



## Original Article

## Examining social capital in relation to sleep duration, insomnia, and daytime sleepiness



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## ABSTRACT

**Objective:** Sleep, which plays an important role in health and well-being, is socially patterned such that certain demographic groups have worse sleep health than others. One possible mechanism driving sleep disparities is social capital. The current study examines the association between social capital and self-reported sleep variables (eg, duration, insomnia symptoms, and daytime sleepiness) among a sample of 1007 participants from the Sleep Health and Activity, Diet and Environment Study (SHADES).

**Methods:** Logistic regressions were used to estimate whether the sleep variables were associated with social capital measures. All models control for age, sex, race/ethnicity (Non-Hispanic White, Black/African-American, Hispanic/Latino, Asian, and multicultural/other), income, and education (less than high school, high school graduate, some college, and college graduate).

**Results:** Lower likelihood of membership in groups was seen for long sleepers (>9hrs, p-value<0.05) and beliefs that neighbors rarely/never help each other was more likely among short sleepers (5–6hrs, p-value<0.05), relative to 7–8 h sleepers. A decreased sense of belonging was seen among short sleepers (5–6hrs, p-value<0.05). Decreased likelihood of trust was reported by those with moderate-severe insomnia (p-value<0.05). Similarly, neighborhood improvement efforts were less likely among individuals with moderate-to-severe insomnia (p-value<0.05).

**Conclusions:** Results of our study show that short and long sleep duration, as well as insomnia, were inversely related to measures of social capital, such as group memberships and a sense of neighborhood belonging. Future research may explore the directionality of the relationship between social capital and sleep and perhaps consider future interventions to improve low social capital and/or poor sleep in community samples.

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## 1. Introduction

Sleep plays an important role in health and well-being [1–3]. Poor sleep health (eg, sleep duration for less than or equal to 6 h of sleep or poor sleep quality) is associated with poor mental health,

anxiety, and depression [4,5]; higher risk of hypertension and cardiovascular disease [6–8]; and greater mortality risk [9,10]. Unfortunately, worse sleep health has been shown to be more common among individuals from low socioeconomic status (SES, low income and education) compared to other groups [11–15]. This paper contributes to a growing body of research on neighborhood-level characteristics and their relationship to sleep [16–19]. Specifically, we examine social capital, a social network concept referring to the quality of connections among individuals in a community [20–23], and its relationship to several

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dimensions of sleep health, including sleep duration, insomnia, and daytime sleepiness.

Previous research has examined a range of neighborhood factors and their association to sleep. Research has shown high risk for sleep apnea among children living in communities that have low average SES [18,19]. After adjustment for SES, research has found favorable neighborhood factors (lower neighborhood disorder and higher safety and social cohesion) are associated with higher objectively measured sleep duration [16], and undesirable neighborhood factors (higher neighborhood disorder and lower safety and social cohesion) are associated with shorter sleep duration [17]. Similarly, research has found, controlling for SES, low social cohesion is associated with shorter sleep duration [24]. Moreover, research has found an association between unfavorable neighborhood factors (eg, crime, noise, and cleanliness) and poor physical health is partially mediated by sleep quality [25]. While previous literature has demonstrated an association between sleep and neighborhood factors, they have not fully addressed the directionality of the relationships among specific social capital components and sleep health dimensions. Further, this growing body of literature to suggest neighborhood factors matter for sleep outcomes [16–19], little attention has been paid to social capital [17,26,27]. Although our research is cross-sectional in nature, we examine the relationships among specific social capital and sleep health dimensions.

Social capital refers to the nature and quality of social relationships and connections among individuals in a neighborhood or social network. In addition to the nature of these relationships, social capital has to do with the resources a person may receive by virtue of their social connections. Social network variables such as social capital are important to consider as evidence shows that health behaviors such as alcohol consumption, smoking [29,30], and sleep duration [31], are remarkably homogenous among groups of socially connected individuals [28]. Previous research has found low social capital is associated with depression [32,33] and mortality risk [34], whereas high social capital is associated with physiological well-being [35]. Research has also shown that, after controlling for SES, social capital is associated with self-reported health [36]. With regards to sleep, one study was identified that examined social capital among community-dwelling Japanese individuals, finding poor social capital is associated with insufficient sleep duration [37].

The Social-Ecological Model of Sleep Health [9,38] posits that poor sleep health is driven by social-contextual factors that underpin health broadly and sleep health specifically. Obtaining a better understanding of relationships between sleep health and social capital may allow for a deeper understanding of the social-environmental causes and/or consequences of poor sleep health. As such, the goal of this paper is to examine discrete measures of social capital and their relationship to a range of sleep health parameters (sleep duration, insomnia, and daytime sleepiness).

Social capital is operationalized in terms of the following dimensions: (1) participation in social or community organization(s) (ie, the number of formal social groups, such as clubs, a person belongs to); (2) neighborhood helping behavior (ie, the degree to which neighbors help each other); (3) neighborhood belonging (ie, the degree to which individuals feel like their neighborhood makes them feel welcome and that they belong); (4) neighborhood trust (ie, the degree to which neighbors trust each other); and (5) neighborhood improvement (ie, the degree to which neighbors work together to improve the neighborhood) [23,39,40]. Based on previous findings that demonstrate an inverse association between sleep duration and social capital [37], we extend these findings to hypothesize an inverse association between social capital and three dimensions of sleep health, including: duration, insomnia, and

sleepiness. Consistent with prior research examining neighborhood factors [16,17,24,37], we propose to control for SES so as to focus on the association between social capital and sleep health. Using cross-sectional data from the Sleep Health and Activity, Diet and Environment Study (SHADES) survey of adults, we examine following hypothesized associations:

**Hypothesis 1 (H1).** Participation in social or community organizations is inversely associated with sleep duration (short and long), insomnia symptoms, and daytime sleepiness.

**Hypothesis 2 (H2).** Helping behavior is inversely associated with sleep duration (short and long), insomnia symptoms, and daytime sleepiness.

**Hypothesis 3 (H3).** Neighborhood belonging is inversely associated with sleep duration (short and long), insomnia symptoms, and daytime sleepiness.

**Hypothesis 4 (H4).** Neighborhood trust is inversely associated with sleep duration (short and long), insomnia symptoms, and daytime sleepiness.

**Hypothesis 5 (H5).** Neighborhood improvement is inversely associated with sleep duration (short and long), insomnia symptoms, and daytime sleepiness.

## 2. Methods

### 2.1. Data source

We analyzed data from the Sleep and Healthy Activity, Diet, Environment, and Socialization (SHADES) study. SHADES was a community-level study of adults ( $N = 1007$ ) age 22–60 in the Philadelphia area, including Philadelphia County and the neighboring Delaware, Montgomery, Bucks, and Chester Counties. Respondents were recruited through advertisements posted in various public spaces and community centers. The study included a survey that was completed online or in person between January 2013 and October 2014. There was only one assessment and no follow-ups, and consisted of a number of items assessing sleep, health, behavior, and environmental factors. Because all online surveys were validated and all in-person surveys ensured completion, there was no missing data.

### 2.2. Measures

Sleep duration was measured using one of the sleep questions from the National Health and Nutrition Examination Survey (NHANES) [41,42]: “How much sleep do you usually get at night on weekdays or workdays?” Responses were recorded in whole numbers and categorized as very short ( $\leq 4$  h), short (5–6 h), recommended duration (7–8 h) and long ( $\geq 9$  h), as is consistent with previous studies [8,43–45].

Insomnia symptoms were measured using the Insomnia Severity Index (ISI) [46]. Accordingly, ISI scores range from 0 to 28, with higher scores indicating greater severity of insomnia symptoms. Recommended cutoffs include 0 to 7 for no insomnia, 8 to 14 for mild insomnia, 15 to 21 for moderate insomnia and 22 to 28 for severe insomnia. Due to the low frequency of severe insomnia, the final two categories were collapsed into a moderate-severe category. The ISI is routinely used as an outcome measure for insomnia research [47] and is well-validated for research [48].

Daytime sleepiness was measured using the Epworth Sleepiness Scale (ESS). This 8-item instrument is routinely used in research [49,50] and is well-validated [51]. Participants were asked to

indicate the likelihood that they would be unable to maintain wakefulness in a variety of situations, including sitting and reading, watching TV, and sitting inactive in a public place, etc. Responses are summed and scores can range from 0 to 24. Recommended cutoffs for sleepiness include 0 to 9 for mild sleepiness and 10 or higher for severe daytime sleepiness [51].

Social capital was measured using variables consistent with prior research [32,52,53]. Social capital domains assessed included group memberships, neighborhood helping behavior, and neighborhood belonging, trust, and improvement. Group memberships were assessed with the questions “how many local groups or organizations in your neighborhood do you currently participate in such as social, political, religious, school-related, or athletic organizations?” Responses were categorized as 0, 1, or  $\geq 2$  or more memberships. Neighborhood helping behavior was assessed with the question, “Please rate how likely people in your neighborhood are willing to help their neighbors with routine activities such as picking up their trash cans, or helping to shovel snow. Would you say that most people in your neighborhood are always, often, sometimes, rarely, or never willing to help their neighbors?” Responses were coded as “Never,” “Rarely,” “Sometimes,” “Often,” and “Always.” Due to cell sizes at the extremes, responses were collapsed to “Never/Rarely,” “Sometimes,” and “Often/Always.” Neighborhood belonging and trust were assessed by asking participants to agree or disagree with the following statements: “I feel that I belong and am a part of my neighborhood,” and “Most people in my neighborhood can be trusted.” These were coded as “Agree” vs “Disagree.” Finally, neighborhood improvement was assessed by asking participants, “Have people in your neighborhood ever worked together to improve the neighborhood? For example, through a neighborhood watch, creating a community garden, building a community playground, or participating in a block party.” Responses were categorized as “Yes” or “No.” For purposes of analysis, the discreet measures of social capital are maintained in the current study (eg, group memberships).

Covariates included age, sex, race/ethnicity (Non-Hispanic White, Black/African-American, Hispanic/Latino, Asian, and multicultural/other), education (less than high school, high school graduate, some college, and college graduate), and income. These were chosen because previous studies have shown them to be related to sleep duration and quality [54–56], and social functioning [57,58].

### 2.3. Statistical analyses

Analysis of variance (ANOVA) was conducted to examine differences in demographic factors by social capital. A series of binomial and multinomial logistic regression models for sleep variables and each of the five social connectedness variables were assessed. In each case, the social capital variable was the outcome and the sleep variable was the predictor. In addition to separate models for each sleep variable (adjusted for covariates), combined models included all sleep variables simultaneously. The reason for including this combined model is that many of the sleep variables overlap with each other and, therefore, associations may be due to the overlapping issue of “poor sleep” and not the specific sleep aspect assessed (ie, sleep duration, insomnia symptoms, or sleepiness). Therefore, a combined model examines whether any individual sleep variable explains variance in the social capital variables that is unique, after controlling for the other sleep variables. In this way, we can examine whether there is a relationship with insomnia that is distinct from the other sleep variables. The 95% confidence intervals (CIs) were computed. Analyses were performed using STATA software version 14 (StataCorp, College Station, TX, USA). All statistical tests were two-tailed. Statistical significance was set at the  $P < 0.05$  level.

## 3. Results

### 3.1. Characteristics of the sample

Among participants, average age was 34.0 years (s.d. = 9.4 years) and the sample was 50.9% male. Participants were 58.1% non-Hispanic white, 55.9% reported a college degree, and 18.6% reported income of \$75,000 or higher. Among participants, recommended duration (7–8 h) was reported by 47.7%. Approximately one third of participants reported no insomnia symptoms (34.8%). Daytime sleepiness scores averaged 7.8 (sd = 4.7). See Table 1 for a detailed summary of the study sample and sleep variables.

### 3.2. Participation in social or community groups

In the separate models, very short ( $\leq 4$  h) and long sleepers ( $> 9$  h) were respectively approximately half as likely as 7–8 h sleepers to report membership in a social or community organization. In the combined model, only the relationship between long sleep and membership in social or community organizations was significant, so that long sleepers were half as likely as 7–8 h sleepers to report participation in one social or community organization. No statistically significant association was identified for short sleep duration, insomnia, or sleepiness (no support for H1, see Table 2).

### 3.3. Helping neighbors

In the separate models, very short sleepers ( $\leq 4$  h) and short (5–6 h) sleepers were approximately 1.5 times more likely to report rarely or never helping their neighbors, compared to 7–8 h sleepers. In addition, individuals with moderate-severe insomnia and daytime sleepiness were also about 1.5 times more likely to report rarely or never helping their neighbors. In the combined model, only short sleep (5–6 h) was significant, so that short sleepers were approximately 1.5 times more likely to report rarely never helping behavior (no support for H2, see Table 3).

### 3.4. Sense of belonging, neighborhood trust and improving the neighborhood

In separate models, short sleepers (5–6 h), individuals with moderate-to-severe insomnia and high daytime sleepiness were less likely to report neighborhood belonging than 7–8 h sleepers. In the combined model, only short sleepers were significantly less likely to report a sense of neighborhood belonging (no support for H3). In separate and combined models, individuals with moderate-to-severe insomnia were less likely to report neighborhood trust (no support for H4). In separate models, short sleepers and individuals reporting moderate-to-severe insomnia were significantly less likely to report neighborhood improvement behaviors. In combined models, individuals with moderate-to-severe insomnia were significantly less likely to report improvement (no support for H5, see Table 4).

## 4. Discussion

There is a large and growing body of literature linking social and environmental factors, such as social capital, with individual health outcomes [36,52,53]. While many areas of health have been examined [32–35], we know less about the relationship between social capital and sleep health. Due to the broad health disparities in sleep and population health, it is vital to identify barriers to sleep health (eg, poor social capital), in order to advance population health [3,59]. This paper extends social capital research to examine

**Table 1**  
Characteristics of the sample (N = 1007).

Demographic characteristics of the study sample		Total		Participation in Social or Community Organizations				Neighborhood Helping Behavior			Neighborhood Belonging			Neighborhood Trust			Neighborhood Improvement			
		N	%	None	One	Two+	P-Value	NeveS	ometime	Often	P-Value	No	Yes	P-Value	Disagree	Agree	P-Value	No	Yes	P-Value
Variable			%	%	%	%		%	%	%		%	%		%	%		%	%	
Age, yrs <sup>a</sup>	Mean	34.0	33.2	33.5	35.3	<b>0.006</b>	35.5	33.2	32.9	<b>0.000</b>	32.5	35	<b>&lt;0.0001</b>	32.5	35	<b>&lt;0.0001</b>	32.9	34.7	<b>0.003</b>	
	Standard Deviation	9.4	9.1	8.9	10.0		10.0	9.0	8.9		8.5	9.9		8.5	9.9		8.9	9.7		
Sex	Male	619	50.9%	39.2%	39.4%	36.8%	0.738	35.4%	40.7%	39.8%	0.290	40.0%	37.6%	0.449	44.4%	35.5%	0.449	37.0%	39.5%	0.432
	Female	597	49.1%	60.8%	60.6%	63.3%		64.6%	59.3%	60.2%		60.1%	62.4%		55.6%	64.6%		63.0%	60.5%	
Race/Ethnicity	Non-Hispanic White	251	58.1%	61.9%	63.9%	53.6%	0.113	58.7%	63.0%	55.6%	0.467	59.0%	59.9%	0.512	46.2%	66.5%	0.512	60.4%	59.0%	<b>0.010</b>
	Black/African-American	46	10.6%	22.2%	21.3%	31.0%		27.2%	22.6%	25.5%		23.8%	25.9%		36.9%	18.8%		21.1%	27.3%	
	Hispanic/Latino	55	12.7%	5.5%	3.9%	3.9%		4.4%	3.7%	6.2%		5.5%	4.0%		6.4%	3.6%		4.0%	4.9%	
	Asian	54	12.5%	5.5%	6.1%	5.1%		4.4%	5.3%	7.3%		5.3%	5.6%		4.1%	6.2%		8.3%	3.8%	
	Other/Multiracial	26	6.0%	5.0%	4.8%	6.3%		5.4%	5.3%	5.4%		6.5%	4.6%		6.4%	4.9%		6.2%	4.9%	
Education	Less than high school	26	2.6%	3.2%	2.2%	1.8%	0.117	2.2%	2.7%	3.1%	0.798	3.0%	2.3%	0.679	3.2%	2.3%	0.679	1.6%	3.2%	0.157
	High School	106	10.5%	12.5%	8.2%	9.3%		12.2%	9.3%	10.0%		9.7%	11.1%		15.9%	7.7%		9.6%	11.1%	
	Some College	312	31.0%	32.2%	26.4%	32.8%		32.2%	31.0%	29.3%		29.8%	31.8%		38.6%	27.0%		29.0%	32.2%	
Income	College	563	55.9%	52.2%	63.2%	56.0%		53.5%	57.1%	57.5%		57.6%	54.8%		42.4%	63.0%		59.8%	53.6%	
	< \$20,000	182	18.1%	18.6%	17.8%	17.5%	0.036	14.1%	19.3%	22.4%	0.002	23.3%	14.7%	<b>&lt;0.0001</b>	25.4%	14.4%	<b>&lt;0.0001</b>	18.6%	17.9%	0.963
	\$20,000-\$34,999	232	23.0%	25.2%	22.5%	20.5%		19.7%	25.4%	23.9%		24.1%	22.2%		28.0%	20.3%		22.6%	23.1%	
	\$35,000-\$49,999	250	24.8%	28.6%	22.1%	21.7%		24.1%	23.5%	27.4%		25.1%	24.5%		24.5%	24.9%		23.7%	25.4%	
	\$50,000-\$74,999	157	15.6%	12.7%	17.3%	18.4%		18.9%	13.2%	14.3%		15.4%	15.7%		13.5%	16.7%		15.7%	15.5%	
> \$75,000	187	18.6%	15.0%	20.4%	22.0%		23.2%	18.5%	12.0%		12.2%	22.9%		8.7%	23.8%		19.4%	18.1%		
Sleep Duration	Very Short (≤4 h)	96	9.5%	10.7%	6.1%	10.2%	<b>0.018</b>	10.3%	6.4%	13.1%	<b>0.020</b>	10.7%	8.8%	0.081	12.4%	8.0%	0.081	8.5%	10.1%	0.439
	Short (5–6 h)	381	37.8%	38.3%	33.3%	40.4%		34.3%	39.4%	40.5%		41.7%	35.3%		43.2%	35.0%		41.0%	36.0%	
	Normal (7–8 h)	480	47.7%	44.4%	57.1%	45.5%		50.5%	50.0%	40.2%		43.2%	50.7%		40.1%	51.7%		45.7%	48.8%	
Insomnia Symptoms <sup>c</sup>	Long (>9 h)	50	5.0%	6.6%	3.5%	3.9%		4.9%	4.2%	6.2%		4.5%	5.3%		4.3%	5.3%		4.8%	5.1%	
	None	350	34.8%	34.2%	35.5%	34.9%	0.105	34.9%	36.2%	32.4%	0.112	29.8%	38.1%	<b>0.010</b>	27.4%	38.6%	<b>0.010</b>	31.7%	36.6%	0.140
	Mild	389	38.6%	36.1%	44.2%	38.3%		41.9%	37.8%	35.1%		39.5%	38.1%		38.9%	38.5%		38.6%	38.7%	
Daytime Sleepiness <sup>b</sup>	Moderate	268	26.6%	29.7%	20.4%	26.8%		23.2%	25.9%	32.4%		30.8%	23.8%		33.7%	22.9%		29.8%	24.7%	
	Mean	7.8	8.1	7.5	7.7	0.208	7.54	7.74	8.43	0.056	8.4	7.5	<b>0.002</b>	8.42	7.46	<b>0.002</b>	7.8	7.9	0.960	
	Standard Deviation	4.7	4.6	4.3	4.7		4.7	4.4	4.8		4.9	4.4		4.8	4.4		4.6	4.6		

Bold indicates significance at the  $p < .05$  level.

<sup>a</sup> Data displayed in mean, standard deviation.

<sup>b</sup> Responses collected on a scale from 1 to 7.

<sup>c</sup> Insomnia was scored as “none” for participants who scored 0 to 7 on the ISI, as “mild” for participants who scored 8 to 14 on the ISI, and “moderate-severe” for participants who scored 15–28.

**Table 2**

Binomial logistic regression, single and combined models, examining the relationship between sleep (duration, insomnia, and sleepiness) and participation in social or community organizations (0 and 1 or more organizations), adjusting for age, sex, race/ethnicity, education, and income (N = 1007).

Variables (Single/Combined Models)		Participation in Social or Community Organizations (Comparison: No Participation)*							
		One Membership				Two + Memberships			
		OR	C.I.		P-Value	OR	C.I.		P-Value
			Lower	Upper		Lower	Upper		
<b>Separate Models</b>									
Sleep Duration	Very Short (≤4hrs)	0.5	0.3	1.0	<b>0.044</b>	0.9	0.5	1.5	0.712
	Short (5–6hrs)	0.7	0.5	1.0	0.067	1.0	0.7	1.4	0.976
	Recommended duration (7–8hrs)	1.00	Reference			Reference			
Insomnia <sup>a</sup>	Long (>9hrs)	0.4	0.2	0.9	<b>0.031</b>	0.6	0.3	1.2	0.133
	None	1.00	Reference			Reference			
	Mild	1.3	0.9	1.8	0.235	1.1	0.8	1.5	0.624
Sleepiness <sup>b</sup>	Moderate-Severe	0.7	0.5	1.1	0.169	0.9	0.6	1.4	0.751
	High	0.8	0.6	1.2	0.320	0.8	0.6	1.1	0.163
<b>Combined Models</b>									
Sleep Duration	Very Short (≤4hrs)	0.5	0.3	1.1	0.101	1.0	0.5	1.7	0.895
	Short (5–6hrs)	0.7	0.5	1.0	0.076	1.0	0.7	1.4	0.957
	Recommended duration (7–8hrs)	1.00	Reference			Reference			
Insomnia <sup>a</sup>	Long (>9hrs)	0.4	0.2	0.9	<b>0.031</b>	0.6	0.3	1.2	0.131
	None	1.00	Reference			Reference			
	Mild	1.4	1.0	2.1	0.086	1.1	0.8	1.6	0.513
Sleepiness <sup>b</sup>	Moderate-Severe	0.9	0.6	1.5	0.778	1.0	0.7	1.6	0.929
	High	0.9	0.6	1.3	0.568	0.8	0.6	1.1	0.161

Bold indicates significance at the p < .05 level.

\*Reference groups include no participation in social or community organizations.

<sup>a</sup> Insomnia was scored as “none” for participants who scored 0 to 7 on the ISI, as “mild” for participants who scored 8 to 14 on the ISI, and “moderate-severe” for participants who scored 15 to 28.

<sup>b</sup> Sleepiness was scored as “high” for participants who scored 10 or higher on the ESS.

**Table 3**

Multinomial logistic regression, single and combined models, examining the relationship between sleep (duration, insomnia, and sleepiness) and neighbor helping behavior (often/always, sometimes, and rarely/never), adjusting for age, sex, race/ethnicity, income, and education (N = 1007).

Variables (Single/Combined Models)		Neighborhood Helping Behavior (Comparison: Often/Always)*							
		Sometimes				Rarely/Never			
		OR	C.I.		P-Value	OR	C.I.		P-Value
			Lower	Upper		Lower	Upper		
<b>Separate Models</b>									
Sleep Duration	Very Short (≤4hrs)	0.7	0.3	1.2	0.24	1.8	1.0	3.2	<b>0.039</b>
	Short (5–6hrs)	1.2	0.9	1.7	0.18	1.6	1.1	2.3	<b>0.009</b>
	Recommended duration (7–8hrs)	1.0	Reference			Reference			
Insomnia <sup>a</sup>	Long (>9hrs)	0.8	0.3	1.6	0.537	1.4	0.6	2.9	0.355
	None	1.0	Reference			Reference			
	Mild	0.8	0.6	1.2	0.356	0.8	0.6	1.3	0.562
Sleepiness <sup>b</sup>	Moderate-Severe	1.1	0.8	1.6	0.545	1.6	1.0	2.5	<b>0.026</b>
	High	1.0	1.0	1.0	0.495	1.0	1.0	1.1	<b>0.023</b>
<b>Combined Model</b>									
Sleep Duration	Very Short (≤4hrs)	0.6	0.3	1.2	0.160	1.5	0.9	2.8	0.221
	Short (5–6hrs)	1.2	0.9	1.7	0.239	1.6	1.1	2.3	<b>0.026</b>
	Recommended duration (7–8hrs)	1.0	Reference			Reference			
Insomnia <sup>a</sup>	Long (>9hrs)	0.8	0.4	1.6	0.531	1.4	0.7	2.9	0.379
	None	1.0	Reference			Reference			
	Mild	0.8	0.6	1.2	0.239	0.8	0.5	1.1	0.170
Sleepiness <sup>b</sup>	Moderate-Severe	1.1	0.7	1.8	0.651	1.2	0.7	2.0	0.492
	High	1.0	1.0	1.1	0.597	1.0	1.0	1.1	0.158

Bold indicates significance at the p < .05 level.

\*Reference group includes often/always neighborhood helping behavior.

<sup>a</sup> Insomnia was scored as “none” for participants who scored 0 to 7 on the ISI, as “mild” for participants who scored 8 to 14 on the ISI, and “moderate-severe” for participants who scored 15 to 28.

<sup>b</sup> Sleepiness was scored as “high” for participants who scored 10 or higher on the ESS.

the relationship between several social capital variables (eg, group participation, neighborhood belonging) and sleep-related variables, including sleep duration, insomnia and sleepiness. We do so in a cross-sectional study among adults living in Philadelphia and surrounding counties.

Our findings contribute to the growing literature on social capital and sleep health [16–19]. Our results show that long

sleepers were less likely to report participation in social or community organizations in both separate and combined models, but not short sleepers. This is a novel contribution to the literature, as Win and colleagues found an association between short sleep duration and poor social capital [37], and Pabayo and colleagues found an association between a similar construct, social fragmentation, and short sleep duration [24]. Then, consistent with the

**Table 4**  
Binomial logistic regression, single and combined models, examining the relationship between sleep (duration, insomnia, and sleepiness) and neighborhood belonging, trust, and improvement adjusting for age, sex, race/ethnicity, education, and income (N = 1007).

Variables (Single/Combined Models)		Neighborhood Belonging			Neighborhood Trust			Neighborhood Improvement					
		OR	C.I.		P-Value	OR	C.I.		OR	C.I.		P-Value	
			Lower	Upper			Lower	Upper		Lower	Upper		
<b>Single Models</b>													
Sleep Duration	Very Short ( $\leq 4$ hrs)	0.6	0.4	1.0	0.056	0.8	0.5	1.4	0.497	0.9	0.5	1.4	0.528
	Short (5–6hrs)	0.6	0.5	0.9	<b>0.003</b>	0.7	0.5	1.0	<b>0.057</b>	0.7	0.5	1.0	<b>0.033</b>
	Recommended duration (7–8hrs)	1.00	Reference			1.0	Reference			1.00	Reference		
	Long (>9hrs)	1.2	0.6	2.3	0.548	1.1	0.6	2.2	0.730	1.0	0.5	1.9	0.987
Insomnia <sup>a</sup>	None	1.00	Reference			1.0	Reference			1.00	Reference		
	Mild	1.2	0.6	2.3	0.548	0.7	0.5	1.0	0.090	0.9	0.6	1.2	0.317
	Moderate-Severe	1.2	0.6	2.3	0.548	0.6	0.4	0.9	<b>0.005</b>	0.6	0.4	0.9	<b>0.011</b>
Sleepiness <sup>b</sup>	High	1.2	0.6	2.3	0.548	0.8	0.6	1.1	0.242	0.9	0.7	1.2	0.515
<b>Combined Model</b>													
Sleep Duration	Very Short ( $\leq 4$ hrs)	0.8	0.5	1.3	0.381	1.1	0.6	1.9	0.760	1.1	0.6	1.8	0.853
	Short (5–6hrs)	0.7	0.5	1.0	<b>0.049</b>	0.8	0.6	1.2	0.327	0.8	0.6	1.1	0.163
	Recommended duration (7–8hrs)	1.00	Reference			1.0	Reference			1.0	Reference		
	Long (>9hrs)	1.3	0.7	2.4	0.459	1.2	0.6	2.4	0.608	1.1	0.6	2.0	0.868
Insomnia <sup>a</sup>	None	1.00	Reference			1.0	Reference			1.0	Reference		
	Mild	0.8	0.6	1.1	0.246	0.8	0.6	1.1	0.170	0.9	0.6	1.2	0.504
	Moderate-Severe	0.7	0.5	1.0	0.066	0.6	0.4	0.9	<b>0.024</b>	0.7	0.4	1.0	<b>0.040</b>
Sleepiness <sup>b</sup>	High	0.8	0.6	1.1	0.139	1.0	0.7	1.3	0.755	1.0	0.8	1.4	0.915

Bold indicates significance at the  $p < .05$  level.

\*Reference groups include no neighborhood belonging, trust, or improvement.

<sup>a</sup> Insomnia was scored as “none” for participants who scored 0 to 7 on the ISI, as “mild” for participants who scored 8 to 14 on the ISI, and “moderate-severe” for participants who scored 15 to 28.

<sup>b</sup> Sleepiness was scored as “high” for participants who scored 10 or higher on the ESS.

work from Win and Pabayo, our results found short sleepers were less likely to report helping behaviors and less likely to report a sense of belonging in their community, in both separate and combined models.

With regards to sleep duration, there is an argued U-shaped relationship whereby short sleep (less than 7 h) is associated with health risks, as is long sleep (greater than 9 h) [60]. While the health detriment associated with short sleeping is well-documented [6,7,9,56], there is less consensus regarding long sleep and its health detriment [2,61]. Our results show long sleepers are less likely to report social capital (eg, group memberships) compared to those sleeping 7–8 h, which is a finding that buttresses the U-shaped curve argument that long sleep is associated with adverse outcomes. However, one argument to explain the association between long sleep and poor social capital in this study could be that long sleep may be due to conditions such as anxiety or depression, which would lower one's capacity and motivation for group interaction and its social capital benefits. On the other hand, it may be that long sleepers have less total available time in a 24-h cycle for socializing thereby limiting their ability to fully engage in their social network.

While other studies examined sleep duration and quality as it relates to social capital, cohesion, and neighborhood-related factors [17,24,27,37], few have examined daytime sleepiness and insomnia as they relate to social capital. Results from our study found insomnia was significantly, inversely associated with neighborhood trust and improvement behavior in combined models. This is a novel finding, as previous work found a significant relationship between social cohesion and sleep duration and sleep quality, but not insomnia [17,24,27,37]. Further, daytime sleepiness, although a predictor in separate models of low neighborhood helping behavior and low neighborhood belonging, was not a significant predictor of either social capital measure in combined models.

It is noteworthy that the different patterns of directionality observed in separate models compared to patterns observed in combined models predicting sleep health dimensions and social capital factors. For instance, daytime sleepiness was a significant predictor of social capital in separate models but not in combined

models. Our aim in analyzing sleep health variables together in combined models was to examine whether any specific sleep-related variable demonstrated an association that was unique and not otherwise explained by the others. In this way, the lack of significant association for sleepiness in combined models suggests that the variance explained by sleepiness generally overlaps with that explained by other sleep variables.

Although not all associations between sleep and social capital components were significant in both separate and combined models, there is a general trend toward a relationship between poor sleep health (eg, short or long sleep, moderate-to-severe insomnia) and poor social capital (eg, fewer group memberships, less neighborhood helping behavior, belonging, trust, and improvement). It could be that certain dimensions of poor sleep health (eg, short sleep) have specific implications for aspects of social behavior, but not others. Combining sleep health dimensions (eg, duration and insomnia) into a single scale may be one opportunity for future research.

In addition, future research might explore the causal direction between sleep duration, insomnia, and sleepiness and social capital in longitudinal research to examine how sleep health and social capital evolve over time. It would also be insightful to examine the impact of improvements to social capital and their implications for sleep health, or conversely, improvements to social capital and their benefit for sleep health.

In sum, social capital may be a concept with potential for advancing our understanding of the link between social/environmental factors, sleep, and perhaps also population health. For instance, poor social capital and lower access to resources (eg, both tangible such as goods or financial assistance and intangible, such as social support) may be a driving force in the link between short or long sleep and undesirable health outcomes.

#### 4.1. Limitations

The sleep-reported data in this study are retrospective self-report and possible biases exist in reports of sleep duration, insomnia, and sleepiness. In addition, the data were collected in

one geographical location and in predominantly urban and suburban settings. Data collected from alternative locations may yield different results. Moreover, the cross-sectional nature of the study precludes any causality inferences. It should be noted that the current study collected self-reported sleep, as opposed to actual sleep need. In addition, while our paper is the first to our knowledge to offer a comprehensive assessment of various social capital dimensions and sleep health parameters, our data are cross-sectional. Future research is needed to understand the directionality of the relationship between social capital and sleep health. Lastly, SES and neighborhood characteristics, such as social cohesion, have been conceptualized in the literature as similar constructs [18,19], yet research examining specific neighborhood dimensions, such as social fragmentation and social capital, have controlled for aspects of SES in their analyses [17,24,27,37]. Consistent with this approach, our analysis controlled for aspects of SES so as to specifically examine social capital. Thus, our findings may be different if we did not control for SES in our study. Future research may examine the conceptual overlap between specific SES dimensions (eg, income, education, race) and their relationship to social capital.

#### 4.2. Implications and future directions

Results from the current study offer several directions for future research. We detected an association between long sleep and several social capital. These patterns may be further explored in future research, as the previous evidence suggests an association between short sleep and poor social capital, research in the future may examine longitudinal patterns of sleep health and social capital to understand the directionality of the association between these constructs.

Public health approaches may be considered for methods, such as engaging community health workers or community events that specifically aim to improve social capital building events and messaging, so as to increase social capital among individuals who reside in communities at risk for poor social capital and poor sleep health or consider community-based methods for improving sleep health as a method for improving social capital. Furthermore, as sleep is a behavior that is linked to a suite of health outcomes, including chronic conditions, such as diabetes, hypertension, and mortality risk [6,9,44], it may be interesting to examine how improving social capital may improve sleep and consequently, chronic disease management. Finally, future research may combine social network analysis (eg, examining connections among individuals) with measures of social capital to examine how these factors interact and bear consequence for sleep and health.

## 5. Conclusion

Our study offers preliminary evidence for the link between social capital and several self-reported sleep variables. Specifically, we find preliminary evidence to suggest poor sleep health (eg, short and long sleep duration and insomnia) is associated with poor social capital (eg, less participation in social or community organizations, lower helping behavior and less neighborhood trust, belonging, and improvement). The importance of social network factors, such as social capital, for health has been demonstrated in other domains, including smoking and alcohol consumption [29,30]. Social capital may be a social network factor that helps advance our understanding of the link between neighborhoods, sleep, and population health.

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## Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: <https://doi.org/10.1016/j.sleep.2019.03.019>.

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