Stressors, allostatic load, and health outcomes among women hotel housekeepers: A pilot study

Marie-Anne S. Rosemberg, Yang Li, Daniel S. McConnell, Marjorie C. McCullagh & Julia S. Seng

Stressors, allostatic load, and health outcomes among women hotel housekeepers: A pilot study

Authors: Marie-Anne S. Rosemberg, Yang Li, Daniel S. McConnell, Marjorie C. McCullagh, Julia S. Seng

Marie-Anne S. Rosemberg, PhD
Assistant Professor
Department of Systems, Populations and Leadership
University of Michigan, School of Nursing

Yang Li, PhD
University of Michigan, School of Nursing

Daniel S. McConnell, PhD
Associate Research Scientist, Epidemiology
University of Michigan, School of Public Health

Marjorie C. McCullagh, PhD, RN, PHNA-BC, COHN-S, FAAOHN, FAAN
Professor and Director Occupational Health Nursing Program
University of Michigan School of Nursing

Julia S. Seng, PhD, RN, CNM, FAAN
Professor
Department of Systems, Populations and Leadership
University of Michigan, School of Nursing

Corresponding Author:
Marie-Anne S. Rosemberg, PhD
400 North Ingalls, Room 3175, Ann Arbor, MI, 48109,
Email: sanon@umich.edu
Tel: (734)-647-0146 (office); Fax: 734-763-0681

ABSTRACT

Hotel housekeepers are exposed to stressors at work and outside of work. Little is known about these workers' pathophysiological responses to those stressors. Allostatic load is a concept increasingly used to understand pathophysiologic manifestations of individuals' bodily response to stress. The purpose of this study was to examine the associations between work and non-work stressors, allostatic load, and health outcomes among hotel housekeepers. Work and non-work stressors (e.g., the number of traumatic events, everyday discrimination, and job strain) and health outcomes (e.g., general health status, physical and mental health, and chronic diseases) were measured. Biometric and anthropometric measures and fasting blood specimens were collected. Blood biomarkers included CRP, HbA1c, HDL, and cortisol. Descriptive analyses, correlations, regressions, and t-tests were conducted. Forty-nine women hotel housekeepers participated, with a mean age of 40 years. One-fifth reported high job strain and over 40% had at least one traumatic event. Chronic conditions were commonly reported, with about 78%, 55%, and 35% reporting one, two, and three chronic conditions, respectively. Correlation analyses showed that reports of high job strain and everyday discrimination were significantly associated with high ALI quartile score (r=0.39, p=0.011; r=0.41, p=0.004). Job strain and everyday discrimination had medium to large effect sizes on ALI quartile scores. High ALI quartile score was significantly associated with having at least one chronic disease (r=0.40, p=0.005), and it had a large effect size on chronic diseases. To our knowledge, this is the first study to explore allostatic load among hotel housekeepers. Hotel housekeepers have high exposure to stressors within and outside of their work and experience poor chronic conditions. Allostatic load had strong associations with both stressors and health outcomes. Despite this worker group being a hard-to-reach worker group to participate in research studies, this study demonstrates the

feasibility of accessing, recruiting and collecting survey data and blood samples among them to determine health risks and guide future targeted interventions.

INTRODUCTION

Hotel housekeepers (also referred to as hotel room cleaners or maids) are examples of low wage workers exposed to multiple stressors of undefined magnitude which increase their risk for poor health outcomes.[1] Among hotel housekeepers, immigrant women and women of color are overrepresented and exposed to physical, chemical, biological, and psychological hazards. [2-7] Hotel housekeepers have the highest injury rate (7.9 per 100) of all workers in the hospitality industry. They experience musculoskeletal disorders (3.2 per 100), low physical function, high levels of pain, and sprains and chronic diseases such as hypertension.[6, 8, 9] Moreover, data show increasing reports of illnesses and injuries among these workers (e.g., 897 more claims per year from 2010 to 2014).[10] A 2006 report of Workers Compensation data analysis identified an annual cost of over $4.7 million from housekeepers alone.[11]

Constituting the majority of the 1.8 million workers in the hospitality industry, hotel housekeepers experience irregular work schedules, time pressure, hazardous physical conditions, few opportunities for professional growth, and lack of autonomy over their tasks.[12-16] This understudied population is part of a large and growing economic sector, thus meriting public health attention. Studies among this low wage worker group mainly focused on work hazards (e.g., musculoskeletal/ergonomic), with little emphasis on factors outside of work that can affect health. More importantly, manifestations of physiological responses to stressors within and outside of work remain unexplored among this at-risk worker group. Currently it is a clinical challenge to identify who is most in need of interventions to remediate stress-related physiological dysregulations in time to prevent disease.

The Concept of Allostatic Load

In 1998, McEwen proposed the concept of Allostatic Load (AL).[17] AL is defined as the accumulative physiological dysregulations across multiple body systems (i.e., cardiovascular, immune, neuroendocrine, and metabolic) in response to chronic or severe stressors.[18, 19] AL is a near-term proxy outcome and can be considered as an early sign for developing clinical symptoms. AL has significant clinical value because it allows us to identify early signs of health risks at a subclinical level and thus can inform interventions geared at preventing further deterioration of health (i.e., health promotion and disease prevention). Although well-studied in the field of stress biology as an outcome, AL has been less studied in its role as a mechanism of adverse health outcomes and has only begun to be studied in occupational health science.[20-24]

Specifically, no studies have explored the AL levels among hotel workers who may experience elevated levels of work and non-work stressors. Quantifying the physiological responses that manifest in relation to work and non-work stressors would assist in identifying workers who are at high-risk for developing clinical conditions such as hypertension, diabetes and autoimmune disorders. Having a reliable, valid biological indicator of dysregulation that is sensitive to stress and stress reduction could aid in developing and testing interventions aimed at promoting worker health and safety and addressing occupational health disparities.

There are debates about inconsistences in the use of indicators to operationalize Allostatic Loads.[25-27] Yet there has been no report of an ideal set of indicators. Regardless of these inconsistences, AL remains a robust approach to determine pathophysiologic functioning and is increasingly being used to understand various eco-social gradients and how they relate to health disparities.[e.g., 21, 28-30] In fact, AL experts urge researchers to select their indicators based on their interested associated morbidity. McEwen stated, *"biomarkers must be chosen and evaluated in*

terms of their functional significance in biological pathways, including both primary and secondary mediators and the secondary and tertiary consequences of their actions".[31] For this study (Figure 1), our primary mediator was cortisol (indicator of the function of the neuroendocrine system). Our secondary consequences include blood pressure, heart rate, peak flow, BMI, waist-hip ratio, cholesterol, C - reactive protein, hemoglobin A1c, triglycerides, and c-reactive protein, all of which together indicate functioning of the cardiovascular, respiratory, immunologic, metabolic and anthropometric systems. The AL score will indicate risks for the tertiary outcomes that are the chronic diseases.

Applying a Model of AL to Address Low Wage Workers' Health

Figure 1 depicts a model to explore stressors, AL, and outcomes among low wage workers. The model is aligned with the current National Institute for Occupational Safety and Health (NIOSH) Total Worker Health® Initiative which emphasizes the need for a comprehensive approach that includes consideration of stressors both within (including the psychosocial work environment: i.e., job strain) and outside (including work-life balance, life stressors, health-related behaviors, and other socio-determinants) of the workplace to promote health and prevent injuries and illnesses among the 21st century workforce.[32-35] It also is consistent with conceptual models of AL.[18] Based on this model, stressors (work and non-work) initiate responses (neuroendocrine, inflammatory) which, when chronic, lead to dysregulations in cardio-respiratory, immune and metabolic systems that interact. These dysregulations then cause "wear and tear" seen as early stages of morbidity, and ultimately manifest in premature disease, decreased work productivity and untimely death.

AL is commonly operationalized as an index of an aggregated set of component indicators—biometric and anthropometric measures and biomarkers (e.g., cortisol, blood

pressure, C – reactive protein, hemoglobin A1c, BMI). One issue to resolve is which indicators to include in the allostatic load index, given that the choice of indicators have varied across studies.[26] Some consensus is beginning to emerge for using a set of approximately 10 components that have strong utility as risk markers for disease in one or more of the body systems. Another issue to resolve is the scoring method. The most common method in research to date uses the high-risk quartile as a cut-point and sums the number of components for which the person's levels are in that risk quartile. This has the weakness of being "sample-specific" (i.e., top quartile among professional athletes versus among their television watching fans); however, there are not yet population norms. An alternative that may better serve clinical purposes would use established clinical cut-points on each indicator, which would be a step toward comparing individual risk based on a norm. In the absence of definitive index components and scoring recommendations, attention to these issues in pilot work remains important.

Measuring Stressors

The Total Worker Health initiative calls for measuring both work and non-work stressors from psychosocial as well as biomechanical and chemical sources. Measures for psychosocial stressors ideally should be assessed across eco-sociological levels, including intra- and inter-personal, contextual, and social determinant factors, such as trauma exposure. It is not known which stressors are most predictive of AL. These factors warrant comprehensive measurement and analysis, but the burdens associated with such comprehensive measurement on low wage workers is a concern, along with literacy level and concerns about acceptability of answering sensitive questions about trauma, or experiences of discrimination, for example. Preliminary

studies are need to continue testing the concept and estimating the effect size of the relationship between stressors and AL.

Feasibility

Low-wage workers are a challenging group to study. The very stressors that may make them vulnerable to poor health outcomes could also deter participation, including immigration status, language and literacy barriers, and irregular shifts or multiple jobs that may make scheduling participation difficult. Pilot work is needed to verify that these workers can be recruited to participate in research studies involving survey, biometric and anthropometric measurements, and fasting blood collection. To assess feasibility, the ability to reach study participants was explored, and participant recruitment approaches were examined for effectiveness. In addition, the willingness of participants to allow blood draws and both willingness and ability of participants to complete the survey booklet were examined.

AL is a promising concept to use in occupational health; however, pilot research is needed. The purposes of this study were to assess feasibility, consider technical issues about measurement of stressors and creation and scoring of an AL index, show test-of-concept, and gather preliminary data.

METHOD

Recruitment and Eligibility

Recruitment flyers were distributed through a local housekeepers' union and augmented by the efforts of a bilingual (English-Spanish) cultural broker who had the trust of the community. The cultural broker along with other members of the research team distributed flyers in local hotels. Either they were instructed to leave the flyers at the front desk or a manager took the flyer and informed the research team that they would post the flyers in the breakrooms. The flyers had

contact information, and individuals who were interested in participating reached out individually. Furthermore, snowball technique and collaboration with interested hotel housekeeping managers offered additional recruitment opportunities. To participate, individuals had to: 1) identify as female; 2) be currently employed as a hotel housekeeper; 3) be of age 18+ years; and 4) be able to provide verbal and written consent in English or Spanish. Exclusion criteria included: 1) private housekeepers and hotel housemen (because their working conditions and workload differ from that of female hotel housekeepers); 2) those with bleeding disorders or unwillingness to provide a blood specimen.

Design, Setting, and Protocol

The study used a cross-sectional design. The study protocol was approved by the authors' affiliating university Institutional Review Board.

Data were collected in home, workplace, or at an urban University site, based on study participants' preference. Once individuals expressed their interest in participating in the study, research team members set up an appointment with them. Two to three days prior to the data collection, research team members contacted the individual to remind them not eat or drink prior to the data collection time. Thus, all the data were collected early in the morning before participants started their day or headed to work. On the morning of data collection, research team members answered participants' questions about the study and obtained written consent. Biometric and anthropometric measures were then completed, followed by blood specimen collection, after which refreshments were provided. The protocol finished with completion of the questionnaire booklet containing the study surveys. Participants received $30 for their participation.

Biometric and Anthropometric Measures

The five biometric and anthropometric measures included systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), waist/hip ratio (WHR), and BMI. SBP, DBP, and HR were measured twice using the left arm, at least 5 min apart, with the participant in a seated position, both feet uncrossed and flat on the floor, using an OMRON Series 5 automated blood pressure device (Lake Forest, IL), following guidelines of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.[36] A measurement tape was used to measure participants' waists and hips. The iliac crest was located by placing hands around their waist, squeezing slightly and then moving fingers downward until the top curve of the hips was felt. A tape measure was placed just above the upper hip bone. Height in feet and inches and weight in pounds were measured to calculate BMI.

Blood Specimen Collection

Participants were instructed not to eat for at least eight hr prior to blood specimen collection. A phlebotomist collected 10 ml of blood to measure four biomarkers: high density lipoprotein (HDL), hemoglobin A1c (HbA1c), C-reactive protein (CRP), and cortisol. Blood specimens were transported (either at room temperature or on ice, depending on the distance traveled from the data collection location to the lab) to the laboratory for processing.

Blood Specimen Assays for Indicators

Cortisol

The human Cortisol (ALPCo, 11-CORHU-E01) assay employs the quantitative competitive enzyme immunoassay technique. An antibody specific for cortisol has been pre-coated onto a microplate. Standards and samples are pipetted into the wells and cortisol present is bound by the immobilized antibody. This competes with enzyme-labeled cortisol for available binding sites. Following a wash to remove any unbound enzyme reagent, a substrate solution is added to the

wells and color develops. The color development is stopped and the intensity of the color is measured. Absorbance at 450 nm is inversely proportional to the amount of cortisol bound in the initial step. The assay has a range (standard curve) of 0.5 – 60 ug/dL. The following coefficients of variation were observed: inter-assay CV: 2.9% at 39.6 ug/dL, 6.1% at 16.2 ug/dL; intra-assay CV: 2.6% at 39.6 ug/dL, 4.4% at 16.2 ug/dL.

High Density Lipoprotein (HDL)

The HDL assay was performed on the Alfa-Wasserman ACE analyzer and utilized a detergent to solubilize only the HDL particles, releasing HDL to react with cholesterol oxidase in the presence of chromogen (N, N-bis (4-sulfobutyl)-m-touidine) to produce a chromophor that absorbs at 592/692 nm. HDL concentration in serum is directly proportional to the amount of chromophor produced. The ACE HDL assay is linear from 2 to 125 mg/dL. The MDL is 2 mg/dL (2 SD greater than the 0 standard). The following coefficients of variation were reported: inter-assay CV: 9.9% at 23.8 mg/dL, 1.7% at 64.8 mg/dL; intra-assay CV: 2.4% at 23.8 mg/dL, 2.0% at 64.8 mg/dL.

C-Reactive protein (hsCRP)

C-Reactive protein was performed on the Alfa-Wasserman ACE analyzer. CRP in the sample reacted with the anti-CRP sensitized latex particles in the hs-CRP antibody reagent to form antigen-antibody complexes that agglutinate the latex particles. The increase in absorbance, measured monochromatically at 592 nm, during a fixed time interval, is directly proportional to the amount of CRP in the sample. The ACE hs-CRP assay is linear from 0.25 to 10.0 mg/L. The MDL is 0.1 mg/dL (2 SD greater than the 0 standard). The following Intra-assay precision expressed as CV: 5.7 % (0.5 mg/L), 2.0% (2.3 mg/L) and 1.2% (9.8 mg/L). The following inter-assay precision are expressed as CV: 7.0 % (0.5 mg/L), 3.3% (2.2 mg/L) and 1.2% (9.8 mg/L).

Hemoglobin A1c (HbA1c)

The human glycated hemoglobin A1c (HbA1c) assay (Antibodies On Line ABIN1570251,
Supplied by Cloud Clone) is designed to quantitative measurement of HbA1c in human serum,
plasma and erythrocyte lysates. This assay employs the competitive inhibition enzyme
immunoassay technique. A monoclonal antibody specific to HbA1c was pre-coated onto a
microplate. A competitive inhibition reaction was launched between biotin labeled HbA1c and
unlabeled HbA1c (standards or samples) with the pre-coated antibody specific to HbA1c. After
incubation the unbound conjugate was washed off. Next, avidin conjugated to Horseradish
Peroxidase (HRP) was added to each microplate well and incubated. The amount of bound HRP
conjugate is inversely proportional to the concentration of HbA1c in the sample. After addition
of the substrate solution, absorbance at 450 nm is inversely proportional to the amount of HbA1c
bound in the initial step. The assay has a range (standard curve) of 12.35-3000 μg/mL with a
minimum detection limit of 4.95 μg/mL. The following Intra-assay precision are reported
expressed as CV: 3.7 % (966 μg/mL). The following inter-assay precision are reported expressed
as CV: 4.5 % (966 μg/mL).

Questionnaire Booklet

Participants completed a questionnaire booklet that contained questions that assessed work and
non-work related stressors. The questionnaire booklet had both English and Spanish version.

Work related stressors

A shortened version of the job content questionnaire (JCQ) was used to measure job strain.[37, 38]
The item score is based on a 4-point Likert scale ranging from "*strongly disagree*" to "*strongly
agree*". According to the scoring method of the JCQ, five items were included to compute the
job demands score and nine items were included to calculate the job decision latitude score. The

medians of the job demands and job decision latitude scores for the overall sample were also calculated. If the subject's job demands score was more than the median and at the same time her job decision latitude score was less than the median, then the subject had high job strain. Otherwise, the subject had low job strain. The reliability (Cronbach's alpha) of the JCQ in our sample was 0.88, indicating a good reliability of the JCQ in the hotel housekeeper sample. Except for job strain as a work related stressor, number of rooms cleaned on a normal shift were also inquired to reflect hotel housekeeper's workload.

Non-work stressors

The nine-item Everyday Discrimination Scale (EDS) was used.[39] This scale measures everyday experiences of discrimination. Answers are based on a 6-point Likert scale ranging from "*almost every day*" to "*never*." According to the scoring method of the EDS, subjects experiencing any of the items a few times a year or more were coded as high levels of discrimination (score of 1) compared to those who reported never or less than once a year (score of 0). The total score was the sum of the dichotomized item scores. A higher score indicated heightened discrimination in everyday life. High everyday discrimination was defined as experiencing any of the nine items a few times a year or more. The reliability (Cronbach's alpha) of the EDS in our sample was 0.93, indicating an excellent reliability of the EDS in the hotel housekeeper sample. The Life Event Checklist was used, which queries lifetime history of 17 traumatic events (e.g., exposures to disaster, accidents, crime victimization, and not having money for food).[40] The six experience responses are "*happened to me,*" "*witnessed it,*" "*learned about it,*" "*part of my job,*" "*not sure,*" and "*doesn't apply to me.*" According to the scoring method of the checklist, for each item, a score of one is given if the subject directly experienced the traumatic event ("*happened to me*") and zero for all other of the remaining five responses. The number of traumatic events is

the sum of the dichotomized item scores. In this study, trauma exposure was coded as having at least one traumatic event for which subjects answered "*happened to me*".

<u>Measures of health outcomes</u>

Participants' health outcomes were assessed through the 12-item Short Form Health Survey (SF-12).[41, 42] The SF-12 is a gold standard measure with 12 items that assess an individual's overall general health with further details regarding physical and mental well-being. The specialized computer software – SF-12v2TM health survey was used to compute SF-12 physical and mental health scores and provide individual and aggregate reports of health status,[43] with higher score indicating better health. The one-item self-rated general health status instrument with five response options (1="e*xcellent,*" 2=*"very good,"* 3=*"good,"* 4=*"fair,"* 5=*"poor"*) was included. General health status was considered as a discrete variable for analysis. In addition, participants were asked if they had any of 13 types of chronic diseases (i.e., arthritis, chronic back pain, chronic neck pain, migraine headache, other frequent or severe headache, other chronic pain, hypertension, diabetes, asthma, high cholesterol, congestive heart failure, chronic sleeping problems, and chronic fatigue or low energy). The number of chronic diseases was computed. The chronic disease item was coded as present/not present.

<u>Socio-demographic characteristics</u>

The questionnaire queried about age, race, ethnicity, education level, marital status, hourly wage, insurance, smoking status, and alcohol use.

Statistical Analysis

Feasibility was analyzed in relation to problems with procedures and amount and pattern of missing data. Feasibility was also determined based on the length of time it took to recruit study participants, any issues or concerns that arose during recruitment, and data collection. The most

effective pathways to recruitment were also explored: the in-person flyer distribution at local hotels, use of the cultural broker, and word of mouths.

The allostatic load index (ALI) consisted of nine biomarkers: SBP, DBP, HR, WHR, BMI, HDL, HbA1c, CRP, and cortisol. Medication use was adjusted for in the preliminary analysis. Participants taking medications for hypertension at the time of assessment had 10 mmHg and 5 mmHg added to their respective SBP and DBP. Medication was adjusted. We dichotomized each biomarker into high- and low-risk two ways. To construct an ALI based on clinical risk parameters established for adult women (ALI-Clinical), we used clinical risk cut-points and summed the number of high-risk biomarkers for each person. The common method of summing the number of high-risk quartiles for each person (ALI-Quartile) was used.[30] Both ALI-Clinical and ALI-Quartile scores range from 0-9.

Frequencies, percentages, means and standard deviations were computed for socio-demographic characteristics, stressors, and health outcomes. Pearson correlation analyses were conducted to examine the correlations between ALI-Clinical and ALI-Quartile with general health status, SF-12 physical health, SF-12 mental health, everyday discrimination, and the number of rooms cleaned. Spearman correlation analyses were conducted to examine the correlations between ALI-Clinical and ALI-Quartile with job strain, trauma exposure, and chronic diseases. Multiple linear regressions were conducted to test the associations between stressors (e.g., job strain, the number of rooms cleaned on a normal day, everyday discrimination, and trauma exposure) with ALI-Clinical and ALI-Quartile. Dependent variables were ALI-Clinical and ALI-Quartile, while independent variables were job strain, the number of rooms cleaned on a normal day, everyday discrimination, and trauma exposure. Regressions were conducted to test the associations between ALI-Clinical and ALI-Quartile with health

outcomes (e.g., general health status, SF-12 physical health, SF-12 mental health, and chronic diseases). Linear regressions were conducted with general health status, SF-12 physical health, and SF-12 mental health as the dependent variable respectively and ALI-Clinical and ALI-Quartile as the independent variable respectively. Binomial logistic regressions were conducted with chronic diseases as the dependent variable and ALI-Clinical and ALI-Quartile as the independent variable, respectively. We also conducted regressions controlling for socio-demographic variables (e.g., age, education, income, hourly wage, and insurance). Lastly, we conducted *t*-tests to compare ALI-Clinical and ALI-Quartile scores between hotel housekeepers with high and low stressors and between those with chronic diseases or not. Cohen's *d* was also calculated to estimate the effect size. All analyses were conducted using the SPSS software (Version 22.0, IBM, Inc., Aramonk, NY).

RESULTS

Feasibility

Study participants were recruited within a period of six months. Accessing and recruiting the workers and data collection were successful. The main initial concerns for the participants were related to the blood sample collections. However, given the skills of the research team members, there were no adverse events with blood sample collection. Participants were really pleased to receive their blood test results in the mail, accompanied by a list of local clinics that provided free or sliding scale services. The list also indicated the presence of Spanish-speaking staff. Data collection in participants' homes and their workplace (when allowed by the manager) were preferred by participants over using the university site location. For example, only three individuals opted to meet at the university satellite option for data collection. Receipt of refreshments after blood specimen collection was also well received.

Socio-demographic Characteristics

A total of 49 female hotel housekeepers participated in the study (Table 1). The mean age was 40 years (SD= 11; range=21-59). The majority (56.3%) reported being Hispanic Latino followed by Black or African American (29.2%). Most (60.4%) were married or partnered. Around 63% were foreign born. Over half of the sample (55%) reported less than high school education. About 37% reported an hourly wage of $10 or less, and about 41% reported an hourly wage of up to $12. More than three-fourths (77%) reported no or partial health benefits from their employer. Around 33% reported experience with smoking and nearly 53% drank alcohol.

Health Outcomes

Almost 92% of study participants rated their health as being excellent, very good, or good (Table 1). However, the SF-12 instrument indicated that 38% and 39% of the study participants scored below the US population for their physical and mental health, respectively. Chronic conditions were commonly reported, with about 78%, 55%, and 35% reporting one, two, and three chronic conditions, respectively. The chronic conditions included chronic back pain (38.1%), migraine headache (31.7%), diagnosed arthritis (31.7%), diagnosed hypertension (30.2%); frequent or severe headache (26.2%), chronic fatigue (22%), chronic sleeping difficulties (15%), diagnosed high cholesterol (15%), diagnosed asthma (14.6%), chronic neck pain (14.3%), diagnosed diabetes (10%); other chronic pain (9.8%), and congestive heart failure (2.5%).

Stressors

Stressors were categorized as work and non-work stressors (Table 1). For the work-related stressors, around 21% of participants reported high job strain, and the average number of rooms cleaned on a normal day was 15 (SD=3; range=8-21). Regarding non-work stressors, nearly 43%

of participants experienced at least one traumatic event and the average everyday discrimination was 2.02 (SD=2.59).

Allostatic Load Index (ALI)

For this study, the ALI was comprised of nine biomarkers. Means with standard deviations and the percentages of participants within the risk thresholds of each biomarker are displayed in Table 2. Compared to the high-risk quartile cut-off points, use of the clinical cut-off points resulted in more participants placed within the risk thresholds of CRP, HDL, WHR, and BMI, while fewer participants were within the risk threshold of HbA1c, cortisol, SBP, DBP, and HR. The distributions of the ALI-Clinical and ALI-Quartile scores are shown in Table 3. The mean ALI-Clinical score was 2.3 (SD= 1.3; range= 0-5); while the mean ALI-Quartile score was 2.1 (SD= 1.5; range= 0-7). Using the clinical cut-off points, most participants (34.7%) scored 2. Using the high-risk quartile cut-off points, the largest group (28.6%) also scored 2.

Associations between ALI, Stressors, and Health Outcomes

Correlation analyses (Table 4) showed that high job strain and everyday discrimination were significantly associated with high ALI-quartile score (r=0.39; P=0.011; r=0.41; P=0.004), while other stressors were not significantly associated with ALI-quartile score (Ps>0.5). There were no significant correlations between all stressors and ALI-Clinical score (Ps>0.05). High ALI-quartile score was significantly associated with having at least one chronic disease (r=0.40; P=0.005), while it was not related to general health status or SF-12 physical and mental health (Ps>0.5). No significant correlations were found between ALI-Clinical score and all health outcomes (Ps>0.05).

Linear regressions showed significant association between everyday discrimination with elevated ALI-quartile score (β=0.36; P=0.040) but the association became not significant after

adjusting for age, foreign born, marital status, education, hourly wage, and insurance (β=0.15; P=0.368). The association between high job strain and ALI-quartile score was close to significant (β=0.28; P=0.072), and became significant after adjusting for socio-demographic factors (β=0.30; P=0.041). Binomial logistic regression showed high ALI-quartile score was associated with increased risk of having at least one chronic disease (OR=2.73; P=0.013). The associations remained significant when adjust for socio-demographic factors (P=0.035). There were no significant associations between ALI-quartile score and any other stressors and health outcomes (Ps>0.05). No associations were found between ALI-Clinical score and all stressors and health outcomes (Ps>0.05).

As seen in Table 5, the t-tests showed that hotel housekeepers with high job strain or everyday discrimination had significantly higher ALI-Quartile scores compared with those with low job strain or everyday discrimination (t=2.31, P=0.026; t=2.12, P=0.040). Job strain and everyday discrimination had medium to large effect sizes on ALI-Quartile scores (Cohen's d=0.87; Cohen's d=0.61). Though no significant differences were found for ALI-Clinical scores between hotel housekeepers with high and low stressors (Ps>0.05), job strain and everyday discrimination had small to medium effect sizes on ALI-Clinical scores (Cohen's d=0.61; Cohen's d=0.35). Hotel housekeepers who had at least one type of chronic diseases had higher ALI-Clinical and ALI-Quartile scores than those without chronic diseases (t=2.04, P=0.047; t=2.64, P=0.011). The effect sizes for ALI-Clinical and ALI-Quartile scores were medium to large (Cohen's d=0.69; Cohen's d=0.90).

DISCUSSION

Our purpose was to assess feasibility, consider technical issues about measurement of stressors and creation and scoring of an AL index, show test-of-concept, and gather preliminary data

among hotel housekeepers. To our knowledge, this is the first study to use an Allostatic load index with biomarkers to explore health risks among this immigrant worker group. Results suggest that such a project is both needed and feasible. Frequent reports of work-related stressors, including high levels of job strain, were found.

These workers are a fairly young group (with a mean age of 40 years). Yet we found frequent reports of chronic conditions such as hypertension, diabetes, high cholesterol, pain, fatigue, and arthritis. Krause and colleagues recently reported high prevalence of hypertension among hotel housekeepers.[44] Previous studies have shown frequent reports of pain.[5, 45, 46] However, this is the first time that a study reported findings of self-reported history of high cholesterol and arthritis diagnoses among these workers.

Despite the small sample size in this feasibility study, significant associations were found between job strain and everyday discrimination with allostatic load, and between allostatic load with chronic diseases. Job strain and every day discrimination had medium to large effect sizes on ALI-Quartile scores and small to medium effect sizes on ALI-Clinical scores. And the differences in mean ALI-Clinical and ALI-Quartile scores in hotel housekeepers with and without chronic conditions also reflected medium to large effect sizes. The findings suggested that those female hotel housekeepers with high work and non-work stressors had elevated physiological dysregulations across multiple body systems. The accumulated multi-system physiological dysregulations could lead to increased risk for having chronic diseases. But the study did not demonstrate the mediating role of AL in the associations between stressors and health outcomes. Future research needs to explore other AL-related stressors that were strongly associated with this population's poor health outcomes. Additionally, previous studies reported lower AL scores in foreign-born immigrants compared to US-born counterparts and some

immigration-related factors such as age upon arrival and length in US residence were associated with AL scores. [47] Given the high proportion of hotel workers who are foreign-born in this study, future research is needed to examine the role of immigration-related factors (i.e., nativity, age upon arrival, time in US residence, and acculturation) in the associations between work-related stressors, allostatic load, and health outcomes among immigrant hotel workers.

The individual biomarkers in the Allostatic load index also showed high risk for disease development. For example, 44.9% of the individuals had C-reactive protein levels outside of the normal limits for the clinical cut off point. Also, about 30% indicated cholesterol levels outside of normal limits. Risks for obesity were also observed, with more than 80% outside of normal limit for waist-to-hip ratio, and more than 34% with BMI above that of the general population for the clinical cut point. Larger studies are needed to explore the relationship between stressors and allostatic load among these workers. In addition, no significant difference between the two approaches of allostatic load scoring were found: AL-Clinical and AL-Percentile. This may be due to the small sample size. A larger study is needed to determine differences between these two scoring methods.

Stressors to which these workers are exposed are very complex. From a socioecological standpoint, hotel housekeepers may experience stressors across the individual, interpersonal, organizational, and structural/systemic levels. Therefore, it remains challenging to fully capture these stressors in their entirety and how they intersect to further affect workers' health. Thus, explorations of these stressors require careful consideration across all aspects of the research methodology (including recruitment, instrumentation and interpretation). In addition, such complexity warrants the need for both quantitative and qualitative data to gauge the objective and subjective interpretation of stressors and how they affect health. Larger studies are needed to

1) identify key stressors and comprehend their significant impact on the health of these workers;

2) compare various factors (e.g., nativity, job description; industry) across different low-wage

worker groups. In addition, qualitative inquiries are needed to explore the workers' perception of

stressors and to identify the protective factors that can be strengthened to buffer the effects of

stressors.

Limitations

A limitation of this study was that it only focused on women, thus the study finding cannot be

generalized to hotel housemen. More studies are needed to include men, for use in comparisons.

Another limitation of the study was our small sample size (N=49), limiting our ability to make

deductions about the relationships between stressors and allostatic load. Many of these

limitations can be addressed with a larger sample size.

ACKNOWLEDGMENT

REFERENCES

1   **Occupational Safety and Health Administration:** "Hotel Housekeeping Safety."

[Online] Available at

https://www.osha.gov/SLTC/etools/hospital/housekeeping/housekeeping.html (accessed 2015).

2   **Buchanan, S., P. Vossenas, N. Krause, J. Moriarty, E. Frumin, J.A.M. Shimek et al.:**

Occupational injury disparities in the US hotel industry. *American Journal of Industrial*

Medicine 53(2): 116-125 (2010).

3   **Bureau of Labor Statistics:** "37-2012 maids and housekeeping cleaners." [Online]

Available at http://www.bls.gov/oes/current/oes372012.htm (accessed 2017).

4   **Bureau of Labor Statistics:** "Occupational outlook handbook, 2014-15 edition: Maids

and housekeeping cleaners." [Online] Available at http://www.bls.gov/ooh/building-and-

grounds-cleaning/maids-and-housekeeping-cleaners.htm (accesssed 2015).

5   **Krause, N., T. Scherzer, and R. Rugulies:** Physical workload, work intensification, and

prevalence of pain in low wage workers: results from a participatory research project with hotel

room cleaners in Las Vegas. *American Journal of Industrial Medicine 48(5)*: 326-337 (2005).

6   **Sanon, M.A.:** Hotel housekeeping work influences on hypertension management.

American Journal of Industrial Medicine 9999: 1-12 (2013).

7   **Sanon, M.A.:** Agency-hired hotel housekeepers: An at-risk group for adverse health

outcomes. *Workplace Safety & Health 62(2)*: 81-85 (2014).

8   **Krause, N., R. Rugulies, and C. Maslach:** Effort–reward imbalance at work and self-

rated health of Las Vegas hotel room cleaners. *American Journal of Industrial Medicine 53(4)*:

372-386 (2010).

9   **Rosemberg, M.A., B. Ghosh, J. Shaver, M. Militzer, J. Seng, and M. McCullagh:**

Blood Pressure and Job Domains among Hotel Housekeepers. *Journal of Health Disparities*

Research and Practice 11(3): 101-115 (2018).

10   **Department of Industrial Relations:** "Issue brief: workplace injuries in hotel

housekeeping in California " 2016.

11   **Frumin, E.:** Workload-related musculoskeletal disorders among hotel housekeepers: employer records reveal a growing national problem (2006).

12   **Hsieh, Y.-C., Y. Apostolopoulos, and S. Sönmez:** Work Conditions and Health and Well-Being of Latina Hotel Housekeepers. *Journal of Immigrant and Minority Health 18(3)*: 568-581 (2016).

13   **Hsieh, Y.-C.J., Y. Apostolopoulos, K. Hatzudis, and S. Sönmez:** Occupational exposures and health outcomes among Latina hotel cleaners. *Hispanic Health Care International 12(1)*: 6-15 (2014).

14   **Hsieh, Y.-C.J., Y. Apostolopoulos, and S. Sönmez:** The world at work: hotel cleaners. *Occupational and environmental medicine* (2013).

15   **Seifert, A.M., and K. Messing:** Cleaning up after globalization: an ergonomic analysis of work activity of hotel cleaners. *Antipode 38(3)*: 557-578 (2006).

16   **Wial, H., and J. Rickert:** *US Hotels and Their Workers: Room for Improvement*: Working for America Institute, 2002.

17   **McEwen, B.S.:** Stress, adaptation, and disease: Allostasis and allostatic load. *Ann N Y Acad Sci 840(1)*: 33-44 (1998).

18   **Read, S., and E. Grundy:** Allostatic load–a challenge to measure multisystem physiological dysregulation. Pathways Node at NCRM(2012).

19   **Seeman, T.E., B.H. Singer, J.W. Rowe, R.I. Horwitz, and B.S. McEwen:** Price of adaptation—allostatic load and its health consequences: MacArthur studies of successful aging. *Arch Intern Med 157(19)*: 2259-2268 (1997).

20   **de Castro, A., J.G. Voss, A. Ruppin, C.F. Dominguez, and N.S. Seixas:** Stressors

Among Latino Day Laborers A Pilot Study Examining Allostatic Load. *AAOHN journal: official*

journal of the American Association of Occupational Health Nurses 58(5): 185 (2010).

21   **Schnorpfeil, P., A. Noll, R. Schulze, U. Ehlert, K. Frey, and J.E. Fischer:** Allostatic

load and work conditions. *Soc Sci Med 57(4)*: 647-656 (2003).

22   **Sun, J., S. Wang, J.-Q. Zhang, and W. Li:** Assessing the cumulative effects of stress:

The association between job stress and allostatic load in a large sample of Chinese employees.

Work & Stress 21(4): 333-347 (2007).

23   **von Thiele, U., P. Lindfors, and U. Lundberg:** Self-rated recovery from work stress

and allostatic load in women. *Journal of psychosomatic research 61(2)*: 237-242 (2006).

24   **Rosemberg, M.A.S., Y. Li, and J. Seng:** Allostatic load: a useful concept for advancing

nursing research. *Journal of Clinical Nursing* (2017).

25   **Beckie, T.M.:** A systematic review of allostatic load, health, and health disparities. *Biol*

Res Nurs 14(4): 311-346 (2012).

26   **Juster, R.P., B.S. McEwen, and S.J. Lupien:** Allostatic load biomarkers of chronic

stress and impact on health and cognition. *Neurosci Biobehav Rev 35(1)*: 2-16 (2010).

27   **Johnson, S.C., F.L. Cavallaro, and D.A. Leon:** A systematic review of allostatic load in

relation to socioeconomic position: poor fidelity and major inconsistencies in biomarkers

employed. *Soc Sci Med* (2017).

28   **Seeman, M., S.S. Merkin, A. Karlamangla, B. Koretz, and T. Seeman:** Social status

and biological dysregulation: The "status syndrome" and allostatic load. *Soc Sci Med 118*: 143-

151 (2014).

29   **Seeman, T., E. Epel, T. Gruenewald, A. Karlamangla, and B.S. McEwen:** Socio-economic differentials in peripheral biology: Cumulative allostatic load. *Ann N Y Acad Sci 1186(1)*: 223-239 (2010).

30   **Seeman, T.E., E. Crimmins, M.H. Huang, B. Singer, A. Bucur, T. Gruenewald et al.:** Cumulative biological risk and socio-economic differences in mortality: MacArthur studies of successful aging. *Soc Sci Med 58(10)*: 1985-1997 (2004).

31   **McEwen, B.S.:** Biomarkers for assessing population and individual health and disease related to stress and adaptation. *Metabolism 64(3)*: S2-S10 (2015).

32   **National Institute of Occupational Safety and Health:** "Research compendium: The NIOSH Total Worker Health Program: Seminnal research papers 2012. ", US Department of Health and Human Services, Public Health Services, Centers for Disease Control and Prevention, National Institute of Occupational Safety and Health and D. (NIOSH) (eds.). Washington DC, 2012.

33   **National Institute of Occupational Safety and Health:** "What is Total Worker Health?" [Online] Available at http://www.cdc.gov/niosh/twh/default.html (accessed 2016).

34   **National Institute of Occupational Safety and Health (NIOSH):** "National occupational research agenda (NORA)/national Total Worker Health agenda (2016-2026): A national agenda to advance total worker health research, practice, policy and capacity": Department of Health and Human Services: Centers for Disease Control and Prevention National Institute of Occupational Safety and Health 2016.

35   **Schill, A., and C. Chosewood:** Total Worker Health®. *Workplace health & safety 64(1)*: 4-5 (2016).

36   **Takahashi, H., M. Yoshika, and T. Yokoi:** Validation of two automatic devices for the self-measurement of blood pressure according to the ANSI/AAMI/ISO81060-2:2009 guidelines: the Omron BP765 (HEM-7311-ZSA) and the Omron BP760N (HEM-7320-Z). *Vasc Health Risk Manag 11*: 49-53 (2015).

37   **Karasek, R., C. Brisson, N. Kawakami, I. Houtman, P. Bongers, and B. Amick:** The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *Journal of Occupational Health Psychology 3(4)*: 322 (1998).

38   **Siegrist, J., D. Starke, T. Chandola, I. Godin, M. Marmot, I. Niedhammer et al.:** The measurement of effort–reward imbalance at work: European comparisons. *Soc Sci Med 58(8)*: 1483-1499 (2004).

39   **Williams, D.R.:** Measuring Discrimination Resource. *Psychology 2(3)*: 335-351 (1997).

40   **Gray, M.J., B.T. Litz, J.L. Hsu, and T.W. Lombardo:** Psychometric properties of the life events checklist. *Assessment 11(4)*: 330-341 (2004).

41   **Brazier, J.E., and J. Roberts:** The estimation of a preference-based measure of health from the SF-12. *Medical care 42(9)*: 851-859 (2004).

42   **Ware, J.E., M. Kosinski, and S.D. Keller:** A 12-Item Short-Form Health Survey: Construction of Scales and Preliminary Tests of Reliability and Validity. *Medical care 34(3)*: 220-233 (1996).

43   **Ware, J.E.:** *The SF-12v2TM how to score version 2 of the SF-12® health survey:(with a supplement documenting version 1)*: Quality Metric, 2002.

44   **Krause, N., and O.E. Arias:** Disparities in prevalence, treatement, and control of hypertension among low wage immigrant workers beyond health insurance coverage: The last

vegas hotel room cleaners blood pressure study. *Joiurnal of Hypertension Management* 1: 003 (2015).

45   **Burgel, B.J., M.C. White, M. Gillen, and N. Krause:** Psychosocial work factors and shoulder pain in hotel room cleaners. *American Journal of Industrial Medicine 53(7)*: 743-756 (2010).

46   **Scherzer, T., R. Rugulies, and N. Krause:** Work-related pain and injury and barriers to workers' compensation among Las Vegas hotel room cleaners. *American journal of public health 95(3)*: 483 (2005).

47   **Doamekpor, L.A., and G.Y. Dinwiddie:** Allostatic Load in Foreign-Born and US-Born Blacks: Evidence From the 2001-2010 National Health and Nutrition Examination Survey. *American Journal of Public Health 105(3)*: 591-597 (2015).
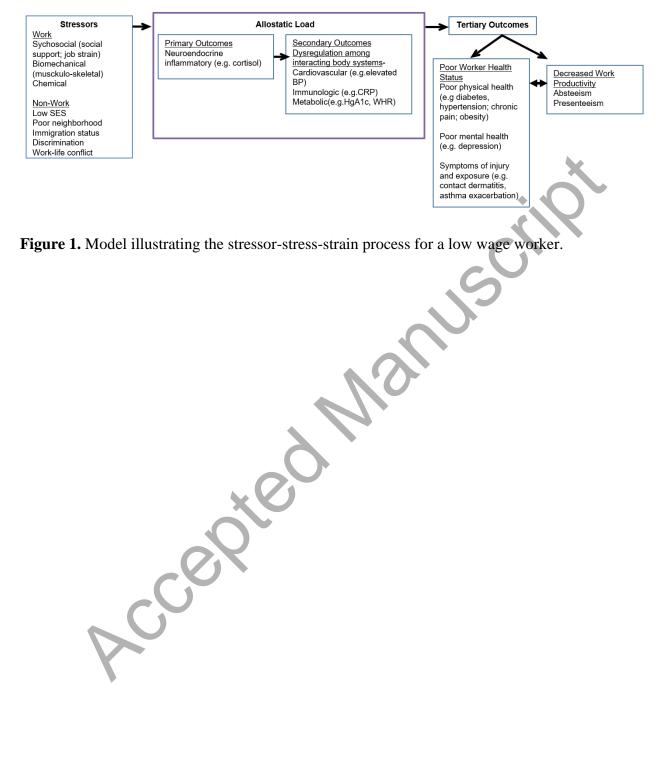
Figure 1. Model illustrating the stressor-stress-strain process for a low wage worker.

Table 1. Sample characteristics (N=49).

		N	M±SD/%	Range
Socio-demographics				
Age		47	40.4±10.5	21–59
Marital status		48		
	Married/Partnered	29	60.4	
	Single/Divorced/Widowed	19	39.6	
Race/ethnicity		48		
	Black or African American	14	29.2	
	White	3	6.3	
	Hispanic, Latino, Mexican American, Mexican	27	56.3	
	American Indian/Alaska Native/Asian	2	4.2	
	More than one race	2	4.2	
Foreign born		49		
	Foreign born	31	63.3	
	US born	18	36.7	
Education		47		
	Some high school but did not graduate or less	26	55.3	
	High school graduate or more	21	44.7	
Hourly wage		49		
	10 or less	18	36.8	
	10.01-12	20	40.8	
	12.01-14	6	12.2	
	More than 14	5	10.0	
Insurance		48		

		N	M±SD/%	Range
	Full insurance	11	28.9	
	Partial or no insurance	37	77.1	
Smoking status		49		
	Currently	8	16.3	
	Ex-smoker	6	12.2	
	Only smoked a few times	2	4.1	
	Never	33	67.3	
Alcohol use		49		
	1-2 days per week	7	14.3	
	1-3 days per month	3	6.1	
	Less than once per month	16	32.7	
	Never	23	46.9	
Stressors				
Number of traumatic events		49	0.9±1.5	0–6
	At least one traumatic event	21	42.9	
	None	28	57.1	
Everyday discrimination		48	2.02±2.59	
	High	25	52.1	
	Low	23	47.9	
Job strain		43		
	High	9	20.9	
	Low	34	79.1	
Number of rooms cleaned on a normal day		45	14.6±2.7	8–21
Health outcomes				

		N	M±SD/%	Range
General health status		49		
	Excellent	6	12.2	
	Very good	7	14.3	
	Good	32	65.3	
	Fair	2	4.1	
	Poor	2	4.1	
SF-12 physical health		49	49.3±8.0	24.2–60.6
SF-12 mental health		49	48.4±10.5	22.4–68.1
Chronic diseases		49	2.2±2.1	0–9
	≥1	38	77.6	
	None	11	22.4	

Table 2. Biomarkers.

	N	M±SD	Clinical cut-off points	High risks, n (%)	High-risk quartile cut-off points	High risks, n (%)
CRP (mg/L)	49	4.2±4.7	≥3.0	22 (44.9)	>6.8	12 (24.5)
HDL (mg/dL)	49	58.2±11.9	<50	15 (30.6)	<46.5	12 (24.5)
HbA1c (ug/mL)	49	633.9±208.6	≥1170	1 (2.0)	>789.0	12 (24.5)
Cortisol (ug/dL)	49	15.3±5.3	>23	6 (12.2)	>19.1	12 (24.5)
SBP (mmHg)	49	124.3±17.9	>140	5 (10.2)	>137.0	10 (20.4)
DBP (mmHg)	49	77.2±11.6	>90	6 (12.2)	>85.5	10 (20.4)
HR	49	74.2±10.9	>100	1 (2.0)	>80.5	12 (24.5)
WHR	49	0.9±0.1	≥0.85	40 (81.6)	>0.9	12 (24.5)
BMI	44	29.5±7.1	≥30	17 (34.7)	>33.4	11 (22.4)

Note. High levels of each biomarker except HDL indicate high risk.

CRP= Serum C-reactive protein, Serum HDL=high density lipoprotein, Serum
HbA1c=hemoglobin A1c, Cortisol= Serum Cortisol, SBP=systolic blood pressure,
DBP=diastolic blood pressure, HR=heart rate, WHR=waist/hip ratio, BMI=body mass index

Table 3. Allostatic load index scores using clinical and high-risk quartile cut-off points.

ALI-Clinical	N (%)	ALI-Quartile	N (%)
0	4 (8.2)	0	6 (12.2)
1	8 (16.3)	1	13 (26.5)
2	17 (34.7)	2	14 (28.6)
3	12 (24.5)	3	8 (16.3)
4	5 (10.2)	4	4 (8.2)
5	3 (6.1)	5	3 (6.1)
		7	1 (2.0)

Note. ALI-Clinical=allostatic load index score using the clinical cut-off points; ALI-quartile=allostatic load index score using the high-risk quartile cut-off points

Table 4. Correlations between allostatic load, stressors, and health outcomes.

	ALI-Clinical		ALI-Quartile	
	r	*P*	*r*	*P*
Job strain	0.23	0.147	0.39*	0.011
Rooms cleaned	0.056	0.713	-0.077	0.615
Everyday discrimination	0.22	0.146	0.41**	0.004
Trauma exposure	0.14	0.332	0.14	0.341
General health status	0.055	0.708	0.25	0.082
SF-12 physical health	-0.13	0.379	-0.18	0.205
SF-12 mental health	0.12	0.433	-0.17	0.251
Chronic diseases	0.27	0.063	0.40**	0.005

Note. ALI-Clinical=allostatic load index scores using the clinical cut-off points; ALI-Quartile=allostatic load index scores using the high-risk quartile cut-off points
* *P*<0.05
** *P*<0.01

Table 5. Comparisons on allostatic load index scores in relation to job strain, everyday discrimination, and chronic diseases.

	Job strain		Everyday discrimination		Chronic diseases	
	High (n=9)	Low (n=34)	High (n=25)	Low (n=23)	Yes (n=38)	No (n=11)
ALI-Clinical						
$M \pm SD$	2.89±1.27	2.12±1.27	2.56±1.36	2.13±1.10	2.50±1.27	1.64±1.12
t	1.62		1.20		2.04	
P	0.114		0.237		0.047	
Cohen's d	0.61		0.35		0.69	
ALI-Quartile						
$M \pm SD$	3.11±1.27	1.88±1.45	2.56±1.71	1.65±1.19	2.39±1.53	1.09±1.04
t	2.31		2.12		2.64	
P	0.026		0.040		0.011	
Cohen's d	0.87		0.61		0.90	