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Low back pain in Hispanic residential carpenters☆

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Abstract

Objective: Low back pain (LBP) is a leading cause of lost work time and has been recognized as America's number one workplace safety challenge. Low back pain is occurring at epidemic proportions among construction workers, and minority populations have been underinvestigated for risk of back injury. This project investigated the multiple potential risk factors for occupational LBP among Hispanic residential carpenters.

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Methods: This investigation evaluated 241 Hispanic residential framing carpenters. Data for this study were collected using a 91-question survey. End points of interest included point, annual, and lifetime prevalence of LBP.
Results: Nineteen percent of respondents reported they had an episode of LBP in their lifetime.
Conclusions: Hispanic residential carpenters reported less than expected prevalence of LBP compared with non-Hispanic counterparts in the same trade and location. Job tasks and personal and workplace risk factors, including psychological and morphological characteristics, affect the prevalence of LBP among Hispanic framing carpenters.

Introduction

The Hispanic construction workforce numbers more than 1.4 million, comprising 15% of all construction workers in the United States.[1] The number of Hispanic workers is growing 36% faster than other minority groups, and they have been correlated with increased injury and illness representation.[2] Guo et al[3,4] identified the construction industry as having the fifth highest annual prevalence rate for low back pain (LBP) at 17.8 per 100 workers. Dement and Lipscomb[5] found a LBP prevalence rate of 22.9 per 100 carpenters in a North Carolina cohort of more than 7400 carpenters. Investigators have reported that Hispanic construction workers are an overrepresented group with disproportionately more musculoskeletal injury including back pain.[2,6]

The construction industry is the sixth largest employer nationwide representing 6% of the nation's labor force.[7-13] This industry accounts for 15% to 17% of all reported workplace injuries and 10% of all disabling injuries.[14] Zwerling et al[15] found injury rates 4.6 times higher for construction workers compared to all other professions in their study of 7798 injury cases in Iowa. Furthermore, 25% of persons with back pain had lost more than 30 days of work because of back pain.

Among construction workers, back pain is at epidemic proportions.[16] Although many characteristics of LBP in the construction industry have been well documented, there remains a paucity of research on personal and workplace factors that specifically affect the onset of LBP and low back injuries among Hispanic residential construction workers.[17] The nature of residential carpentry work includes a variety of job-task demands such as cutting, handling, fitting, installing, and assembling wood materials into single-family homes, duplexes, apartments, and other wood-frame structures.[7,9,18-20] Framing carpenters construct the skeleton structure of a building, erecting walls, partitions, window wells, floors, stairways, ceilings, and roof joists. Because of the diversity of work demands and environment, carpenters are exposed to a variety of potential hazards including excessive physical demands and awkward postures. Cook et al[18] investigated the self-reported degree of problem or difficulty associated with specific carpentry tasks, finding major problematic tasks involved: holding the same position for an extended time, awkward bending/twisting of the back, being in awkward or cramped positions, reaching overhead or away from the body, and carrying or lifting heavy materials.

This project investigated the multiple potential risk factors for occupational LBP among Hispanic residential carpenters. The primary focus was measuring subjective low back strain at the job-task level to better understand physical risk factors associated with LBP. A task-based approach to evaluating the activities of framing carpenters established a framework for understanding their job. Personal and workplace factors were also evaluated to explore their relation or interaction with LBP. The point, 12-month, and lifetime prevalences of LBP were determined in the study participants.

Methods

This investigation was a nested cross-sectional study of 241 Hispanic residential framing carpenters within a larger longitudinal cohort study evaluating the effectiveness of the HomeSafe Pilot Program, a safety and health program designed by the Occupational Safety and Health Administration (OSHA) Region VIII and the Home Builders Association of Metropolitan Denver (HBA) to reduce injuries and fatalities in residential construction.[21] Approximately 5500 Hispanic framing carpenters were identified within the larger residential construction population of approximately 50 000 working in the program area, which was restricted to 5 counties in the Denver metropolitan area. A randomly selected sample of 241 Hispanic framing carpenters was identified through participating general contractors within the HomeSafe Pilot Program.

Table 1 Description of evaluated personal and workplace variables

Variables Evaluated	Variable Description (and Scoring)
Years of Construction	The Number of Years in Residential Construction of Any Type
Years of Framing	The Number of Years Working in Residential Framing Carpentry
Hours Worked/Week	The Number of Hours Worked per Week
Hours Safety Training	The Number or Hours of Safety Training Received Annually
Safety Trainer	Who Provided the Safety Training (1-6: 1 = General Contractor, 2 = Foreman, 3 = Safety Consultant, 4 = OSHA, 5 = HBA, 6 = Other)
Risk Rating	Rate the Risk of Injury in Framing (0-4: 0 = None, 1 = Slight, 2 = Moderate, 3 = High, 4 = Severe)
Back Strain Carpentry	Rate Back Strain in Framing (0-4: 0 = None, 1 = Low, 2 = Moderate, 3 = High, 4 = Very High)
Job Satisfaction	Rate Your Level of Job Satisfaction (0-4: 0 = None, 1 = Very Little, 2 = Some, 3 = Mostly, 4 = Very)
Coworker Caring	Belief About Coworker Caring (0-4: 0 = Not at All, 1 = Very Little, 2 = Some, 3 = Mostly, 4 = Very Concerned)
Boss Caring	Belief About Boss Caring (0-4: 0 = Not at All, 1 = Very Little, 2 = Some, 3 = Mostly, 4 = Very Concerned)
Mentally Exhausted	Rate Level of Mental Fatigue (0-4: 0 = Never, 1 = Sometimes, 3 = Frequently, 4 = Almost Always, 4 = Always)
Physically Exhausted	Rate Level of Physical Fatigue (0-4: 0 = Never, 1 = Sometimes, 3 = Frequently, 4 = Almost Always, 4 = Always)
Boring Work	Perception That Work Is Boring (0-4: 0 = Not at All, 1 = Very Little, 2 = Sometimes, 3 = Most of the Time, 4 = All the Time)
Time Pressure	Perception of Time Pressure (0-4: 0 = Not at All, 1 = Very Little, 2 = Sometimes, 3 = Mostly All of the Time, 4 = All the Time)
Side Jobs	Hours per Month Engaged in Side Job Work (0-4: 0 = None, 1 = <8, 2 = 9-16, 3 = 17-20, 4 = >21)
WC insurance	Worker Compensation Insurance Coverage Paid for by (0-4: 0 = Not Covered, 1 = General Contractor, 2 = Subcontractor, 3 = Company, 4 = Self)
Risk/Hazard Training	Did You Receive Risk and Hazard Training (Yes or No: 0 = No, 1 = Yes)?
LBP Prevention	Did Safety Training Include Low Back Injury Prevention (Yes or No: 0 = No, 1 = Yes)?
Job Task–Related LBP	Are Any Job Tasks Associated to LBP (Yes or No: 0 = No, 1 = Yes)?
Temperature Exposures	Exposure to Hot and Cold Temperature at Work (Yes or No: 0 = No, 1 = Yes)
Noise Exposures	Exposure to Loud Noises at Work (Yes or No: 0 = No, 1 = Yes)
Self-employed	Are You a Self-employed Subcontractor (Yes or No: 0 = No, 1 = Yes)?
Employee Status	Are You an Employee of the Framing Company (Yes or No: 0 = No, 1 = Yes)?
Age	How Old Were You at Your Last Birthday, in Years?
Married	Are You Married (Yes or No: = No, 1 = Yes)?
Height	How Tall Are You, in Feet and Inches?
Weight	How Much Do You Weigh in Pounds?
Quet (Calculated)	Weight in Kilograms/Height in Square Meters
Education Level	Education Level (1-6: 1 = <8 y, 2 = Some High School, 3 = High School Graduate, 4 = Trade School, 5 = Some College, 6 = College Graduate)
Income	Income level in Dollars (0-4: 0 = <10 000, 1 = 11 000-20 000, 2 = 21 000-35 000, 3 = 36 000-50 000, 4 = >50 000)
Primary Language	What Is Your Primary Language?
Smoking Status	Smoking Status (1-3: 1 = Never, 2 = Former, 3 = Current)
Alcohol Consumption	How Much Consumed per Week in Beers or Drinks (0-4: 0 = None, 1 = 1-2, 2 = 3-5, 3 = 6-10, 4 = >10)
Exercise Activity	Exercise per Week in Addition to Work (0-4: 0 = None, 1 = Light, 2 = Moderate, 3 = Heavy, 4 = Very Heavy)
Health Status	Health Status (0-4: 0 = Poor, 1 = Fair, 2 = Good, 3 = Very Good, 4 = Excellent)

Table 1 (continued)

Variables Evaluated	Variable Description (and Scoring)
Health Problems	Health Problems Revealed (0-6: 0 = None, 1 = Heart, 2 = Respiratory, 3 = Diabetes, 4 = Arthritis, 5 = Depression, 6 = Other)
Type of Low Back Injury	Single Incident vs Cumulative Trauma (0-3: 0 = None, 1 = Single, 2 = Cumulative)
Days With LBP	Days With LBP in Past Year (0-5: 0 = None, 1 = 1-5, 3 = 11-14, 4 = 15-20, 5 = >20 d)
Continuous LBP	Do You Have Continuous LBP (Yes or No: 0 = No, 1 = Yes)
Lost Workdays With LBP	Have You Ever Lost Work Because of LBP (Yes or No: 0 = No, 1 = Yes)
LBP Problem Framer	Rate Level of LBP as a Problem in Framing Carpentry (0-3: 0 = None, 1 = Slight, 2 = Moderate, 3 = Severe)

Quet, Quetelet index.

Questionnaire

Data for this study were collected using a 91-question survey developed for this investigation. The survey was designed to assess the amount of back strain experienced during the major job tasks performed by residential framing carpenters, as well as to gather personal and workplace information on other potential risk factors for LBP (Table 1).

For the identification of major job tasks performed by residential framing carpenters, expert sources including individual general contractors, framing companies, building experts, OSHA, and HBA representatives were consulted. Lists of building phases and tasks were requested from each source. Information was reviewed and assessed for similarities, and a comprehensive list of 44 major job tasks was developed (Table 2).

Next, a series of focus groups were held with framing carpenters to refine the list to accurately reflect the major job tasks performed when building a wood-frame home. The survey was piloted through another series of focus groups. The final survey was then sent to 15 of the original expert sources for review and comment. The last step consisted of translating the survey into Spanish and back-translating into English.

In administering the survey, bilingual individuals were available to assist workers who spoke only Spanish. A bilingual student from the Department of Environmental Health at Colorado State University assisted for consistency and accuracy of communication with Hispanic workers.

Participants were asked to rate perceived strain to the low back while performing the 44 major job tasks required to build a wood-framed house using a modified Borg scale of 1 to 5, where 1 = no strain and 5 = very high strain. The study protocol was reviewed and approved by Colorado State University's human research committee.

Data analysis

Questionnaire data were entered into SPSS Base 10.0 (SPSS Inc, Chicago, Ill) for storage, management, and data analysis. Descriptive statistics, frequencies, univariate analysis, and binary logistic regression were used for the data analysis while adhering to appropriate statistical methods. Survey data on response variables were found to be normally distributed using the 1-sample Kolmogorov-Smirnov test. Descriptive statistics included the generation of job-task mean strain scores, as well as mean values and proportions for personal and workplace factors for all variables of interest and for estimation of prevalence proportions for LBP within the past 2 weeks (point), 12 months (annual), and over the subject's lifetime. One-way analysis of variance was used to estimate effect of personal and workplace variables as dependent variables on the individual mean strain scores for each of the 44 major job tasks as independent variables. Binary logistic regression was used to evaluate the relationship of dependent variables of interest with respect to point, annual, and lifetime prevalence of LBP. Confounding was evaluated by assessing the effect of each dependent variable on mean strain scores. Specifically, those job-task and personal variables found to be significantly ($P < .05$) associated with the respective LBP prevalence were evaluated jointly via multiple logistic regression analysis based on the forward selection method. Variables found to affect mean strain scores in at least 11 of the 44 job tasks were then used to adjust the final models. Adjusted job-task models combined with personal and workplace models into one model would more accurately represent interactions and assist in identifying those factors related to the onset of LBP. After the completion of each regression model, the 2 models pertaining to each end point of interest were combined (integrated) to produce the final model for predictors of LBP.

Table 2 Description of 44 residential framing job tasks evaluated

Job-Task Variable	Job-Task Description
Floor Framing Job Tasks	
Break Materials	Open the House Materials Package and Begin Building
Sort Floor Materials	Sort Floor Material by Type and Length Into Separate Piles
Measure Layout	Measure Correct Layout for the Floor Plan and Snap Lines on the Foundation Floor for Placing Walls
Place and Plate Beams by Hand	Place and Plate Any Beams That Are in the Floor Plan and Place Them in the Proper Location by Hand
Place and Plate Beams Using Crane	Place and Plate Any Beams That Are in the Floor Plan and Place Them in the Proper Location Using a Crane
Install Sill Plates	Measure the Green Plate, Cut It to the Correct Length, Measure and Drill Holes for the Foundation Bolts, Place Sill Sealer on the Foundation Walls, and Bolt Down the Green Plate
Frame Walkouts	Building/Framing House Walkouts
Cut Floor Joists	Cut the Floor Joists to Correct Length
Sort Precut Floor Trusses	Sort Precut Floor Trusses Into Stacks of Similar Length
Install Floor Joists	Install the Floor Joists to the Correct Location and Length
Sheet Floor With 3/4-in oriented strand board (OSB)	Sheet the Floor With 3/4-in OSB by Gluing the Joist and Then Nailing the Board Down With 8d Ring Shank Nails
Snap Lines	Snap Lines on the Floor for Wall Placement and Framing
Install Beams by Hand	Install Wood Beams or Microlamination Beams by Hand
Install Beams Using Crane	Install Wood Beams or Microlamination Beams Using a Crane
Wall Framing Job Tasks	
Sort Wall Material	Sort the Wall Material by Type and Length and Stack in Orderly Piles
Lay Out Plates	Cut and Layout or Place Plates to Floor Plan
Set Up Cut Station	Set Up a Cut Station for Centralized Use by Framers
Create Cut List	Check Plans, Measurements, and Create a Cut List for the Wall Materials
Cut Material	Cut the Material to Proper Length and Nail the Walls Together at Floor Level
Square Wall	Square Wall to Rectangular Dimensions at Floor Level Using 5- or 10-lb Sledge Hammer
Sheet Exterior Wall Down	Sheet the Exterior Walls With Proper Sheeting Material at Floor Level (Thermoply or 1/2-in OSB, Fiber Board)
Sheet Exterior Wall Upright	Sheet the Exterior Walls With Proper Sheeting Material in an Upright Position (Thermoply or 1/2-in OSB, Fiber Board)
Stand Walls	Stand Walls and Nail Them in Place and Brace Them Properly
Roofing Framing and Truss Installation Job Tasks	
Sort Trusses	Sort the Trusses in Order of Placement Into Structure
Sheet Gable Ends	Sheet Gable Ends With Proper Material (1/2 OSB)
Rack Trusses	Position the Trusses Into Location of Installation
Cut Tails	Cutting the Roofing Joist Ends to Even Length
Install Roof Anchors	Install the Roof Anchor on the Truss
Boom Trusses	Using a Crane to Lift or Boom the Trusses in Place and/or Nail Them Off As You Go
Install Truss Clips	Nail Off and Install Truss Clips As You Frame Roof
Brace Trusses	Brace Trusses Off With 2 × 4s or 1 × 4s on the Truss Chords
Installation of Sheeting Job Tasks	
Sheet First Row on Roof	Sheet the First Row While Standing Inside the Trusses if Possible
Finish Sheeting Roof	Finish Sheeting Roof
Install Fascia Rafters	Install Fascia Rafters/Barge in Subfascia

Table 2 (continued)

Job-Task Variable	Job-Task Description
Other Framing Job Tasks	
Roll Out/Set Up Tools	Job Arrival and Tool Setup for Framing Work
Build and Install Stairs	Frame and Install Stairs and Landings
Set Prebuilt Stairs	Set into Place and Secure Prebuilt Stairs and Landings
Build and Install Partitions	Frame and Install Partitions, Half Walls, or Floating Walls
Build Basement Floor	Frame Wood Floor for Basement
Build Exterior Deck	Frame and Finish Exterior Decks and Railings
Nail Metal Connections	Nail All Connections and Metal Hangers
Cut Roof Vents	Cut Roof Vents Where Designed in Plans
Clean Up Scrap Material	Clean Up Scrap Material From Job-Site Activities
Roll Up/Put Tools Away	End-of-Day Tool Cleanup, Storage, and Transport

Results

Descriptive statistics for the 241 Hispanic carpenters are presented in Table 3. All the respondents were males between the ages of 15 and 56 years (mean, 27.1 years). On average, they self-reported as being shorter in stature (<1.6 m in 48%) and weighing less (<72.5 kg in 60%) than the average non-Hispanic US male of 1.7 m and 78 kg.[22] Twenty-seven percent reported having some high school education, and 9% indicated that they had completed high school. Sixty-six percent reported incomes of less than $20 000/y with only 12% reporting an income of more than $35 000/y. Most respondents worked fewer than 45 h/wk (59%) and did not work another job (63%).

Seventy-six percent of respondents had been working in residential construction from 1 to 5 years with only 5% working more than 11 years (Table 3). Most of them had worked as a framing carpenter for less than 5 years (83%) with 12% reporting doing this work for 6 to 10 years. Only 5% reported between 11 and 15 years of working in construction. In general, the respondents were satisfied with their occupation (81%), felt their overall health was "good" (77%), were not currently smoking (78%), had light alcohol consumption (<2 beers or drinks per week, 79%), and

Table 3 Personal and workplace characteristics of Hispanic residential framing carpenters

Worker Characteristics	Percentage	Mean (SD)	n
Sex (Male)	100	–	241
Age (y; Range, 15-56 y)	–	27.1 (7.3)	217
Body Height (m, % = No. With <1.6 m)	48	1.7 (0.09)	224
Body Weight (kg, % = No. With 43.5-72.5 kg)	60	72.0 (11.5)	223
Marital Status (Married)	37	–	228
Education (Score: 1-6, % = No. With Some High School)	27	1.9 (1.3)	223
Yearly Income (Score: 0-4, % = No. With <$21 000)	66	1.1 (1.1)	219
Work (h/wk, % = No. With >45 h/wk)	29	44.1 (7.9)	232
Side Jobs (h/mo, % = No. With ≤8 h/mo)	80	0.8 (1.3)	229
Residential Construction (y, % = No. With <5 y)	79	3.5 (3.1)	236
Residential Framing (y, % = No. With <5 y)	83	3.3 (3.1)	236
Health Status (Score: 0-4, % = No. With >2)	77	2.2 (0.9)	231
Smoking Status (Score: 1-3, % = No. of Current Smokers)	22	1.7 (0.8)	229
Alcohol Consumption (Score: 0-4, % = No. With ≥3 per Week)	79	0.8 (1.0)	229
Exercise (Score: 0-4, % = No. With <10 min, Twice per Week)	87	0.6 (0.7)	224
Back Strain in Carpentry (Score: 0-4, % = No. With Score of ≤1)	54	2.4 (1.1)	222
Job Satisfaction (Score: 0-4, % = No. With Score of ≥3)	81	3.1 (0.9)	232
Work Mentally Exhausting (Score: 0-4, % = No. With Score of ≤1)	78	1.3 (0.9)	230
Time Pressure at Work (Score: 0-4, % = No. With Score of ≤1)	74	0.8 (1.1)	230
Lost Workdays From LBP (Score: 0 or 1, % = No. With "Yes" Answer [1])	11	0.1 (0.3)	228

Table 4 Low back mean strain scores (Borg score of 1-5) for 44 job tasks rated by Hispanic framing carpenters

Job-Task Variable	Mean Strain Score[a] ± SD
Break Materials	1.07 ± 0.76
Sort Floor Materials	1.20 ± 0.77
Measure Layout	1.17 ± 0.82
Place and Place Beams by Hand	1.37 ± 1.02
Place and Plate Beams Using Crane	1.30 ± 1.03
Install Sill Plates	1.11 ± 0.68
Frame Walkouts	1.26 ± 0.89
Cut Floor Joists	1.26 ± 0.89
Sort Precut Floor Trusses	1.22 ± 0.95
Install Floor Joists	1.45 ± 0.97
Sheet Floor With 3/4-in OSB	1.28 ± 0.86
Snap Lines	1.03 ± 0.70
Install Beams by Hand	1.33 ± 1.05
Install Beams Using Crane	1.12 ± 0.86
Sort Wall Material	1.36 ± 0.76
Lay Out Plates	1.00 ± 0.81
Set Up Cut Station	0.91 ± 0.72
Create Cut List	0.98 ± 0.67
Cut Material	1.30 ± 0.79
Square Wall	1.04 ± 0.61
Sheet Exterior Wall Down	1.20 ± 0.88
Sheet Exterior Wall Upright	1.20 ± 0.92
Stand Walls	1.39 ± 1.04
Sort Trusses	1.29 ± 0.87
Sheet Gable Ends	1.18 ± 1.00
Rack Trusses	1.14 ± 1.03
Cut Tails	1.26 ± 0.98
Install Roof Anchors	1.09 ± 0.91
Boom Trusses	1.23 ± 0.91
Install Truss Clips	1.34 ± 0.83
Brace Trusses	1.18 ± 0.78
Sheet First Row on Roof	1.14 ± 0.88
Finish Sheeting Roof	1.13 ± 0.94
Install Fascia Rafters	1.21 ± 1.09
Roll Out/Set Up Tools	1.03 ± 0.67
Build and Install Stairs	1.15 ± 0.88
Set Prebuilt Stairs	1.20 ± 1.05
Build and Install Partitions	1.16 ± 0.93
Build Basement Floor	1.01 ± 0.95
Build Exterior Deck	1.03 ± 0.95
Nail Metal Connections	1.11 ± 0.91
Cut Roof Vents	1.12 ± 0.86
Clean Up Scrap Material	1.15 ± 0.60
Roll Up/Put Tools Away	1.08 ± 0.61

[a] Mean scores based upon N = 241 (rating scale of 0-5; 0 = not performed, 1 = no strain, 2 = low strain, 3 = moderate strain, 4 = high strain, and 5 = very high strain).

were not especially physically active outside of work (<10 minutes of exercise twice per week, 87%). They did not find their work to be mentally exhausting (78%). A slight majority (54%) felt that the magnitude of back strain in carpentry was "low" or less.

Mean low back strain Borg scores were obtained for the 44 major job tasks performed (Table 4). Mean strain scores ranged from the lowest for setting up a cut station and creating a cut list (0.91 and 0.98, respectively) to the highest for installing floor joists (1.45). All job tasks were rated at the "no strain" to "low strain" level; none were ranked as moderate, high, or very high. Low variability is seen in the SDs, which ranged from a low of 0.61 to as much as 1.05.

Table 5 Odds ratios for personal variables as predictors of lifetime work-related LBP at the .05 level

Variables	OR Estimate	95% CL-L	95% CL-U	*P*
Personal Variables				
Years in Construction	2.07	1.251	3.434	.005
Years in Framing	1.82	1.098	3.032	.02
Income Level	1.39	1.030	1.885	.03
Alcohol Consumption	1.52	1.105	2.099	.01
Health Status	0.64	0.438	0.936	.021
Quet	1.28	1.032	1.597	.025

None of the 44 job-task variables were significant in the model. The remainder of personal and workplace variables were not significant in the model.

Low back pain

Lifetime prevalence of LBP

Nineteen percent of the respondents reported they had an episode of LBP or injury in their lifetime that had caused them to seek medical care or alter some aspect of normal living. Table 5 presents only those personal variables found to be significant predictors of lifetime work-related LBP. Both years in construction (1-5 years) and years in framing (1-5 years) produced the largest odds ratio (OR) for lifetime work-related

Table 6 Adjusted OR for personal variables as predictors of lifetime work-related LBP

Variables	OR Estimate	95% CL-L	95% CL-U	*P*
Years in Construction	3.04	0.736	12.576	.1
Years in Framing	0.81	0.199	3.293	.7
Income Level	1.41	0.934	2.129	.1
Alcohol Consumption	0.82	0.521	1.298	.4
Health Status	0.46	0.266	0.793	.005
Quet	1.28	0.959	1.701	.09

Adjusted for boss caring, hours worked per week, mental exhaustion, and time pressure.
CL-L, confidence limit-lower; *CL-U*, confidence limit-higher.

LBP, 2.07 (CI, 1.25-3.43) and 1.82 (CI, 1.09-3.03), respectively. An individual's overall health status provided a protective effect against lifetime work-related LBP (OR, 0.64; CI, 0.44-0.94). None of the 44 job-task variables entered a predictive model at the .05 significance level; therefore, integrating with personal and workplace factors could not be accomplished for lifetime prevalence of LBP. The final model was adjusted for boss caring, hours worked per week, mental exhaustion, and time pressure; 6 variables remained in the model (Table 6).

Table 7 Odds ratios for job-task and personal variables as predictors of 12-month work-related LBP at the .05 level

	OR Estimate	95% CL-L	95% CL-U	*P*
Task Variables				
Sorting Materials	1.83	1.092	3.062	.022
Plate Beams by Hand	1.49	1.027	2.185	.036
Frame Walkouts	1.94	1.244	3.036	.004
Cut Floor Joists	1.88	1.231	2.879	.004
Install Floor Joists	1.81	1.217	2.690	.003
Install Wood Beams by Hand	1.51	1.026	2.208	.037
Sorting Wall Materials	1.76	1.050	2.944	.032
Cutting Materials	1.68	1.022	2.773	.041
Sheet Wall on Ground	1.63	1.053	2.529	.028
Sheet Wall Upright	1.63	1.085	2.434	.018
Stand Walls	1.86	1.283	2.685	.001
Rack Trusses	1.68	1.179	2.392	.004
Cut Tails	2.02	1.397	2.909	<.001
Install Roof Anchors	1.64	1.140	2.355	.008
Install Truss Clips	2.21	1.405	3.482	.001
Brace Trusses	1.83	1.130	2.955	.014
Finish Sheeting Roof	1.72	1.134	2.603	.011
Install Fascia Rafters	1.52	1.074	2.147	.018
Roll Out at Job Site	2.18	1.282	3.692	.004
Set Prebuilt Stairs	1.74	1.230	2.447	.002
Nail Hangers	1.72	1.180	2.519	.005
Personal Variables				
Years in Construction	1.97	1.055	3.670	.033
Hours Worked per Week	3.05	1.249	7.450	.014
Job Satisfaction	0.65	0.424	0.986	.043
Coworker Caring	0.59	0.412	0.840	.003
Mental Exhaustion	1.64	1.114	2.425	.012
Physical Exhaustion	1.59	1.019	2.469	.041
Time Pressure	2.05	1.420	2.952	<.001
Hazard and Risk Training	5.59	1.270	24.615	.023
Self-employed	3.31	1.349	8.099	.009
Smoking Status	1.92	1.129	3.267	.016
Health Problems	1.33	1.030	1.720	.029
Health Status	0.49	0.275	0.876	.016

Table 8 Adjusted ORs for integrated model of 12-month prevalence of LBP by combining personal, workplace, and job-task variables and adjusting

Variables	OR Estimate	95% CL-L	95% CL-U	*P*
Coworker Caring	0.39	0.205	0.772	.006
Time Pressure	2.71	1.605	4.582	<.000
Smoking Status	2.36	1.061	5.237	.035

Adjusted for boss caring, hours worked per week, mental exhaustion, and time pressure. Many personal and workplace variables and all job-task variables fell out of the model.

Twelve-month prevalence of LBP

Ten percent of respondents reported having an episode of LBP within the past 12 months sufficient to seek treatment or alter some aspect of normal living. Table 7 presents 21 significant individual job-task and 12 personal and workplace variables as predictors of 12-month work-related LBP. Of interest, years in construction and years in framing had a significant OR of 1.98 (CI, 1.06-3.67) and 1.77 (CI,

Table 9 Odds ratios for job-task and personal variables as predictors of recent work-related LBP at the .05 level

Variables	OR Estimate	95% CL-L	95% CL-U	*P*
Task Variables				
Break Materials	1.852	1.150	2.982	.011
Sort Materials	1.810	1.045	3.134	.034
Frame Walkouts	1.623	1.000	2.633	.050
Cut Floor Joists	1.612	1.024	2.538	.039
Sort Wall Material	1.959	1.128	3.401	.017
Cut Material	2.106	1.249	3.550	.005
Sheet Wall Upright	1.728	1.128	2.646	.012
Install Roof Anchor	1.763	1.209	2.569	.003
Install Truss Clip	1.999	1.241	3.220	.004
Brace Truss	1.686	1.006	2.824	.047
Finish Sheeting Roof	1.672	1.061	2.635	.027
Roll Out/Set up Tools	1.947	1.113	3.404	.019
Nail Hangers	1.695	1.126	2.551	.011
Clean Up Scrap	2.171	1.135	4.152	.019
Roll Up/Put Tools Away	2.676	1.479	4.840	.001
Personal Variables				
Hours Worked per Week	3.099	1.156	8.305	.025
Job Satisfaction	0.595	0.379	0.933	.024
Coworker Caring	0.480	0.324	0.711	<.001
Mental Exhaustion	1.852	1.226	2.797	.003
Employee of the Framing Contractor	0.279	0.105	0.745	.011
LBP as a problem for Framers	1.956	1.072	3.566	.029

Table 10 Adjusted ORs for integrated model of point prevalence of LBP by combining personal, workplace, and job-task variables and adjusting

Variables	OR Estimate	95% CL-L	95% CL-U	*P*
Coworker Caring	0.388	0.218	0.691	.001
Roll Up/Put Tools Away	2.155	1.006	4.617	.048

Adjusted for boss caring, hours worked per week, mental exhaustion, and time pressure.

0.946-3.35), respectively, with hours worked per week (40-45) also being significant (OR, 3.05; CI, 1.25-7.45). Integrating separate models into a forward regression combined model eliminated many personal and workplace variables and all job-task variables. Remaining variables included working under time pressure and smoking status as significant predictors for LBP, whereas higher levels of coworker caring was protective (Table 8).

Point prevalence of LBP

Only 8% of respondents reported they had an episode of LBP within the past 2 weeks of sufficient intensity to seek treatment or alter some aspect of normal living. Table 9 presents 15 significant job-task variables and 6 personal and workplace variables related to the point prevalence of LBP. Hours worked per week (40-45) again was a significant risk factor prediction (OR, 3.10; CI, 1.16-8.30) for LBP. Tool rollup was a significant job-task predictor of LBP (2.76; CI, 1.48-4.84). Integrating variables into one regression model eliminated most variables but did retain one each of the original models (Table 10). The level of coworker caring was protective, whereas end-of-the-day rollup and putting tools away remained the sole significant predictor of the point prevalence of LBP.

Discussion

Investigators have reported that Hispanic construction workers are an overrepresented group with disproportionate musculoskeletal injury including back pain.[2,6] We did not find supporting evidence in this study; however, this may have been due to underreporting. Gilkey et al[23] suggested there might be 3 possible reasons for underreporting: (1) fear of retaliation from superiors, such as supervisor, foreman, or general contractor; (2) legal status; and (3) construction's machismo cultural influences. Investigators found much higher rates of LBP reported among non-Hispanic than among Hispanic carpenters in working in the Denver metro area. Non-Hispanic framing carpenters were found to have prevalence estimates of 14%, 38%, and 54%, respectively, for point, annual, and lifetime LBP, which are more consistent with results reported by other researchers[15,24] who found LBP in approximately 50% of subjects. It should be noted that, although these 2 populations of framing carpenters work side by side in the Denver metro area of Colorado, they are very different in many ways.[23]

When using perceived low back strain related to job tasks as a surrogate for back stress, many job tasks were identified as significant ($P < .05$) predictors of LBP for all end points of interest. However, personal and workplace factors were more consistent in predicting LBP when separate models were combined. No job-task variables were included in the integrated models for annual or lifetime work-related LBP.

Six personal and workplace risk factors affected lifetime work-related LBP with ORs ranging from 0.6 (CI, 0.44-0.94) to 2.0 (CI, 1.25-3.43). Years in construction and framing are a direct measure of exposure duration and risk. By and large, this cohort was young and had less experience on the job than the non-Hispanic counterpart of this study.[23,25] This may explain why age was not identified to be a confounder. We found increasing prevalence of LBP with age among Dutch trades, as did Latza et al[26] in their investigation of German construction workers. Both studies demonstrated that the prevalence of LBP did not level off until the fourth decade of age (32% and 50%, respectively). Lipscomb et al[27] found no effect with age among union carpenters in the Washington State relative to back sprains when grouping 18- to 30-year-old carpenters. However, when investigators reclassified subjects by those younger than 20 years, they were at higher risk for injury of all types compared with other age groups. The relative youth and lack of exposure to heavy work may partially explain the reduced prevalence of LBP among this cohort. In fact, construction demands are such that workers who have difficulty meeting the continuing physical demands of construction will select to quit. Gilkey et al[23] report an increasing trend of using younger Hispanic carpenters in the Denver metro area of Colorado while following the HomeSafe cohort from 1997 through 2001. Income was noted to increase risk for LBP and may represent overtime, rapid-paced work, reduction of safe work practices, and increased exposure. Income for Hispanic carpenters was significantly lower than those of the non-Hispanic counterpart with 60% making less than \$20 000 annually, whereas 60% of non-Hispanic carpenters earned greater than \$20 000/y.[23]

With increasing intake of alcohol, the risk for LBP increased over a lifetime; however, Hispanic carpenters reported one half the proportion of non-Hispanic carpenters who consumed 3 to 5 alcoholic drinks per week or greater (21% and 42%, respectively). If alcohol consumption occurs at work, great risk of injury could be due to direct effects of alcohol on the motor and cognitive systems resulting in reduced safe work practices. Alcohol consumption has also been associated with increased risk of many disease processes and injury outcomes.

Body anthropometry has been identified by some investigators as a risk factor for LBP.[28-30] Zwerling et al[30] found an increased risk with a body mass index (BMI)/Quetelet index of higher than 30 suggesting that weight-height ratio was involved in risk potential, whereas Barnekow-Bergkvist et al[28] found increased risk for women (OR, 2.55; CI, 1.08-6.02) and a protective effect for men (OR, 0.54; CI, 0.26-1.15) with a BMI/Quetelet index of less than 20. This study found a positive correlation with BMI/Quetelet index and LBP. The literature remains mixed on the effects of height and weight in relation to LBP. Bigos et al[31] found no relationship to BMI/Quetelet in their evaluation of a large cohort of nearly 4000 workers in the aerospace industry. Overall health status was protective with an OR of 0.49 (CI, 0.31-0.81). The higher the health status self-rating the lower the risk for LBP. Other researchers have identified prior disability and LBP as predictors for future LBP.[30,32]

Twenty-one job tasks posed significant ($P < .05$) increased risk as predictors of LBP for the previous 12 months and had ORs ranging from 1.5 (CI, 1.03-3.04) for installing fascia boards to 2.2 (CI, 1.41-3.48) for installing clips on rafters. Of the 21 job tasks, 13 had ORs greater than 1.7 including sorting materials, framing walkway, cutting floor joists, installing floor joists, sorting wall material, standing walls, cutting tails, installing clips, bracing trusses, finishing sheeting, rollout, setting stairs, and nailing hangers. Physical demands vary greatly between these tasks with mean strain scores ranging from 1.03 for rollout to 1.45 for installing floor joists. Again, the strain ratings for these job tasks were rated lower than seen in non-Hispanic carpenters and may reflect a common perception or bias among this cohort that no low back strain to low strain levels exist relative to these job tasks. It is interesting to note that the non-Hispanic counterpart rated each job task significantly ($P < .05$) higher than the Hispanic cohort. This might also suggest that sampling techniques did not get to the question among the Hispanic group. Despite the appropriate protocol of translating our survey from English to Spanish and then back to English, there may have been inadequate explanation in the Spanish language of the low back strain scale and the intended meaning of response selections. Leavitt et al[33] used 2 bilingual physicians to translate their LBP checklist that was ethnically identified with Mexico and Guatemala. In this study, academic translation services were sought within the university, not within the bilingual medical community. There may have also been a cultural miscommunication insufficient to convey the intent of the survey. In any case, investigators feel that the lower than expected job-task back strain ratings are counter to prior characterization of carpentry work by other investigators.[18]

Fifteen job tasks were significant ($P < .05$) predictors of LBP within the last 2 weeks (point prevalence) with ORs ranging from 1.61 (CI, 1.02-2.54) to 2.68 (CI, 1.48-4.84). Of the 15 job tasks, 10 had ORs greater than 1.7 including breaking material, sorting material, sorting wall material, cutting material, sheeting an exterior wall up, installing roof anchors, installing clips, rollout, cleaning scrap material, and rollup. Low back strain scores range from 1.03 to 1.35. Again, subjective strain ratings are lower than expected given the physical demands of certain job tasks such as sheeting an exterior wall in the upright position. This involves lifting construction materials weighing 40 lb (18.18 kg) into position, holding, and nailing in place. Field observations conducted by investigators suggest that this job task is very physically demanding and might warrant a higher rating.

Low back pain has been associated with a large number of work, personal, and psychosocial risk factors. In this study, investigators found 9 personal and workplace risk factors were significantly ($P < .05$) associated with increased risk for annual prevalence of LBP with ORs ranging from 1.33 (CI, 1.03-1.72) to 5.59 (CI, 1.27-24.62). Of these, 6 had ORs of more than 1.7 including years in construction, hours worked per week, time pressure on the job, hazard and risk training, self-employment, and smoking status. Riihimaki et al[32] found an increased occurrence of sciatic pain among carpenters (OR, 1.5; CI, 1.09-2.07) when comparing occupations. They also identified increased risk due to smoking (OR, 1.29; CI, 0.98-1.69). Thorbjornsson et al[34] identified increased risk for LBP due to heavy physical workload with few development opportunities (OR, 2.4; CI, 0.9-6.4), working under time pressure (OR, 1.1; CI, 0.6-2.4), and smoking (OR, 1.1; CI, 0.7-1.8) among a cohort of 24-year-old subjects drawn randomly from Sweden's general population but did not find increased risk with working overtime. Barnekow-Bergkvist et al[28] investigated the general population in Sweden and also found self-employment (OR, 1.62; CI, 0.63-4.17) and smoking (OR, 2.21; CI, 0.95-5.14) increased the risk for LBP. Zwerling et al[30] identified increased risk (OR, 2.07; CI, 1.46-2.95) for those engaged in heavy physical work as did Koster et al[35] and Vingard et al.[36]

Of the 12 personal variables, 3 had a protective effect for LBP in the last year including job satisfaction, coworker caring, and overall health status. Other investigators have also found striking relationships between LBP and job dissatisfaction.[36-38] Many investigators report the negative relationship more often than the positive effects as measured in our study. We recognized an inverse relationship evidenced by declining risk for LBP as the level of job satisfaction rises. Work culture and employee caring have also been associated with positive affects in the workplace.[20]

Three personal risk factors were significantly ($P < .05$) associated with increased risk for LBP within the last 2 weeks (point prevalence definition): the number of hours worked per week (OR, 3.09; CI, 1.16-8.31) and mental exhaustion (OR, 1.85; CI, 1.23-2.97), as well as the level of rating LBP as a problem in framing carpentry (OR, 1.96; CI, 1.07-3.57). Mental stress and fatigue have also been identified by other investigators as contributing to the increased risk of LBP and disability among the other cohorts studied.[29,39] Protective effects for LBP were again seen for job satisfaction and coworker caring.

Because the development of occupational LBP involves not only the job task but also personal risk factors, these 2 classes of variables were combined or integrated into the model to provide an overall assessment of risk for the development of occupational LBP in Hispanic construction workers. This strategy seems to have eliminated most variables and nearly all job-task factors. Among the final models developed, only one job-task remained significant for the prediction of LBP. Rollup and putting tools away was a significant predictor (OR, 2.16; CI, 1.01-4.62) for the point prevalence of LBP. The job task was rated with a mean low back strain score of 1.03 (SD, 0.67), a fairly benign level representing "no strain." Fatigue may be a factor at the end of a long workday where increased risk may exist for LBP. This job task is highly variable and can be accomplished by one, few, or many on the job site. Some carpenters transport all of their tools and equipment daily to and from the work site, whereas other organized crews often maintain a trailer onsite for the convenience of storage and easy access. It usually requires less physical effort to put tools into a well-organized storage trailer than a personal vehicle.

A number of personal and workplace variables remained present in the integrated models. The number of years in construction (1-5 years) increased the risk for the development of LBP (OR, 2.34; CI, 1.26-4.35), whereas the person's overall health status had a protective effect (OR, 0.49; CI, 0.31-0.81) for LBP. These findings are not unusual or unique to this Hispanic cohort.

When integrating variables to evaluate predictors for annual prevalence of LBP, 3 risk factors remained in the model: time pressure at work, smoking status, and level of coworker caring. These findings are again consistent with findings in the literature and not unique to this ethnic cohort. Riihimaki et al[32] found an increased occurrence of sciatic pain among carpenters (OR, 1.5; CI, 1.09-2.07) when comparing occupations. They also identified increased risk due to smoking (OR, 1.29; CI, 0.98-1.69). Thorbjornsson et al[34] identified increased risk for LBP due to heavy physical workload with few development opportunities (OR, 2.4; CI, 0.9-6.4), working under time pressure (OR, 1.1; CI, 0.6-2.4), and smoking (OR, 1.1; CI, 0.7-1.8) among a cohort of 24-year-old subjects drawn randomly from Sweden's general population but did not find increased risk with working overtime. Barnekow-Bergkvist et al[28] investigated the general population in Sweden and also found self-employment (OR, 1.62; CI, 0.63-4.17) and smoking (OR, 2.21; CI, 0.95-5.14) increased the risk for LBP. It was interesting that no job-task variables were seen in the final model.

Conclusion

Whereas other studies have found higher incidents of work-related LBP, Hispanic framers in the present study reported less lower back pain than their non-Hispanic counterparts.[23] This investigation has identified risk factors by way of using subjective strain index values as surrogates for ergonomic stressors, such as overexertion, repetition, awkward postures, and sudden loading, which have been identified as risk factors for occupational LBP. In evaluating 44 common job tasks seen in the residential home building process, we have identified increased risk associated with LBP. We also have identified personal, psychosocial, and worker factors that impact the perceptions of low back strain. We adjusted for several influences identified in this cohort to model risk: boss caring, hours worked, mental exhaustion, and working under time pressure. The integrated models dramatically reduced the number of predictors for LBP. Our findings suggest that the Hispanic cohort is not uniquely different from other subjects identified in the literature. Despite the reporting of overrepresentation of Hispanics in construction related to injury, this is not confirmed when looking only at LBP. We believe that potential is present in this study. Additional work needs to be completed, further identifying more effective methods when gathering information in multicultural, multilanguage worker populations. In summary, we believe that our data underrepresent the actual size of the LBP problem among Hispanic carpenters and that further studies must focus on optimal methods for evaluating Hispanic construction populations.

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