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Commuting and Sleep: Results From the Hispanic Community Health Study/Study of Latinos Sueño Ancillary Study

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Abstract

Introduction—Commute time is associated with reduced sleep time, but previous studies have relied on self-reported sleep assessment. The present study investigated the relationships between commute time for employment and objective sleep patterns among, non-shift working U.S. Hispanic/Latino adults.

Methods—From 2010 to 2013, Hispanic/Latino employed, non-shift working adults ($n=760$, ages 18–64 years) from the Sueño study, ancillary to the Hispanic Community Health Study/Study of Latinos, reported their total daily commute time to and from work, completed questionnaires on

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sleep and other health behaviors, and wore wrist actigraphs to record sleep duration, continuity, and variability for 1 week. Survey linear regression models of the actigraphic and self-reported sleep measures regressed on categorized commute time (short: 1–44 minutes; moderate: 45–89 minutes; long: 90 minutes) were built adjusting for relevant covariates. For associations that suggested a linear relationship, continuous commute time was modeled as the exposure. Moderation effects by age, sex, income, and depressive symptoms also were explored.

Results—Commute time was linearly related to sleep duration on work days such that each additional hour of commute time conferred 15 minutes of sleep loss ($p=0.01$). Compared with short commutes, individuals with moderate commutes had greater sleep duration variability ($p=0.04$) and lower interdaily stability ($p=0.046$, a measure of sleep/wake schedule regularity). No significant associations were detected for self-reported sleep measures.

Conclusions—Commute time is significantly associated with actigraphy-measured sleep duration and regularity among Hispanic/Latino adults. Interventions to shorten commute times should be evaluated to help improve sleep habits in this minority population.

INTRODUCTION

Many chronic health conditions are driven by lifestyle behaviors that are time dependent and constrained to the 24-hour day.^{1–3} Time spent in one activity invariably affects time spent in another. In this 24-hour culture, sleep often is curtailed to accommodate time for other activities. However, insufficient sleep is associated with adverse health outcomes and mortality.⁴ One of the most common activities that sleep is traded for is commuting.⁵ Commuting times in the U.S. have increased in recent decades because of a larger and more mobile workforce.⁶ Lengthy commuting is associated with stress, greater sedentary time, and negative health outcomes.^{7–9} Commuting also is related to truncated sleep duration^{5,7,8,10–15} with 28%–35% of commute time being attributable to decreases in sleep time.¹⁴ However, previous studies have relied on self-reported sleep measures, which correlate only moderately with objective measurement via wrist actigraphy, and are confounded with sociodemographic and other sleep factors that may be correlated with commute time.^{16,17} Furthermore, the associations between commute time and other aspects of sleep related to adverse health outcomes, such as timing and regularity, have not been evaluated.^{18,19}

The aim of this study is to investigate the relationships between work commute time and actigraph-derived sleep patterns and self-reported sleep disturbances among a large sample of Hispanic/Latino adults, a population with worse sleep, sleep-related health morbidities, and longer commute times compared with their non-Hispanic/Latino counterparts.^{6,20,21} The primary hypothesis is greater time spent commuting for work would be associated with shorter sleep duration.^{5,7,8,10–15} Though evidence of the relationships between commute time and other features of sleep is lacking, longer commutes are associated with greater stress and sedentary behavior,^{4–6} which are both associated with greater sleep disturbance.^{22,23} Thus, it is hypothesized that longer commute times would be associated with lower sleep continuity, earlier timing, greater night-tonight variability, and greater symptoms of insomnia and daytime sleepiness. These analyses expand what is currently known in the

field by using actigraphy, examining other aspects of sleep in addition to sleep duration, and focusing on an exclusively Hispanic/Latino population.

METHODS

Study Sample

The Hispanic Community Health Study/Study of Latinos (HCHS/SOL) is a community-based prospective cohort study of 16,415 self-identified Hispanic/Latino adults recruited from randomly selected households in four U.S. field centers (Chicago, IL; Miami, FL; Bronx, NY; San Diego, CA) with baseline examination occurring from 2008 to 2011. The HCHS/SOL study sample and design have been described elsewhere.^{24,25} The Sueño ancillary study recruited a subset of HCHS/SOL participants across all four sites from 2010 to 2013, aged 18–64 years and free of severe sleep disorders (apnea hypopnea index <50/hour, no positive airway pressure treatment for sleep apnea, and no diagnosis of narcolepsy) to undergo more detailed sleep assessment.^{26,27} IRBs at all field centers and coordinating sites approved the study and all participants provided informed consent.

All Sueño participants attended a clinic visit where they completed questionnaires in either English or Spanish about their sleep, employment status, and job characteristics, and wore a wrist actigraph to measure their sleep for 1 week. For the present analyses, only participants who were employed outside the home with complete commute time and actigraphy data were included. Those who did shiftwork (i.e., typical work schedule reported as afternoon, night, split, irregular/on call, or rotating) were excluded.

Measures

Commute time was measured with the Sueño Work Schedule Questionnaire, which is available at the BioLINCC website: <https://biolincc.nhlbi.nih.gov/studies/hchssol/>. All employed participants were asked: *On average, how long does it take for you to travel from home to work (and from work to home) each day?* Total commute time in hours and minutes was summed and categorized into statistically derived tertiles (short: 1–44, moderate: 45–89, long: 90 minutes).

Each participant was provided with an Actiwatch Spectrum® wrist actigraph to be worn on their nondominant wrist along with a sleep diary for 1 week. Wrist actigraphy using Actiwatch Spectrum® has been found to be accurate and sensitive relative to gold standard polysomnography though with low specificity,²⁸ which is characteristic of all actigraph devices.²⁹ Sleep actigraph data of more than five 24-hour periods recorded were considered complete. Rest intervals were set according to a standardized hierarchy of data values in the following order of importance: event marker, diary, light, and activity.²⁶ Sleep/wake status in each 30 second epoch during the rest intervals were determined using the Actiware 5.59 scoring algorithm. Sleep onset was defined as 5 immobile minutes, whereas sleep offset was defined as 0 immobile minutes. The main sleep outcome variables were average sleep duration (minutes) on work days and all days recorded, SD of sleep duration from all days (measure of sleep duration variability), average sleep efficiency (%), calculated as time spent asleep from sleep onset to sleep offset), average mid-sleep time on work days and all days

(the midpoint in sleep time between sleep onset and sleep offset), social jet lag (the difference between the average mid-sleep time on work days and non-work days), time in bed on work days and all days, and interdaily stability (a measure of regularity in sleep/wake schedule each day). Interdaily stability was calculated as the proportion of total variance in sleep/wake regularity that is explained by the time of day (i.e., clock time in 1-hour bins).³⁰ Interdaily stability ranged from zero (when the 1-hour bins explain none of the variance in sleep/wake status) to one (when the 1-hour bins explain all of the variance). Higher values indicate greater interdaily stability in sleep/wake schedules.

Participants completed the Insomnia Severity Index (ISI) and Epworth Sleepiness Scale, which are both well-validated, widely used instruments, available in English and Spanish.^{31,32} The ISI assesses the severity of nighttime and daytime insomnia symptoms. Scores 15 indicate at least moderate insomnia,³³ thus the ISI was examined categorically based on this clinical cut-off value. The Epworth Sleepiness Scale assesses daytime sleepiness with higher scores indicating greater levels. Participants reported frequency of sleep medication use (i.e., natural, herbal, over-the-counter, or prescription) over the past 4 weeks. Frequency was dichotomized into <1 per week vs 1 per week.

Participants reported on the following: demographics including age,⁷ sex,⁷ and annual household income (based on the median cut point: <\$20,000 vs \$20,000 vs missing)⁷; work variables including multiple job status (one versus more than one job)¹² and total weekly work hours (analyzed continuously)^{7,10}; mental health symptoms including current depressive (Center for Epidemiological Studies–Depression-10 scale³⁴) and anxiety symptoms (State-Trait Anxiety Inventory–Trait Score³⁵)^{7,8}; and caffeine consumption (cups on a typical day). These covariates were chosen because of their direct and indirect, evidence-based relationships with both sleep patterns and commute time. Longer commute times are related to greater age, income, multiple jobs, longer work hours, and heightened psychologic distress. Men tend to have longer commutes than women.⁷ Lastly, caffeine intake, as an effective countermeasure to driving-related fatigue, is often used by long-distance drivers to combat fatigue.^{36–38}

Statistical Analysis

All analyses accounted for unequal weighting, clustering, and stratified sampling utilized to recruit both the HCHS/SOL participants as well as the Sueño participants from the parent cohort, which have been detailed elsewhere.²⁵ Age- and sex-adjusted distributions of all covariates and sleep outcomes by commute time tertile were calculated accounting for sampling weights and standardized to the age and sex distribution of the U.S. population based on the 2010 U.S. Census. Separate survey linear regression models evaluated the associations between commute time tertile and each sleep variable adjusting for covariates. In models indicating the association between commute time tertile and sleep appeared linear, further analysis was conducted modeling commute time continuously. All reported values (means, prevalence) were weighted to adjust for sampling probability and nonresponse and the complex survey study; and $p < 0.05$ was deemed statistically significant. All tests were two-sided without multiple comparison adjustments. All analyses were conducted using SAS, version 9.3.

RESULTS

Of the 2,189 Sueño study participants, 2,156 participants had complete sleep actigraphy data. Of those, 902 participants were not employed and were therefore excluded. Three participants were excluded for missing commute time data. Further, 448 participants were excluded because they reported employment in shiftwork. Lastly, 43 participants were excluded because they were not commuting to their place of employment. The total sample was 760 participants.

Mean age of the study sample was 46.8 years (SD=10.4, range, 20–64) and 61.2% were women ($n=465$). Mean commute time was 73.4 minutes per day (SD=50.6). Table 1 displays age- and sex-adjusted characteristics by commute time tertiles. Household income and anxiety symptoms varied significantly by commute time tertile. Individuals with long commute times tended to have household incomes <\$20,000 per year and reported more anxiety symptoms.

Table 2 displays age- and sex-adjusted means of the sleep variables by categorized commute time. All commute groups had average sleep durations of <7 hours on all days and work days. Long commuters slept on average 362.4 minutes/workday ($\cong 6$ hours) compared with moderate commuters (381.7 minutes) and short commuters (395.8 minutes or $\cong 6.5$ hours). Thus, there was approximately a half hour difference in sleep duration between long commuters and short commuters. Short commuters had greater interdaily stability than moderate commuters, but were no different than long commuters.

Table 3 summarizes results from regression models evaluating the association of commute time category with each sleep variable adjusting for all covariates. Short commuters (1–44 minutes) were the referent group. Though, not significant, moderate (–11 minutes) and long (–16 minutes) commuters had less sleep duration on work days compared with short commuters indicating a linear relationship. Therefore, an additional model assessing the association of commute time modeled continuously with sleep duration was assessed. The adjusted model revealed that long commute times were significantly related to shorter sleep durations on work days ($\beta = -15.0$, 95% CI= $-26.8, -3.2$, $p=0.01$) such that for each additional hour of daily commute time, there was 15 minutes less sleep duration on work days. Commute time did significantly differentiate sleep duration variability and interdaily stability. Pairwise comparisons indicated that moderate commuters had significantly greater sleep duration variability (9.0 minutes) compared with short commuters, and long commuters (3.2 minutes) did not differ from short commuters. Similarly, moderate commuters had significantly lower interdaily stability compared with short commuters, and long commuters did not differ from short commuters. Commute time was not significantly associated with any other sleep variable. Clinically meaningful differences in insomnia prevalence and sleep duration on work days also were present, though not statistically significant. Long commuters had a 7% greater prevalence of insomnia (ISI 15) than short commuters.

DISCUSSION

The study found that Hispanic/Latino adults with longer commute times were more likely to have shorter sleep durations consistent with the hypotheses. Contrary to the original hypotheses, moderate commuters (45–90 minutes) had the lowest regularity in their sleep/wake schedules, and the greatest variability in sleep duration relative to short commuters. Therefore, longer commute times were associated with truncated sleep duration, whereas moderate commuters had greater sleep irregularity compared with short commuters. There were no other significant associations with any other sleep variable including self-reported sleep symptoms.

The results suggest that 15 minutes of sleep duration are lost for every additional hour of time spent commuting for work. The association between longer commute times and shorter sleep durations is not surprising. Trading sleep to be able to attend work may delay sleep onset or advance wake-up time. The present study replicates other studies based in the U.S. and other countries.^{10,12,39,40} For example, an aggregate of studies drawing from community-based U.S. residents over 31 years found long commute times were associated with being a self-reported short sleeper (<6 hours).¹² Similarly in a U.S. representative sample, lengthy travel including commute time to and from work, was a major determinant of reported sleep duration and differentiated short from normal and long sleepers.³⁹ The analyses were stratified by race/ethnicity, and the result was maintained across all races/ethnicities including Hispanics/Latinos. Thus, in this previous study and the present study, Hispanic/Latinos do not appear immune to this trend. The reason might be that mean commute times for Hispanic/Latinos (≈ 73 minutes) in the present study were not too dissimilar from the average commute times reported by a nationally representative sample from the American Time Use Survey (62 minutes).¹⁵ However, what makes the results remarkable is instead of relying on self-reported sleep duration, actigraphy was used as an objective estimate of sleep duration. Previous evidence suggests the correlation between self-reported and actigraphic measurement of sleep duration is not strong, and self-reported sleep duration can be biased by SES and other factors.^{16,17} The present study's use of actigraphy enhances the literature, and suggests that previous studies' results indicating reported short sleep durations were related to longer commute times might be reflected in the actual experience of the participants. No other studies have examined actigraphic sleep with commute time. In the univariate analyses conducted, individuals with long commute times (>90 minutes) had about a half hour less sleep duration than individuals with short commute times (<45 minutes). These results are compounded by the fact that all commute groups, even the short commute group had insufficient sleep durations per National Sleep Foundation and American Academy of Sleep Medicine recommendations.^{41,42} Thus, longer commute times may be a significant determinant of restricting sleep to suboptimal levels in this population.

Restricted sleep is associated with safety issues and poor health outcomes including increased risk for cardiovascular disease, stroke, metabolic disorders, and mortality.^{44–46} The effects of commuting on shortening sleep duration may be an important mechanism by which long commute times impact risk of obesity and cardiometabolic disorders. Interventions to mitigate these effects are complicated because they cross multiple system

levels outside of the individual affected and often out of the individual's control. Nonetheless, commute time is a modifiable social determinant of sleep. At the individual level, there is little to no control over the actual commute time itself with the exception of the choice of when to commute and where to live, which may depend on a variety of individual factors either modifiable, semi-flexible, or unmodifiable. A modifiable individual factor might be how much value a person assigns to adequate sleep opportunity, which may compel an individual to apply for employment close to home (or choosing a residence near their place of employment), or with more flexibility in scheduling to avoid rush hour. A semi-flexible individual factor is SES. Studies suggest that lower SES or undocumented legal status is associated with less job accessibility and longer commute times to jobs.^{47–49} At the workplace level, individual workplace policy changes that allow for tele- and video-commuting, flexible hours, and later start-times (to avoid rush hour) may shorten individual workers' commute times. At a societal level, interventions to reduce commute time may include increased investments in public transportation, more quality housing near job-rich centers to counter the effects of urban sprawl,⁵⁰ modifying urban design to improve highway infrastructure,⁵¹ and making more affordable and accessible public parking.

A strength of the present study was the examination of other sleep variables beyond sleep duration including sleep variability, timing, continuity, and self-reported sleep disturbances. Contrary to the hypotheses, there was no significant relationships between commuting and sleep timing, continuity, and disturbance. Further, moderate rather than long commuting was associated with greater sleep duration variability (plus 9 minutes) and less interdaily stability (i.e., irregular sleep schedules). These results are contrary to a study of young adults that found that sleep duration variability measured with sleep diaries was not significantly correlated with commute time.⁵² The present findings might suggest that moderate commute times allow for greater flexibility in scheduling other activities. Time constraints of long commute times may force an individual to maintain a regular sleep schedule to function well in daily life. An alternate explanation is that moderate commute times may be less predictable or moderate commuters tend to have more variable workplace schedules. Whatever the reasons, this irregularity in sleep patterns might confer poor health outcomes among moderate commuters. Irregular sleep patterns may translate to irregular light exposure, which may lead to circadian rhythm alterations that could affect numerous physiologic systems. A study of older adults found greater sleep variability was associated with higher levels of inflammatory markers.⁵³ In addition, a systematic review found that greater sleep duration variability was correlated with a greater number of physical health conditions, and greater variability in sleep timing was associated with higher BMI and weight gain.⁵⁴ However, it is unclear how clinically meaningful the observed 9 minute difference in sleep duration variability is, but this difference is similar to the differences between sleep duration variability quartiles observed in community-based studies that show associations between sleep duration variability, obesity, and other adverse health outcomes.^{18,55,56} Given the potential for societal-level modification of commuting, future research should investigate the role of commuting and other social determinants on variability in sleep patterns.

Limitations

This study had several strengths including the use of actigraphy, consideration of sleep variability, and an exclusive focus on Hispanics/Latinos, an often understudied demographic in the sleep field especially in relation to occupational health. The present study is not without its limitations. The study is cross-sectional, thus causality cannot be confirmed. Gold-standard polysomnography to directly observe sleep patterns was not used, though actigraphy allows for multiple nights of estimated objective sleep. The results may not generalize to rural populations given that the study sites were in urban centers. Lastly, data on the mode of transportation used as well as the time of day commuting occurred were not captured, which may confound the investigated relations.

CONCLUSIONS

Time spent commuting for employment was a significant, social determinant of sleep duration and regularity in this Hispanic/Latino sample. Hispanic/Latino adults with long commutes are equivalently hampered in their ability to achieve adequate sleep compared with other populations, and thus would benefit from individual, workplace-base, and societal interventions that shorten commute times. Unique among the findings was the irregularity of sleep duration and timing among moderate commuters. Greater understanding of how commute time might affect sleep/wake regularity is needed. Future studies should prospectively assess factors affecting both commute and sleep time to illuminate the best targets for intervention.

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Table 1**Age and Sex Adjusted Characteristics by Commuting Time**

Variables	Overall (N=760)	Mean total commute time per day			F	p-value
		Short commute 1-44 minutes (n=273)	Moderate commute 45-89 minutes (n=226)	Long commute 90-330 minutes (n=261)		
Household income <\$20,000/year (%)	39.0	34.0	34.0	51.0	4.32	0.01
Weekly work hours	38.3 (0.7)	37.7 (1.0)	39.7 (1.0)	37.5 (1.1)	1.42	0.24
Multiple jobs (%)	9.0	7.0	11.0	9.0	1.01	0.36
CESD-10 score	6.0 (0.3)	5.8 (0.4)	5.7 (0.3)	6.7 (0.5)	1.44	0.24
STAI-Trait score	15.6 (0.3)	14.9 (0.4)	15.6 (0.4)	16.5 (0.5)	4.15	0.02
Caffeine use (cups/day)	2.1 (0.1)	1.9 (0.1)	2.2 (0.2)	2.4 (0.3)	1.84	0.16

Notes: Boldface indicates statistical significance ($p < 0.05$). All data accounted for the Hispanic Community Health Study/Study of Latinos survey design and sampling weights and was standardized to 2010 U.S. Census age and sex distribution. *P*-values from survey regression models adjusting for continuous age and sex.

CESD-10, Center for Epidemiological Studies – Depression Scale; STAI, Spielberger Trait Anxiety Inventory

Table 2

Age and Sex Adjusted Mean Sleep Characteristics by Commuting Time

Variables	Overall (N=760)	Short commute 1–44 minutes (n=273)	Moderate commute 45–89 minutes (n=226)	Long commute 90–330 minutes (n=261)	F	p-value
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
Actigraphy						
Sleep duration, all days (minutes)	401.0 (2.8)	408.2 (4.1)	398.1 (4.4)	395.1 (5.4)	2.38	0.09
Sleep duration, work days (minutes)	381.5 (5.8)	395.8 (5.7)	381.7 (5.3)	362.4 (15.0)	3.75	0.03
Sleep duration variability (minutes)	70.5 (2.7)	65.6 (2.8)	74.1 (2.6)	72.6 (6.3)	2.88	0.06
Mid-sleep time, all days (HH:MM[minutes])	3:19 (5.3)	3:19 (5.5)	3:16 (7.9)	3:21 (9.4)	0.12	0.89
Mid-sleep time, work days (HH:MM [minutes])	3:01 (5.0)	3:06 (6.1)	2:55 (8.7)	3:02 (7.7)	0.65	0.52
Social jet lag of mid-sleep time (minutes)	54.7 (5.2)	40.9 (7.5)	67.4 (7.9)	56.8 (9.7)	2.83	0.06
Inter-daily stability	0.76 (0.01)	0.78 (0.01) ^a	0.74 (0.01) ^a	0.75 (0.02)	3.80	0.02
Sleep efficiency (%)	86.4 (0.4)	86.8 (0.4)	86.6 (0.5)	85.6 (0.8)	1.00	0.37
Self-reported						
Epworth sleepiness scale score	5.5 (0.2)	5.5 (0.5)	4.9 (0.3)	6.2 (0.4)	2.82	0.06
Insomnia severity index 15 (%)	9.0	10.0	7.0	12.0	0.84	0.43
Sleep medication use (%)	9.0	7.0	9.0	11.0	0.81	0.44

Notes: Boldface indicates statistical significance ($p < 0.05$). Data presented in means and standard deviations unless otherwise noted. All data accounted for the Hispanic Community Health Study/Study of Latinos survey design and sampling weights. Calculation of Social Jet Lag was based on subjects who have both work day and free day data available (n=584). P-values from survey regression models and adjusting for continuous age and sex.

^aIndicates significant post hoc comparison between noted commute groups.

HH:MM, clock hours and clock minutes

Table 3

Adjusted Associations of Commute Time Categories with Actigraphy and Self-reported Sleep Dependent Variables

Dependent variable/Commute time categories (in minutes)	Beta estimate	95% CI	Overall <i>p</i> -value
Actigraphy			
Sleep duration, all days (min)			
Reference: Short	–	–	0.83
Moderate	–3.3	–13.7, 7.2	
Long	–2.2	–15.4, 11.1	
Sleep duration, work days (min)			
Reference: Short	–	–	0.21
Moderate	–11.5	–25.3, 2.2	
Long	–15.8	–39.2, 7.6	
Sleep duration variability (min)			
Reference: Short	–	–	0.04
Moderate	9.0	2.1, 16.0	
Long	3.2	–7.9, 14.2	
Mid-sleep time, all days (min)			
Reference: Short	–	–	0.84
Moderate	–1.1	–16.9, 14.7	
Long	4.5	–13.7, 22.7	
Mid-sleep time, work days (min)			
Reference: Short	–	–	0.42
Moderate	–7.3	–26.5, 11.8	
Long	–8.3	–25.8, 9.1	
Social jet lag of mid-sleep time (min)			
Reference: Short	–	–	0.10
Moderate	22.0	–0.9, 44.9	
Long	18.2	–4.2, 40.6	
Inter daily stability			
Reference: Short	–	–	0.046
Moderate	–0.03	–0.06, –0.01	
Long	–0.01	–0.05, 0.03	
Sleep efficiency (%)			
Reference: Short	–	–	0.64
Moderate	–0.3	–1.5, 0.8	
Long	–0.8	–2.4, 0.9	
Self-report			
Epworth sleepiness scale			
Reference: Short	–	–	0.10
Moderate	–0.7	–1.5, 0.2	
Long	0.3	–0.6, 1.2	

Dependent variable/Commute time categories (in minutes)	Beta estimate	95% CI	Overall <i>p</i> -value
Insomnia severity index (>15, prevalence %)			
Reference: Short	–	–	0.16
Moderate	–1.5	–6.4, 3.4	
Long	7.1	–1.5, 15.8	
Sleep medication use (prevalence %)			
Reference: Short	–	–	0.87
Moderate	1.1	–4.5, 6.6	
Long	1.1	–5.0, 7.3	

Notes: Boldface indicates statistical significance ($p < 0.05$). Adjusted for age, sex, Hispanic/Latino background, study site, household income, weekly work hours, depressive and anxiety symptoms, and caffeine intake. Beta estimates for models with prevalence modelled on 0.00–1.00 scale. Therefore, beta estimates can be interpreted as percentage prevalence.