self-selected flight attendants might be more conscious of their symptoms and have a lower threshold for reporting WMSDs (Josephson et al., 1997; Ursin et al., 1988). In addition, other personal characteristics (job dissatisfaction or readiness to report complaints) may also influence the relationships between risk factors and WMSDs (Bjorksten et al., 1996). Conversely, as with most cross-sectional studies, it is possible that flight attendants with severe WMSDs have a higher probability of leaving their jobs or changing jobs to a less arduous job. This healthy worker effect leads to an underestimation of the results. The effect could not be examined in this study, but the participants' long length of employment as flight attendants indicates that this study population is stable. So, it is speculated that the healthy worker effect is unlikely to influence the observed associations.

The self-report nature of the data raises concerns of reporting bias for physical load estimation between flight attendants with WMSDs and those without WMSDs. Systematic overestimation of physical load among flight attendants with WMSDs will lead to increased risk estimates. On the other hand, flight attendants with WMSDs might have learned to perform their job tasks in a way that minimizes physical load to alleviate symptoms (Punnett & Keyserling, 1987). However, the presence of WMSDs did not influence their ratings of frequency and duration of strenuous work posture and movement on the questionnaires as compared with observation (Burdorf & Laan, 1991) or interview data (Leijon, Wiktorin, Harenstam, & Karlqvist, 2002). In this study, the presence of the recall bias due to presence of symptoms could not be validated because no reference measures, such as logs and interviews, were collected.

In the current study, only one airline was studied because of the feasibility of accessing the target population of interest. Thus, generalizability is limited to the airline studied because of the effect of sample selection. Although flight attendants work the same flights and on the same aircrafts, the context of their job tasks, work organization, and personal characteristics may differ with the airline.

D. Implications for Nursing Practice and Future Research

Occupational health nurses can play key roles in promoting workers' health and protecting them from occupational and environmental hazards (Association of American Occupational Health Nurses [AAOHN], 1999). This study has several implications for occupational health nursing and research in monitoring flight attendants' WMSDs and potential risk factors and planning intervention programs.

The ecological perspective, which embraces a broad perspective encompassing both person and environment, played a role in this study by providing a systematic structure and an

understanding of the context in which flight attendants' WMSDs occur. Although the physical load is the most important factor in the etiology of WMSDs among female flight attendants, a holistic perspective on WMSDs leads to expanding the focus to the work organization, the physical (cabin) environment, the external environment, and personal factors. This is likely to be successful as a guiding framework to use in assessing multiple WMSD risk factors and conducting surveillance of flight attendants, who heretofore have been little studied. In the unique and changing contexts of the environment in which flight attendants work, the broader ecological perspective may enable occupational health nurses to enhance WMSD intervention from targeting physical load factors exclusively (e.g., proper lifting technique, use of light weight in-flight items) to including other types of intervention (e.g., self-defense training, exercise, installation of high-quality air system, change of service schedule).

It is important to use standardized case definitions for WMSDs, with specific levels of symptoms to be included in the definition. The case definition used in this study supports its usefulness for the study of the etiology of the disorders in that it captures true disorders. It is also helpful for occupational health nurses to evaluate the progress of disorders and effectiveness of interventions over time. On the other hand, measuring the presence of any level of symptoms has implications for prevention. As a screening tool, it may allow occupational health nurses to detect flight attendants who are in the early stages of WMSDs and thus help them to avoid developing severe symptoms.

It is worthwhile to note that the results of this study showed the chronicity of many of the flight attendants' musculoskeletal symptoms. Of the flight attendants who had experienced musculoskeletal symptoms of the trunk during the past year, nearly 30% have almost always (daily) experienced some level of musculoskeletal symptoms in neck, shoulders, or lower-back.

During the past year, more than one in five flight attendants experienced symptoms that lasted over three months. These findings suggest that flight attendants are at risk for potential functional consequences such as decreased worker productivity, lost time from work, temporary or permanent disability, inability to perform job tasks, and an increase in worker compensation costs. There is a need for studies that will evaluate the functional consequences of WMSDs and the relationship between levels of symptoms and functional consequences.

The job task measures established good reliability in this study. Although the content validity was, to some extent, established by experts' opinions (flight attendants, union air-safety and health staff, and a focus group), the measures need to be examined regarding the extent to which different ways of measuring the same construct inter-correlate with each other (convergent validity). For example, the overall physical load retrospectively measured by a self-reported measure should correlate with that measured by a job-task log kept during the working hours. In addition, the capacity of a measure to produce relevant group differences (divergent validity) needs to be evaluated. For example, the overall physical load for a given period reported by full-time female flight attendants on long-haul international flights should be higher than what part-time flight attendants on same flights report because of the increased frequency. Future studies for these further evaluations of construct validity will ensure generalizations from the operationalization of physical load to the concept of physical load.

The work-related psychosocial factors and physical and external environmental factors that revealed positive bivariate associations with WMSDs became insignificant after controlling for physical-load factors. This may be explained by the indirect pathways through physical-load factors to the occurrence of WMSDs. These plausible pathways warrant further analysis using more sophisticated regression modeling. Structural equation modeling specifying a set of

regression equations among the risk factors may explain the indirect effects of these risk factors via physical-load factors or other risk factors on WMSDs.

Lastly, nowadays, as a result of an aging population, the number of older workers has increased and is projected to continue to increase. As shown in this study, the proportion of flight attendants over age 50 is remarkable, indicating that the job of flight attendant was viewed as a long-term career, which is in contrast to the high turnover rates in the mid-1960s. In the airline studied, flight attendants can continue to work as long as they are willing and able. Flight attendants with WMSDs may continue to work if the disorders are not disabling or the jobs play an important role economically or socially (Wegman, 2000). Thus, in planning WMSD intervention programs, occupational health nurses in airlines need to take this change in flight attendant demographics into consideration. Although preventive strategies should be incorporated at all stages of a working life, the interventions also need to focus on helping older flight attendants be in optimal conditions to handle the physical load at work and maintain muscle function. In addition, the high percentage of WMSD cases found in this study population may be the consequence of many years of accumulated physical load exposure as a result of continuing to work. However, the current study could not examine the difference in physical load and WMSDs between younger and older age groups because the majority of flight attendants in this sample were over the age of 50 years. In the airline studied, international flight attendants who reside in five international base cities are relatively young, thus a study that included these international flight attendants may allow a comparison of the effects of age on WMSDs. This remains for future research.

E. Summary and Conclusion

One of the main findings of this study was that female flight attendants on long-haul international flights were a population at high risk for WMSDs of the trunk, especially lower-back WMSDs. For most factors under study, there seems to be slight difference between the four body regions and their links with work-related risk factors. Overlap in the body regions of the WMSD cases might have obscured the relationship between each of the body regions and the work-related risk factors examined.

Physical load factors were found to be of the utmost importance as risk factors for the neck, shoulder, upper-back, and lower-back WMSDs in female flight attendants on long-haul international flights. Similar to other studies, physical load induced by manual material-handling activities and certain awkward or static work postures was strongly associated with the occurrence of WMSDs of the trunk among female flight attendants. In addition, among the work organizational factors examined in the study, low social support increased the risk of upper-back WMSDs and high job insecurity increased the risk of lower-back WMSDs. Female flight attendants frequently reported uncomfortable cabin environmental factors because of air quality and noise. Uncontrollable external environmental factors, such as turbulence, terrorism threats, air rage, and aircraft malfunction, were also matters of much concern in this study population. Personal factors such as long duration of employment as flight attendants and increased age found were important background information and played a role in interpreting the relationship between other risk factors and WMSDs and in providing suggestions for future studies. Although the positive association remained insignificant after adjustment for other factors, in an ecological view looking at both environment and person, it is also important to include these

environmental (physical and external) and personal factors that may place female flight attendants on long-haul flights at risk for WMSDs.

In conclusion, to date there has been little research into the flight attendant population, although concerns about their health problems linked to their vulnerable work environment have consistently been raised. Therefore, it is worthwhile to note that the results of this study provide evidence of the presence of one significant work-related health problem, WMSDs of the trunk. Further, physical load, social support, and job insecurity were found to be risk factors for WMSDs in this study population. In particular, the flight attendant job-specific tasks developed for this study provided contextual understanding of actual job tasks that may put flight attendants at risk for WMSDs. The findings suggest that the future planning of efficient and effective preventive strategies to reduce the risk of WMSDs focuses on these main factors.

APPENDICES

APPENDIX A

1. Cover letter (1st mailing)

Dear Flight Attendant,

Flight attendants work on their feet in a unique environment doing a variety of physically strenuous tasks, some of which may result in musculoskeletal symptoms. It is important to learn more about how your work affects your health, so that we can continue to make your work environment as safe as possible. It is particularly important to hear firsthand from you about your workplace and how it may influence musculoskeletal health.

I am writing to ask for your help in a survey being conducted for female flight attendants on work-related musculoskeletal symptoms. The purpose of this research study is to examine the relationships between various risk factors and the occurrence of musculoskeletal symptoms in female flight attendants. Of particular interest is the impact of workplace factors including job tasks, work organization, and physical environment on the occurrence of trunk (neck, shoulder, and back) musculoskeletal symptoms. As a doctoral student in nursing, a former occupational health nurse, and medical attendant for Korean Airline, I have a special interest in this topic and have seen the problem firsthand.

I am conducting my research with the full support of the Association of Flight Attendants (AFA). Your name was drawn randomly from the AFA membership roster. This survey packet including a cover letter and a questionnaire was prepared by us and the AFA was asked to send them to you directly because we do not have any information about your name and address.

Results from the survey will be used to identify high priority risk factors for work-related musculoskeletal symptoms, which will be studied in more detail in future research. Also, by knowing more about the relationships between risk factors and musculoskeletal symptoms in flight attendants, we can suggest ideas for making changes in safety policies and facilitate effective surveillance and intervention programs for work-related musculoskeletal symptoms.

The information you provide in the questionnaire will be kept completely confidential, and it will be used for research purposes only. This survey questionnaire contains an identification number on the back cover of the questionnaire. I will use the identification number to avoid sending you needless reminders about completing the survey. The identification number will be cut off from the questionnaire once your questionnaire has been returned. You should not put your name on the questionnaire so that your name can never be connected to the results in any way. The results of the study will be reported in group form so that individual persons who answered the questionnaire cannot be identified. Specifically, your individual responses will not be made to available to your employer.

This survey is voluntary. However, only with your generous help, by your sharing your experiences and opinions, can this research be useful. Upon completing the questionnaire, please return it in the enclosed stamped, self-addressed envelope. It should take you about 25-35 minutes to complete. By completing and returning the questionnaire, you are agreeing to participate. If for some reason you prefer not to

respond, please let me know by returning the blank questionnaire in the envelope. This would be very helpful, and you will not receive future reminders.

If you have any questions or comments about the study, please call me at (312) 413-4073 or e-mail me at hlee39@uic.edu. If you have any questions about your rights as a research subject, please call the UIC Office for the Protection of Research Subjects at (312) 996-1711. Thank you very much for helping with this important study.

Sincerely,

Hyeonkyeong Lee, MS, RN
Principal Investigator
Flight Attendant Research Project

APPENDIX A (continued)

2. Reminder postcard (2nd mailing)

Dear Flight Attendant,

A survey questionnaire asking about your work environment and work-related musculoskeletal symptoms was mailed to you about two weeks ago.

If you already have completed and returned the questionnaire to me, please accept my sincere thanks. If not, please do so at your earliest convenience. I am especially grateful for your help because it is only by asking people like you to share your experiences and opinions that I can better understand what workplace factors are associated with musculoskeletal symptoms in flight attendants.

Sincerely,

Hyeonkyeong Lee, MS, RN
Principal Investigator
Flight Attendant Research Project

APPENDIX A (continued)

3. Cover letter with first replacement questionnaire (3rd mailing)

Dear Flight Attendant,

About one month ago, I sent you a survey questionnaire asking about your work experiences and your opinions of your workplace environment and any musculoskeletal symptoms you may have experienced. To the best of my knowledge, it has not yet been returned. I am writing again because it is important to receive input from as many people as possible since everyone has unique circumstances, experiences, and opinions.

A few people have written to say that they should not have received the questionnaire because they do not meet the selection criteria for this survey. If this applies to you, please let me know by returning the questionnaire in the enclosed envelope so that I can remove you from the mailing list for this study.

The information you provide in the questionnaire will be kept and completely confidential, and it will be used for research purposes only. This survey packet including a cover letter and a questionnaire was prepared by us and the AFA was asked to send them to you directly because we do not have any information about your name and address. This survey questionnaire contains an identification number on the back cover of the questionnaire. I will use the identification number to avoid sending you needless reminders about completing the survey. The identification number will be cut off from the questionnaire once your questionnaire has been returned. You should not put your name on the questionnaire so that your name can never be connected to the results in any way. The results of the study will be reported in group form so that individual persons who answered the questionnaire cannot be identified. Specifically, your individual responses will not be made to available to your employer.

This survey is voluntary. However, only with your generous help, by your sharing your experiences and opinions, can this research be useful.

I hope that you will complete the questionnaire and return it soon, as the information you share will greatly benefit our research and help us to better understand what workplace factors are associated with musculoskeletal symptoms in flight attendants. It should take you about 25-35 minutes to complete. By completing and returning the questionnaire, you are agreeing to participate. If for any reason you prefer not to answer it, please return a note or a blank questionnaire in the enclosed stamped, addressed envelope, and your name will be removed from the mailing list.

If you have any questions or comments about the study, please call me at (312) 413-4073 or e-mail me at hlee39@uic.edu. If you have any questions about your rights as a research subject, please call the UIC Office for the Protection of Research Subjects at (312) 996-1711.

Thank you very much for helping with this important study.

Sincerely,

Hyeonkyeong Lee, MS, RN
Principal Investigator
Flight Attendant Research Project

APPENDIX A (continued)

4. Cover letter with second questionnaire replacement (final contact)

Dear Flight Attendant,

During the last two months I have sent you several mailings about an important research study I am conducting for flight attendants. The purpose is to examine the relationships between various risk factors and the occurrence of musculoskeletal symptoms in female flight attendants.

For your convenience, I have enclosed another copy of the questionnaire and a postage-paid return envelope. Hearing from everyone in the random sample helps ensure that the survey results are as accurate as possible.

The information you provide in the questionnaire will be kept and completely confidential, and it will be used for research purposes only. This survey packet including a cover letter and a questionnaire was prepared by us and the AFA was asked to send them to you directly because we do not have any information about your name and address. This survey questionnaire contains an identification number on the back cover of the questionnaire. I will use the identification number to avoid sending you needless reminders about completing the survey. The identification number will be cut off from the questionnaire once your questionnaire has been returned. The results of the study will be reported in group form so that individual persons who answered the questionnaire cannot be identified. Specifically, your individual responses will not be made to available to your employer.

I also want to assure you that your response to this study is voluntary. If for some reason you prefer not to respond, please let me know by returning the blank questionnaire in the envelope. This would be very helpful, and I can then remove your name from the mailing list.

I appreciate your willingness to consider my request to participate in this study, and hope that you will complete out and return the questionnaire soon, as the information you share will greatly benefit our research to better understand what workplace factors are associated with flight attendants' musculoskeletal symptoms. It should take you about 25-35 minutes to complete. By completing and returning the questionnaire, you are agreeing to participate.

If you have any questions or comments about the study, please call me at (312) 413-4073 or e-mail me at hlee39@uic.edu. If you have any questions about your rights as a research subject, please call the UIC Office for the Protection of Research Subjects at (312) 996-1711.

Thank you very much for helping with this important study.

Sincerely,

Hyeonkyeong Lee, MS, RN
Principal Investigator
Flight Attendant Research Project

APPENDIX A (continued)

5. Support letter

ASSOCIATION OF FLIGHT ATTENDANTS – CWA, AFL-CIO
501 Third Street, NW, Washington, DC 20001-2797
PHONE 202•434•1300 FAX 202•434•1319

November 15, 2004

Dear AFA member,

I am writing to request your support of an important new research study into risk factors for work-related musculoskeletal disorders in female flight attendants. This study is being conducted by Ms. Hyeonkyeong Lee, a doctoral candidate at the University of Illinois at Chicago College of Nursing.

This research is essential to understanding how flight attendant job tasks and physical environments relate to the development of musculoskeletal disease symptoms. United flight attendant volunteers, along with staff from the United-AFA MEC office and the AFA Air Safety, Health and Security Department, have worked closely with Ms. Lee and her dissertation committee over the past year to develop a valid, accurate survey form.

You have been randomly selected to receive this survey from a recent list of female flight attendants who have been awarded international bids. The survey is specifically targeted to active female flight attendants who have worked at least one long haul international flight during the past three months. To verify your eligibility for completing the entire survey, please answer **at least** the first three questions – if you answer **Yes** to all three, complete the entire survey. If you answer **No** to any of the three, simply leave the rest of the survey blank and return it in the enclosed stamped, self-addressed envelope.

Your responses to the survey questions will help develop a thorough, scientific understanding of how the flight attendant work environment influences musculoskeletal health. With this knowledge, AFA and the scientific community can develop specific recommendations for changes to equipment and safety policies that reduce ergonomic hazards and facilitate effective surveillance and intervention programs. Therefore, I urge you to support this study by taking the time to complete and return the enclosed survey.

In Solidarity,

Patricia A. Friend
International President

APPENDIX B

University of Illinois at Chicago
College of Nursing

Flight Attendant Work-related Musculoskeletal Symptom Survey

Conducted by:

Hyeonkyeong Lee, MS, RN
Principal Investigator
Flight Attendant Research Project
University of Illinois at Chicago College of Nursing

with the support of

Association of Flight Attendants-CWA, AFL-CIO

APPENDIX B (continued)

Screening Questions

Before starting the questionnaire, please answer the following screening questions to determine if you are eligible to participate in this survey. Please circle only one response for each question. If you answer "No" to a question, please follow the directional arrows.

1. Are you female?

   Yes 1

   No 0

2. During the past 3 months, have you worked at least one long haul international flight that included both meal services and duty free sales?

   Yes 1

   No 0

3. During the past 30 days, have you worked at least a 75 hour flight schedule?

   Yes 1

   No 0

If you answered "Yes" to Questions 1, 2, and 3, you are Eligible for this survey. Please go to Page 2.

If you answered "No" to one or more of the above three questions, thank you very much for agreeing to participate. Unfortunately, you do not meet all of the criteria to participate in this study. Please do not complete the remaining questions in this survey questionnaire. To help us to maintain our records, please return your questionnaire in the enclosed stamped and self addressed return envelope.

APPENDIX B (continued)

I. WORKPLACE FACTORS

A. Job tasks

The following is a list of job tasks you perform on board the aircraft. Descriptions for the tasks were developed by a focus group that included UAL flight attendants who work long haul international routes. For each one, first please indicate how frequently you performed physically strenuous job tasks during long haul international flights in the past 30 days. Second, please indicate how physically strenuous each of these tasks is to you. Third, for each one, please indicate how much ache, pain or discomfort that you have experienced while performing these tasks based on your own personal experience. It is expected that different people will rate the tasks somewhat differently. PLEASE CIRCLE ONLY ONE RESPONSE FOR EACH QUESTION.

	1a. On average, how often did you perform this job task per segment in the past 30 days?				1b. On average, how physically strenuous is this job task for you?				1c. How much ache, pain or discomfort did you experience while performing this job task? The numbers between 0 and 10 represent ALL levels of ache, pain, or discomfort a person could experience. "Zero" means no ache, pain, or discomfort and "10" means ache, pain, or discomfort as bad as it could be. Please circle ANY number between 0 and 10 that describes your experience.										
	Not Done	Occasionally	Frequently	Almost Always	Not Strenuous Strenuous	Somewhat Strenuous	Strenuous	Very	0 No pain										10 as bad as it could be	
Carry-on baggage handling																				
(1) Carrying passengers' bags	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	
(2) Carrying crew bags while walking up and down stairs	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	
(3) Lifting and reaching to stow passengers' bags in overhead bins	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	
(4) Lifting and reaching to stow crew bags in overhead bins	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	
(5) Reaching, pulling, and pushing bags to reposition in overhead bins	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	
(6) Reaching and pushing to close overhead bins	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	

APPENDIX B (continued)

	1a. On average, how often did you perform this job task per segment in the past 30 days?				1b. On average, how physically strenuous is this job task for you?				1c. How much ache, pain or discomfort did you experience while performing this job task? The numbers between 0 and 10 represent ALL levels of ache, pain, or discomfort a person could experience. "Zero" means no ache, pain, or discomfort and "10" means ache, pain, or discomfort as bad as it could be. Please circle ANY number between 0 and 10 that describes your experience. 0 (No pain) — 10 (as bad as it could be)										
	Not Done	Occasionally	Frequently	Almost Always	Not Strenuous	Somewhat Strenuous	Strenuous	Very Strenuous												
Cart handling																				
(7) Pulling and pushing beverage carts with hands while walking on an incline	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	
(8) Pulling and pushing meal carts with hands while walking on an incline	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	
(9) Pulling and pushing duty free carts with hands while on an incline	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	
(10) Pushing against the cart with knees and hips	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	
(11) Pushing and pulling to steer the cart away from passengers	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	
(12) Pushing and pulling carts to reposition in the galley	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	
(13) Pushing and pulling carts to move to/from upstairs by an elevator	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10	

APPENDIX B (continued)

	1a. On average, how often did you perform this job task per segment in the past 30 days?				1b. On average, how physically strenuous is this job task for you?				1c. How much ache, pain or discomfort did you experience while performing this job task? The numbers between 0 and 10 represent ALL levels of ache, pain, or discomfort a person could experience. "Zero" means no ache, pain, or discomfort and "10" means ache, pain, or discomfort as bad as it could be. Please circle ANY number between 0 and 10 that describes your experience.										
	Not Done	Occasionally	Frequently	Almost Always	Not Strenuous	Somewhat Strenuous	Strenuous	Very Strenuous	0 No pain										10 as bad as it could be
Galley work																				
(14) Lifting bins out of carts over your head into galley	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(15) Reaching to reposition galley bins in higher levels	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(16) Reaching, bending, and squatting to reposition galley bins in lower levels	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(17) Reaching to latch galley bins in higher levels	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(18) Reaching, bending, and squatting to latch galley bins in lower levels	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(19) Reaching, bending, and squatting to take the lids off food in carts	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(20) Reaching for the supplies in higher galley bins	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(21) Reaching, bending, and squatting for supplies in lower galley bins	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(22) Lifting food load in the ovens to cook and pulling it out of the ovens	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10

APPENDIX B (continued)

	1a. On average, how often did you perform this job task per segment in the past 30 days?				1b. On average, how physically strenuous is this job task for you?				1c. How much ache, pain or discomfort did you experience while performing this job task? The numbers between 0 and 10 represent ALL levels of ache, pain, or discomfort a person could experience. "Zero" means no ache, pain, or discomfort and "10" means ache, pain, or discomfort as bad as it could be. Please circle ANY number between 0 and 10 that describes your experience.										
	Not Done	Occasionally	Frequently	Almost Always	Not Strenuous Strenuous	Somewhat Strenuous	Strenuous	Very	0 No pain										10 as bad as it could be
Service (beverage, meal, & duty-free)																				
(23) Hand carrying the coffee pot	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(24) Rotating wrist to pour coffee and beverages	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(25) Reaching to serve passengers	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(26) Pinching tongs to hold service items	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(27) Reaching and bending to serve the passengers at the window seat	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(28) Reaching for items while kneeling	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(29) Squatting to take meal trays in/out of carts	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(30) Lifting and carrying heavy duty-free sale items	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(31) Squatting and pulling bottom bins with heavy items	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10

APPENDIX B (continued)

	1a. On average, how often did you perform this job task per segment in the past 30 days?				1b. On average, how physically strenuous is this job task for you?				1c. How much ache, pain or discomfort did you experience while performing this job task? The numbers between 0 and 10 represent ALL levels of ache, pain, or discomfort a person could experience. "Zero" means no ache, pain, or discomfort and "10" means ache, pain, or discomfort as bad as it could be. Please circle ANY number between 0 and 10 that describes your experience.										
	Not Done	Occasionally	Frequently	Almost Always	Not Strenuous	Somewhat Strenuous	Strenuous	Very Strenuous	0 No pain										10 as bad as it could be
Safety Check																				
(32) Reaching, bending, and squatting to read pressure gauges	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(33) Pushing aisle seats into upright positions	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(34) Reaching and pushing window and center seats into upright positions	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(35) Pushing with feet to restore footrests to proper positions	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
Miscellaneous																				
(36) Arming/ disarming door	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(37) Standing for a long time	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(38) Walking for a long time	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(39) Lifting or physically assisting disabled or elderly passengers	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(40) Sleeping in passenger seat in economy section	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10
(41) Awkward postures when sleeping in cramped bunk beds	1	2	3	4	1	2	3	4	0	1	2	3	4	5	6	7	8	9	10

APPENDIX B (continued)

B. Organizational factors

The following section asks about work organizational factors, which refer to management and supervisory practices and production processes, and to their influence on the way jobs are designed and performed in the workplace. This includes factors such as effort required to carry out your work, interpersonal aspects of work, the scheduling of work, and characteristics of company management. For the questions below, please circle the response that comes closest to the way you feel.

Psychological job demands	Strongly Disagree	Disagree	Agree	Strongly Agree
42. My job requires working very fast	1	2	3	4
43. My job requires working very hard	1	2	3	4
44. I am not asked to do an excessive amount of work	1	2	3	4
45. I have enough time to get the job done	1	2	3	4
46. I am free from conflicting demands that others make on my job	1	2	3	4

Decision latitude	Strongly Disagree	Disagree	Agree	Strongly Agree
47. My job requires that I learn new things	1	2	3	4
48. My job involves a lot of repetitive work	1	2	3	4
49. My job requires me to be creative	1	2	3	4
50. My job requires a high level of skill	1	2	3	4
51. I get to do a variety of different things on my job	1	2	3	4
52. I have an opportunity to develop my own special abilities on my job	1	2	3	4
53. My job allows me to make a lot of decisions on my own.	1	2	3	4
54. On my job, I have very little freedom to decide how I do my work	1	2	3	4
55. I have a lot of say about what happens on my job.	1	2	3	4

Social support	Strongly Disagree	Disagree	Agree	Strongly Agree
56. My purser/lead is concerned about the welfare of those under him/her	1	2	3	4
57. My purser/lead pays attention to what I am saying	1	2	3	4
58 My purser/lead is helpful in getting the job done	1	2	3	4
59. My purser/lead is successful in getting people to work together	1	2	3	4
60. Flight attendants I work with are competent in doing their jobs	1	2	3	4
61. Flight attendants I work with take a personal interest in me	1	2	3	4
62. Flight attendants I work with are friendly	1	2	3	4
63. Flight attendants I work with are helpful in getting the job done	1	2	3	4

APPENDIX B (continued)

Job security

	Strongly Disagree	Disagree	Agree	Strongly Agree
64. My job security is good.	1	2	3	4
65. My prospects for career development and promotions are good	1	2	3	4
66. In five years, my skills will still be valuable.	1	2	3	4

67. How steady is your work?

Regular and steady 1
Seasonal 2
Frequent layoffs or furloughs 3
Both seasonal and frequent layoffs or furloughs 4
Other (*Specify*: _____) 5

68. During the past year, how often were you in a situation where you faced job loss, layoff or furlough?

Never 1
Faced the possibility once 2
Faced the possibility more than once 3
Constantly 4
Actually layed off or furloughed 5

69. Sometimes people permanently lose jobs they want to keep. How likely is it that during the next couple of years you will lose your present job with your employer?

Not at all likely 1
Not too likely 2
Somewhat likely 3
Very likely 4

APPENDIX B (continued)

Work schedules

70. On average, how many flight hours a month do you work? _____ flight hours/ month

71. When you fly, what is the average number of flight segments you work per week? _____ segments/ week

72. On average, how many hours per flight segment do you work? _____ hours/ segment

73. Currently, which cabin(s) do you work in most often? (*Circle all that apply*).

First 1
Business 2
Economy 3

74. Which of these would best describe your current in-flight work role?

Responsible for all in-flight services 1
Supervise other colleagues 2
Crew / Team Member 3
Other (*Specify*: _____) 4

75. What kind of aircraft do you most often work?

B747 1
B767 2
B777 3
A340 4
Other (*Specify*: _____) 5

APPENDIX B (continued)

C. Physical environmental factors

The following section asks about the physical environment in the cabin.

	How often are you exposed to the following conditions while working in the cabin?	Never	Occasionally	Often	Always
76.	Too little air movement	1	2	3	4
77.	Air temperature too hot	1	2	3	4
78.	Air temperature too cold	1	2	3	4
79.	Air is too dry (low humidity)	1	2	3	4
80.	Stuffy air	1	2	3	4
81.	Unpleasant odor in air	1	2	3	4
82.	Excessive noise	1	2	3	4
83.	Cabin lighting too dark	1	2	3	4
84.	Excessive vibration	1	2	3	4
85.	Potentially toxic chemicals (e.g., pesticide, smoke, oil mist)	1	2	3	4
86.	Insufficient oxygen due to low cabin pressure	1	2	3	4
87.	Rapid variations in cabin pressure	1	2	3	4

II. EXTERNAL FACTORS

The next four questions deal with external factors that may contribute to injuries and/or psychological stress. Please circle the response that comes closest to the way you feel.

		Never	Little	Some	Very Much
88.	While on duty, how concerned are you about turbulence?	1	2	3	4
89.	While on duty, how concerned are you about the threat of terrorism?	1	2	3	4
90.	While on duty, how concerned are you about air rage or assault by passengers?	1	2	3	4
91.	While on duty, how concerned are you about potentially catastrophic equipment malfunctions (e.g., smoke, fire, engine or flight control system failure, rapid decompression, etc.)?	1	2	3	4

APPENDIX B (continued)

III. MUSCULOSKELETAL SYMPTOMS

The following section asks about musculoskeletal symptoms including frequency, duration, intensity, and date of onset. For the questions below, please circle the response that comes closest to the way you feel.

92a. Have you at any time during the last 12 months had trouble (ache, pain, or discomfort) that you consider to be related to work in:		92b. How often have you had trouble (ache, pain, or discomfort) during the last 12 months? 1. Almost always (daily) 2. Frequently (once a week) 3. Sometimes (once a month) 4. Rarely (every 2-3 months) 5. Almost never (every 6 months)	92c. How long does this trouble (ache, pain, or discomfort) usually last? 1. Less than 1 hour 2. 1 hour to 1 day 3. More than 1 day to 1 week 4. more than 1 week to 2 weeks 5. More than 2 week to 4 weeks 6. More than 1 month to 3 months 7. More than 3 months	92d. How would you describe the intensity of the trouble (ache, pain, or discomfort)? 1. No pain 2. Mild pain 3. Moderate pain 4. Severe pain 5. Worst pain ever	92e. When did you first notice the trouble (ache, pain, or discomfort)?
 In this picture you can see the approximate position of the parts of the body referred to in Q92. Limits are not sharply defined, and certain parts overlap. You should decide for yourself in which part you have or have had	(1) Neck 1. Yes → 2. No	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4 5	____/____ Month Year
	(2) Shoulders 1. Yes → 2. No	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4 5	____/____ Month Year
	(3) Upper back 1. Yes → 2. No	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4 5	____/____ Month Year
	(4) Low back 1. Yes → 2. No	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4 5	____/____ Month Year

APPENDIX B (continued)

IV. PERSONAL FACTORS

The next group of questions deals with some personal background information. This information is needed in order to group your responses with those of persons with a similar background when the results of this study are analyzed.

93. What is your age? _____ years

94. How many years and months have you worked as a flight attendant? (*Please only include years and months during which you were actually working as a flight attendant*). _____ years _____ months

95. Which of the following best describes the work pattern you have followed since you first became a flight attendant?

Since I first became a flight attendant I have:
- continued to work uninterrupted 1
- taken a total of 1 to 5 years off from work... 2
- taken more than 5 years off from work at one time 3
- taken more than 5 years off from work, but not all at one time 4

96. About how much do you weigh, without shoes? _____ pounds

97. About how tall are you, without shoes? _____ feet/ inches

98. On a scale of 1 to10, with 1 being poorest sleep quality and 10 being best sleep quality, how would you rate your sleep quality over the past two weeks?

1 2 3 4 5 6 7 8 9 10

99. On a scale of 1 to10, with 1 being minimal fatigue and 10 being most severe fatigue, how would you rate your fatigue over the past two weeks?

1 2 3 4 5 6 7 8 9 10

100. On a scale of 1 to10, with 1 being least comfortable or most restrictive and 10 being most comfortable, how would you rate the comfort of your uniform?

1 2 3 4 5 6 7 8 9 10

101. Approximately how high are the heels of the shoes you wear while performing service tasks, in inches? (*If you wear flats, please enter "0"*).
_____ inches

APPENDIX B (continued)

102. What is the airport code of your home base? _____

103. In the space below, please write any comments about your work and musculoskeletal symptoms. Your comments will be considered carefully as an important part of the evaluation (*Please attach additional sheets if necessary*).

_____

_____

_____

_____

_____

_____

_____

_____

Thank you very much for your cooperation!

It is important in survey research to determine if the questionnaire is reliable. One way to check this is to ask the questions to the same person at different time periods. Questionnaires that receive similar responses at two different points in time from the same person are considered more credible.

Would you be willing to answer a shorter version of this questionnaire one more time?

Yes ( ) If you give us permission here, we will mail you the short version questionnaire in 2 weeks.
No ( )

Thank you again for your support!

APPENDIX C

TABLE I

MEANS AND STANDARD DEVIATIONS FOR JOB TASK FREQUENCY

Task	Mean	SD
Standing for a long time	3.92	0.28
Arming/ disarming door	3.87	0.42
Reaching to serve passengers	3.78	0.44
Walking for a long time	3.78	0.49
Reaching and bending to serve the passengers at the window seat	3.77	0.43
Hand carrying the coffee pot	3.69	0.52
Rotating wrist to pour coffee and beverages	3.67	0.57
Reaching and pushing to close overhead bins	3.65	0.57
Reaching, bending, and squatting to read pressure gauges	3.61	0.68
Pushing and pulling carts to reposition in the galley	3.59	0.65
Squatting to take meal trays in/out of carts	3.54	0.69
Reaching for the supplies in higher galley bins	3.46	0.67
Pinching tongs to hold service items	3.44	0.79
Reaching to latch galley bins in higher levels	3.43	0.73
Pushing and pulling to steer the cart away from passengers	3.4	0.72
Squatting and pulling bottom bins with heavy items	3.4	0.76
Reaching, bending, and squatting for supplies in lower galley bins	3.36	0.74
Reaching, bending, and squatting to reposition galley bins in lower levels	3.29	0.79
Reaching, bending, and squatting to take the lids off food in carts	3.25	0.84
Reaching, bending, and squatting to latch galley bins in lower levels	3.21	0.85
Carrying crew bags while walking up and down stairs	3.2	0.9
Pulling and pushing beverage carts with hands while walking on an incline	3.2	0.81
Lifting and reaching to stow crew bags in overhead bins	3.17	0.94
Reaching for items while kneeling	3.15	0.87
Reaching to reposition galley bins in higher levels	3.08	0.87
Reaching, pulling, and pushing bags to reposition in overhead bins	3.01	0.85
Pulling and pushing meal carts with hands while walking on an incline	2.9	0.98
Lifting and carrying heavy duty-free sale items	2.9	0.95
Lifting bins out of carts over your head into galley	2.85	1.04
Lifting food load in the ovens to cook and pulling it out of the ovens	2.81	0.94
Pushing aisle seats into upright positions	2.77	0.97
Pushing against the cart with knees and hips	2.72	1.07
Awkward postures when sleeping in cramped bunk beds	2.71	0.86
Pushing with feet to restore footrests to proper positions	2.69	0.97
Reaching and pushing window and center seats into upright positions	2.53	1.06
Sleeping in passenger seat in economy section	2.39	1.08
Lifting and reaching to stow passengers' bags in overhead bins	2.29	0.89
Pushing and pulling carts to move to/from upstairs by an elevator	2.28	1.1
Pulling and pushing duty free carts with hands while on an incline	2.18	1.05
Carrying passengers' bags	1.86	0.64
Lifting or physically assisting disabled or elderly passengers	1.86	0.73

APPENDIX C (continued)

TABLE II

MEANS AND STANDARD DEVIATIONS FOR STRENOUSNESS OF JOB TASK

Task	Mean	SD
Lifting and reaching to stow crew bags in overhead bins	3.25	0.81
Carrying crew bags while walking up and down stairs	3.21	0.8
Squatting and pulling bottom bins with heavy items	3.04	0.84
Pushing and pulling carts to reposition in the galley	3.03	0.81
Reaching and pushing to close overhead bins	2.99	0.95
Standing for a long time	2.94	0.88
Reaching, pulling, and pushing bags to reposition in overhead bins	2.92	0.84
Pushing and pulling to steer the cart away from passengers	2.89	0.8
Pulling and pushing beverage carts with hands while walking on an incline	2.87	0.87
Lifting and reaching to stow passengers' bags in overhead bins	2.85	0.94
Reaching to reposition galley bins in higher levels	2.79	0.87
Squatting to take meal trays in/out of carts	2.78	0.86
Lifting bins out of carts over your head into galley	2.77	0.89
Sleeping in passenger seat in economy section	2.76	1.17
Reaching and bending to serve the passengers at the window seat	2.74	0.9
Rotating wrist to pour coffee and beverages	2.7	0.95
Hand carrying the coffee pot	2.68	0.93
Reaching, bending, and squatting to reposition galley bins in lower levels	2.67	0.79
Lifting and carrying heavy duty-free sale items	2.67	0.83
Reaching to serve passengers	2.64	0.91
Reaching for items while kneeling	2.6	0.91
Walking for a long time	2.59	0.89
Pulling and pushing meal carts with hands while walking on an incline	2.58	0.92
Reaching for the supplies in higher galley bins	2.55	0.83
Pushing against the cart with knees and hips	2.47	0.94
Pushing and pulling carts to move to/from upstairs by an elevator	2.46	0.87
Lifting food load in the ovens to cook and pulling it out of the ovens	2.45	0.95
Reaching to latch galley bins in higher levels	2.4	0.96
Pulling and pushing duty free carts with hands while on an incline	2.37	0.9
Reaching, bending, and squatting for supplies in lower galley bins	2.35	0.9
Reaching, bending, and squatting to take the lids off food in carts	2.32	1.05
Lifting or physically assisting disabled or elderly passengers	2.31	0.85
Carrying passengers' bags	2.21	0.91
Reaching, bending, and squatting to latch galley bins in lower levels	2.17	0.83
Pushing with feet to restore footrests to proper positions	2.14	1.03
Awkward postures when sleeping in cramped bunk beds	2.11	0.94
Reaching, bending, and squatting to read pressure gauges	1.91	0.86
Reaching and pushing window and center seats into upright positions	1.85	0.82
Pinching tongs to hold service items	1.7	0.87
Pushing aisle seats into upright positions	1.64	0.71
Arming/ disarming door	1.43	0.67

APPENDIX C (continued)

TABLE III

MEANS AND STANDARD DEVIATIONS FOR SYMPTOM INTENSIDY

Task	Mean	SD
Lifting and reaching to stow crew bags in overhead bins	5.78	3.02
Carrying crew bags while walking up and down stairs	5.7	2.88
Sleeping in passenger seat in economy section	5.54	3.44
Standing for a long time	5.4	2.95
Squatting and pulling bottom bins with heavy items	5.27	2.96
Reaching and pushing to close overhead bins	5.13	3.04
Hand carrying the coffee pot	5.11	3.06
Rotating wrist to pour coffee and beverages	5.09	3.16
Pushing and pulling carts to reposition in the galley	5.06	2.85
Reaching, pulling, and pushing bags to reposition in overhead bins	4.98	2.87
Pushing and pulling to steer the cart away from passengers	4.9	2.88
Squatting to take meal trays in/out of carts	4.87	3.08
Walking for a long time	4.86	3.08
Lifting and reaching to stow passengers' bags in overhead bins	4.71	2.96
Lifting bins out of carts over your head into galley	4.66	2.88
Pulling and pushing beverage carts with hands while walking on an incline	4.64	2.8
Reaching to reposition galley bins in higher levels	4.63	2.88
Reaching and bending to serve the passengers at the window seat	4.54	3.15
Reaching to serve passengers	4.52	2.84
Reaching for items while kneeling	4.37	2.93
Reaching, bending, and squatting to reposition galley bins in lower levels	4.3	2.69
Pulling and pushing meal carts with hands while walking on an incline	4.15	2.73
Reaching for the supplies in higher galley bins	4.13	2.92
Pushing against the cart with knees and hips	3.98	2.89
Awkward postures when sleeping in cramped bunk beds	3.9	3.15
Lifting food load in the ovens to cook and pulling it out of the ovens	3.82	2.84
Reaching, bending, and squatting for supplies in lower galley bins	3.8	2.81
Reaching, bending, and squatting to take the lids off food in carts	3.75	2.89
Reaching to latch galley bins in higher levels	3.73	2.87
Pushing and pulling carts to move to/from upstairs by an elevator	3.65	2.98
Lifting or physically assisting disabled or elderly passengers	3.57	3.19
Lifting and carrying heavy duty-free sale items	3.51	2.97
Pulling and pushing duty free carts with hands while on an incline	3.51	2.83
Reaching, bending, and squatting to latch galley bins in lower levels	3.38	2.71
Carrying passengers' bags	2.88	2.48
Pushing with feet to restore footrests to proper positions	2.86	2.52
Reaching, bending, and squatting to read pressure gauges	2.66	2.69
Pinching tongs to hold service items	2.59	2.88
Reaching and pushing window and center seats into upright positions	2.45	2.38
Pushing aisle seats into upright positions	2.04	2.18
Arming/ disarming door	1.57	2.07

APPENDIX C (continued)

TABLE IV

MEANS AND STANDARD DEVIATIONS FOR PHYSICAL LOAD

Task	Mean	SD
Standing for a long time	9.48	1.73
Lifting and reaching to stow crew bags in overhead bins	9.22	2.04
Carrying crew bags while walking up and down stairs	9.17	1.92
Reaching and pushing to close overhead bins	9.17	1.96
Pushing and pulling carts to reposition in the galley	9.14	1.9
Squatting and pulling bottom bins with heavy items	9.04	2.02
Rotating wrist to pour coffee and beverages	8.92	1.97
Hand carrying the coffee pot	8.89	1.89
Reaching and bending to serve the passengers at the window seat	8.88	1.9
Squatting to take meal trays in/out of carts	8.79	1.98
Reaching to serve passengers	8.78	1.74
Walking for a long time	8.78	1.84
Pushing and pulling to steer the cart away from passengers	8.78	1.92
Pulling and pushing beverage carts with hands while walking on an incline	8.54	2.06
Reaching, pulling, and pushing bags to reposition in overhead bins	8.48	2.09
Reaching to reposition galley bins in higher levels	8.31	2.06
Reaching, bending, and squatting to reposition galley bins in lower levels	8.29	1.87
Reaching for the supplies in higher galley bins	8.24	2.01
Lifting bins out of carts over your head into galley	8.11	2.2
Reaching for items while kneeling	8.08	2.18
Sleeping in passenger seat in economy section	7.99	2.7
Reaching to latch galley bins in higher levels	7.96	1.97
Reaching, bending, and squatting for supplies in lower galley bins	7.86	2
Reaching, bending, and squatting to take the lids off food in carts	7.81	2.05
Pulling and pushing meal carts with hands while walking on an incline	7.78	2.14
Lifting and reaching to stow passengers' bags in overhead bins	7.65	2.18
Lifting food load in the ovens to cook and pulling it out of the ovens	7.59	2.11
Pushing against the cart with knees and hips	7.47	2.21
Reaching, bending, and squatting to latch galley bins in lower levels	7.45	2.05
Reaching, bending, and squatting to read pressure gauges	7.34	1.85
Awkward postures when sleeping in cramped bunk beds	7.12	2.57
Pushing and pulling carts to move to/from upstairs by an elevator	7.05	2.54
Pinching tongs to hold service items	6.93	2
Arming/ disarming door	6.77	1.32
Pulling and pushing duty free carts with hands while on an incline	6.76	2.53
Pushing with feet to restore footrests to proper positions	6.71	1.99
Lifting and carrying heavy duty-free sale items	6.5	2.36
Lifting or physically assisting disabled or elderly passengers	6.33	2.35
Reaching and pushing window and center seats into upright positions	6.16	2.04
Pushing aisle seats into upright positions	6.06	1.85
Carrying passengers' bags	6.05	1.77

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PUBLICATIONS:	Wilbur, J. McDevitt, J., Dancy, B., Wang, E., Briller, J., Nicola., Ingram, D., Lee, H., (Accepted). Recruitment of African American women to a walking program: Eligibility and Attrition during screening. *Research in Nursing and Health.* Lee, H.K., Wilbur, J., Conrad, K., & Miller, A. (Submitted). A focus Ggroup as A final step in preparation for a survey to examine risk factors Associated with work-related musculoskeletal disorders in flight attendants. *AAOHN Journal.* Wilbur, J., Chandler, P.J., Dancy, B., & Lee, H. (2003). Correlates of physical activity in urban Midwestern Latinas. *Am J Prev Med, 25* (3 Suppl 1), 69-76.

Wilbur, J., Chandler, P.J., Dancy, B., & Lee, H. (2003). Correlates of physical activity in Urban Midwestern African-American women. *Am J Prev Med, 25* (3 Suppl 1), 45-52.

PRESENTATIONS: Wang, E., Wilbur, J., McDevitt, J. Ingram, D., & Lee, H. (2005, December). *Effects of neighborhood environment on physical activity and cardiovascular risks among midlife African American women.* Paper presented at the annual meeting of the American Public Health Association, Philadelphia, PA.

McDevitt, J., Wilbur, J., Wang, E., Green, J., Ingram, D., & Lee, H. (2005, December). *Patterns of exercise adherence in African American women participating in a home-based walking program.* Paper presented at the 133rd annual meeting of the American Public Health Association, Philadelphia, PA.

Lee, H., & Wilbur, J. (2005, May). *Risk factors for work-related musculoskeletal disorders (WMSDs) in flight Attendants.* Paper presented at the ergonomics roundtable session at the American Industrial Hygiene Conference & Expo, Anaheim, CA.

Lee, H., & Wilbur, J. (2005, April). *Risk factors associated with trunk work -related musculoskeletal disorders in female flight attendants: focus group study.* Poster presented be presented at the Association of American Occupational Health Nurses Symposium and Expo, Minneapolis, MN.

Wilbur, J., McDevitt, J. Ingram, D., Wang, E. & Lee, H. (2005, April). *African American (AA) women's adherence to walking.* Paper presented at the annual meeting of at the Society of Behavioral Medicine Annual Meeting, Boston, MA.

Lee, H., Wilbur, J., Conrad, K., Kviz, F., Kim, M.J., Freels, S., & Miller,A. (2003, November). *Risk factors associated with trunk and lower extremity work-related musculoskeletal disorders in female workers: Integrative literature review.* Poster presented at the International Conference on Overseas Korean Nursing Scholarship: Commemorating the 50th Anniversary of Korean Nurses Immigration to the USA, Los Angeles, CA.

Wilbur, J., Chandler, P.J., Dancy, B., Buntin, M., & Lee, H. (2003, November). *Correlates of physical activity among urban dwelling African American and Latino Women.* Paper presented at the annual meeting of the American Public Health Association, San Francisco, CA.

Wilbur, J., Chandler, P.J., Lee, H., & Miller, A. (2003, June). *Moderate intensity home-based walking and symptoms in midlife African American and Caucasian women.* Paper presented at the annual meeting of the Society of Menstrual Cycle Research Conference, Pittsburgh, PA.

PROFESSIONAL MEMBERSHIPS:

American Association of Occupational Health Nurses
American College of Occupational and Environmental Medicine
Asian Health Coalition of Illinois
Sigma Theta Tau International, Honor Society of Nursing
Aerospace medical Association