



# Cross-sectional Association Between Sleep Duration and Body Mass Index, Body Composition in Thai Cohort EGAT 3/1

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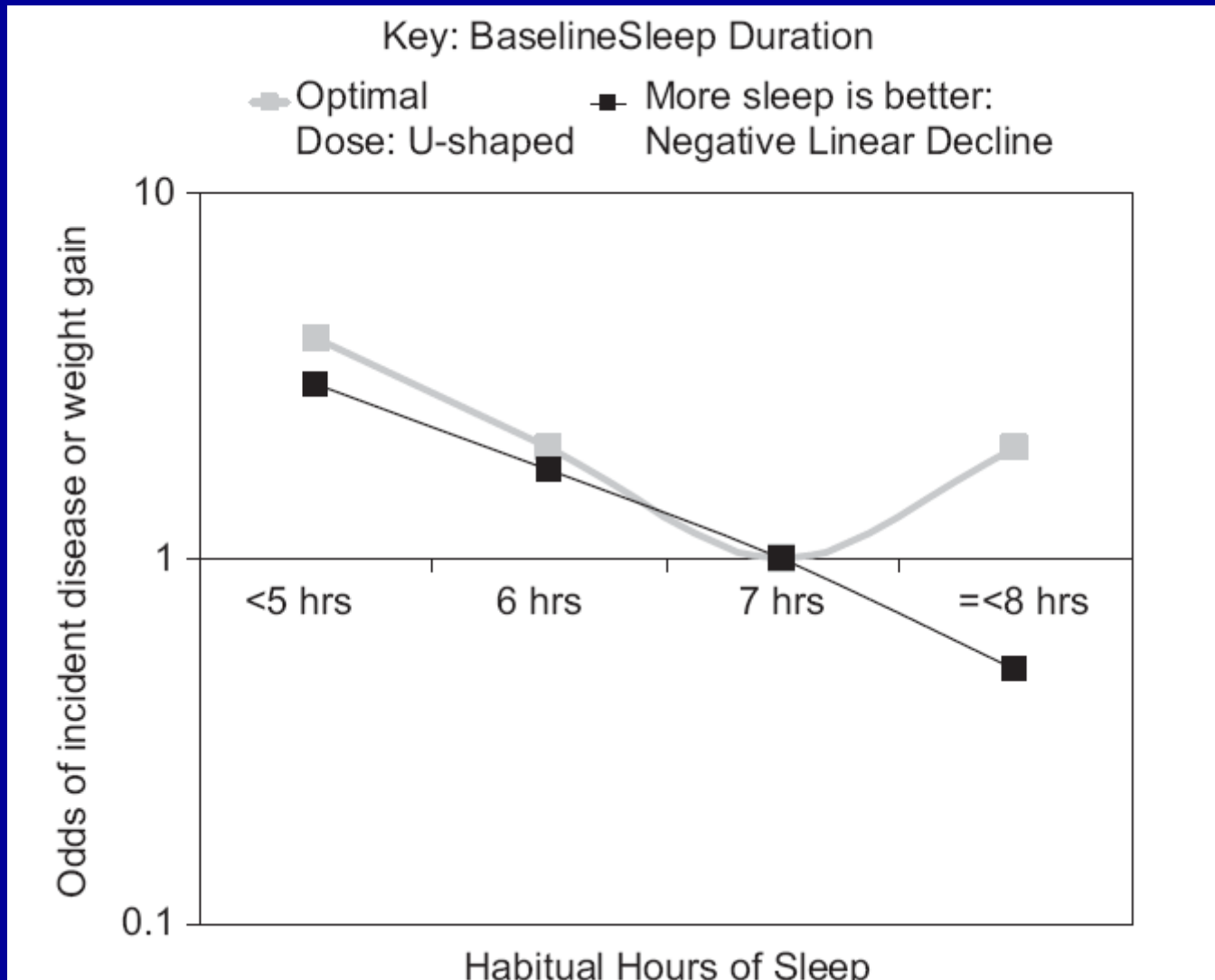
# Background

- There appeared to be a clear pattern that shorter sleep duration was associated with obesity in pediatric population.
- Existing data about the association between sleep duration and obesity in adults have variable consistency.
- Cross-sectional and longitudinal studies in adults often demonstrated an association of short sleep duration with increased weight.
- Some studies showed that long sleep duration was associated with obesity.

Marshall NS et al. *Sleep Medicine Reviews* 2008;12:289-298  
Nielsen LS et al. *Obesity Reviews* 2011;12:78-92



# Background





# Objectives

- (1) To determine the pattern of association between sleep duration and obesity parameters, and body compositions: skeletal muscle mass, body fat mass in Thai EGAT 3/1 adults
- (2) To examine the effect of physical activity, age and gender, snoring and sleep apnea on obesity parameters.



# Methods

- Sleep duration was obtained from each participant by a single self- report questionnaire.

Sleep duration was categorized into 6 groups

- 1)  $< 4$  h
- 2) 4-5 h
- 3) 5-6 h
- 4) 6-7 h
- 5) 7-8 h
- 6)  $> 8$  h







# Methods

- Body weight and height, waist circumference were measured.
- Body composition was assessed by multi-frequency bioelectrical impedance (In Body 720, Soul, South Korea). Skeletal muscle mass, and body fat mass were obtained.
- Skeletal muscle mass index and body fat mass index adjusted by height were calculated.





# Methods

- Demographic data, education level, income level, co-morbid diseases (presence of at least one of the following conditions: HT, DM, CHF, CAD, history of angioplasty, coronary bypass graft, or stroke), and presence of metabolic syndrome and sleep disorders were also obtained for the analysis.

**Metabolic syndrome (AHA/NHLBI 2005):** any 3 of 5 of the following;  
SBP $\geq$ 130 or DBP $\geq$ 85 mmHg or on anti-HT medication in patients with history of HT,  
TG  $\geq$ 150 mg/dl, HDL <40 mg/dl (males), <50 mg/dl (females),  
Elevated fasting glucose > 100 mg/dl or on glucose lowering drugs  
Central obesity: WC  $\geq$  90 cm in males,  $\geq$  80 cm in females (modified for Asians)



# Methods

- The Global Physical Activity Questionnaire (GPAQ) was developed by WHO for physical activity surveillance
  - Comprising 16 questions in 3 domains
    - Activity at work
    - Travel to and from places
    - Recreational activities
  - directly obtained from the participants containing the activity recall during the past 4 weeks





# MET

## (Metabolic equivalents)

- Ratio of a person's working metabolic rate relative to the resting metabolic rate
- One MET = energy cost of sitting quietly, and is equivalent to a caloric consumption of 1 kcal/kg/hour
- It is estimated that, compared to sitting quietly, a person's caloric consumption is 4 times as high when being moderately active, and 8 times as high when being vigorously active.



# Population's physical activity (or inactivity)

- (1) estimate a population's mean or median physical activity using a continuous indicator such as MET-minutes per week or time spent in physical activity
- (2) classify a certain percentage of a population as 'inactive' by setting up a cut-point for a specific amount of physical activity



# MET value for physical activity level

Domain	MET value
Work	<ul style="list-style-type: none"><li>• Moderate MET value = 4.0</li><li>• Vigorous MET value = 8.0</li></ul>
Transport	Cycling and walking MET value = 4.0
Recreation	<ul style="list-style-type: none"><li>• Moderate MET value = 4.0</li><li>• Vigorous MET value = 8.0</li></ul>



# Continuous indicator

- MET values are applied to the time variables according to the intensity (moderate or vigorous) of the activity
- Applying MET values to activity levels allows us to calculate total physical activity



# Definition of physical activity level

- High
  - vigorous-intensity activity on at least 3 days achieving a minimum of 1500 MET-minutes/week OR
  - 7 or more days of any combination of walking, moderate or vigorous-intensity activity achieving a minimum of 3000 MET-minutes/week
- Moderate
  - 3 or more days of vigorous-intensity activity of at least 20 minutes/day OR
  - 5 or more days of moderate-intensity activity or walking at least 30 minutes/day OR
  - 5 or more days of any combination achieving a minimum of 600 MET-minutes/week



# Statistical analysis

- SPSS software version 17
- Continuous variables were expressed as mean and SD, and difference of mean value for each sleep duration category were compared by one-way ANOVA and post-hoc multiple comparison using Bonferroni
- Logistic regression to examine the strength of association between sleep duration and obesity with controlling the covariates in multivariate analysis. Results were presented as odds ratio and 95% CI. Odds ratio for each sleep duration category was referenced to the 7-8 h sleep group.



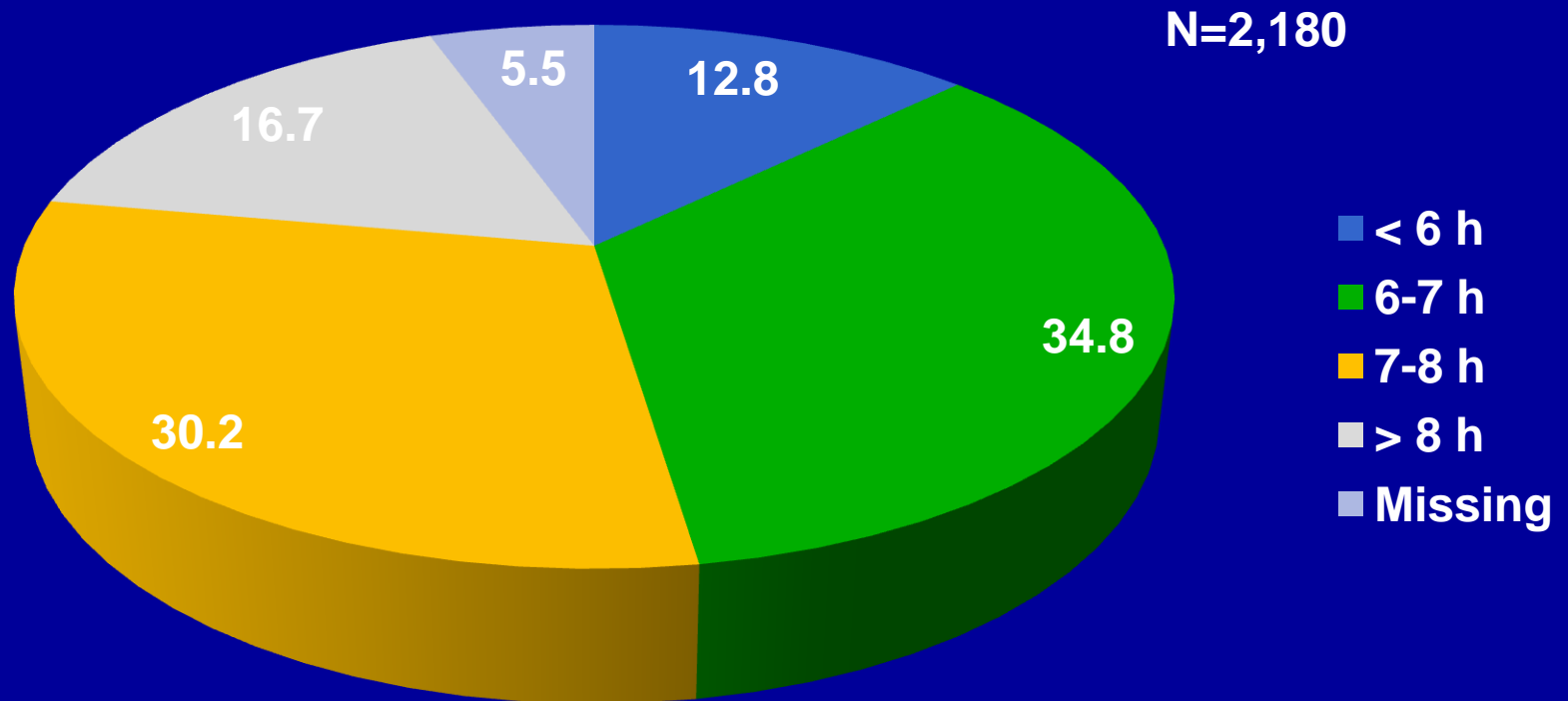


# Results



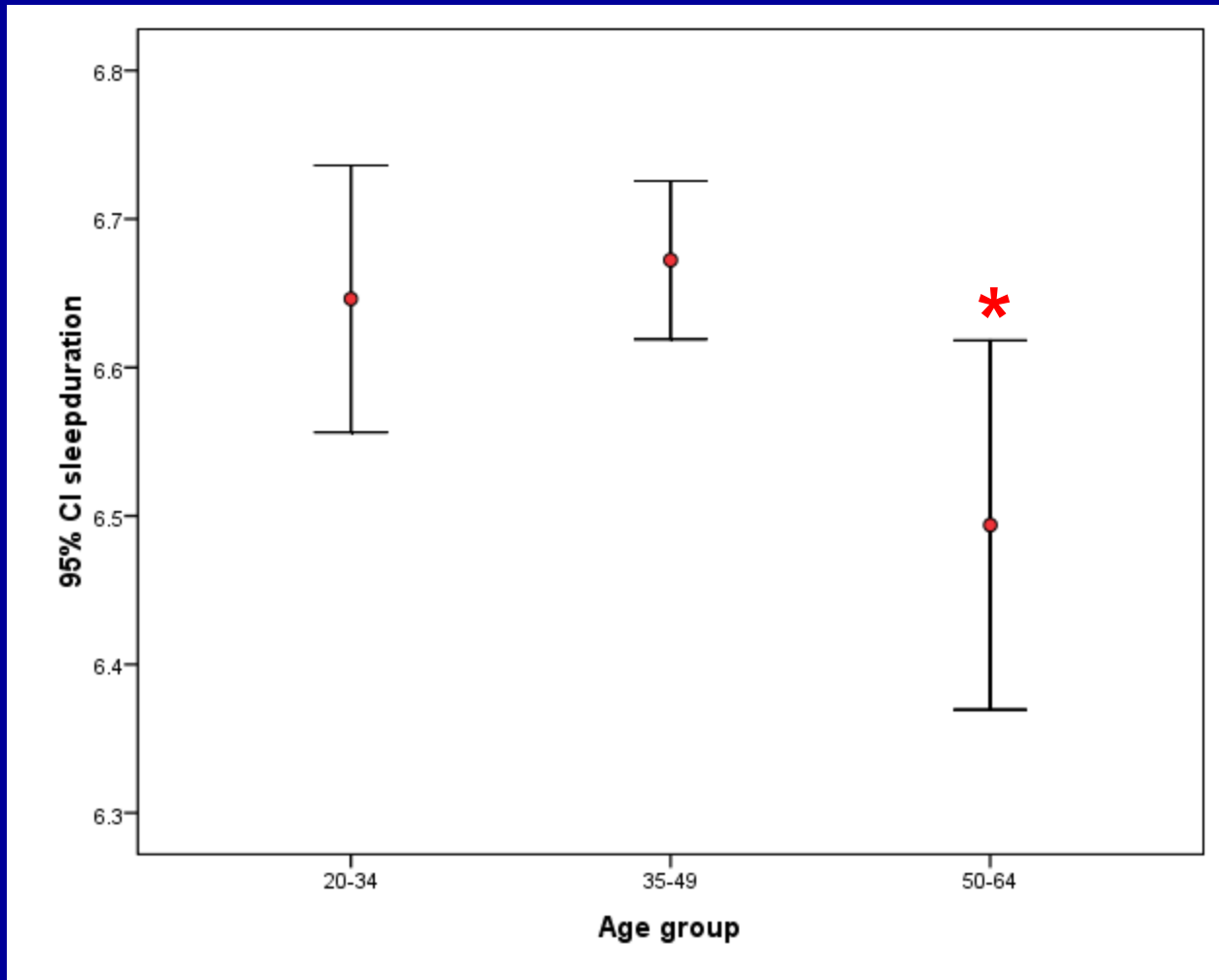
# Sleep duration category

Percentage of each sleep duration category





# Reduced sleep duration in older adults



Data are expressed as mean  
Error bars represent 95% CI

\*  $p < 0.05$  vs 35-49 yr



# Anthropometric characteristics by sleep duration

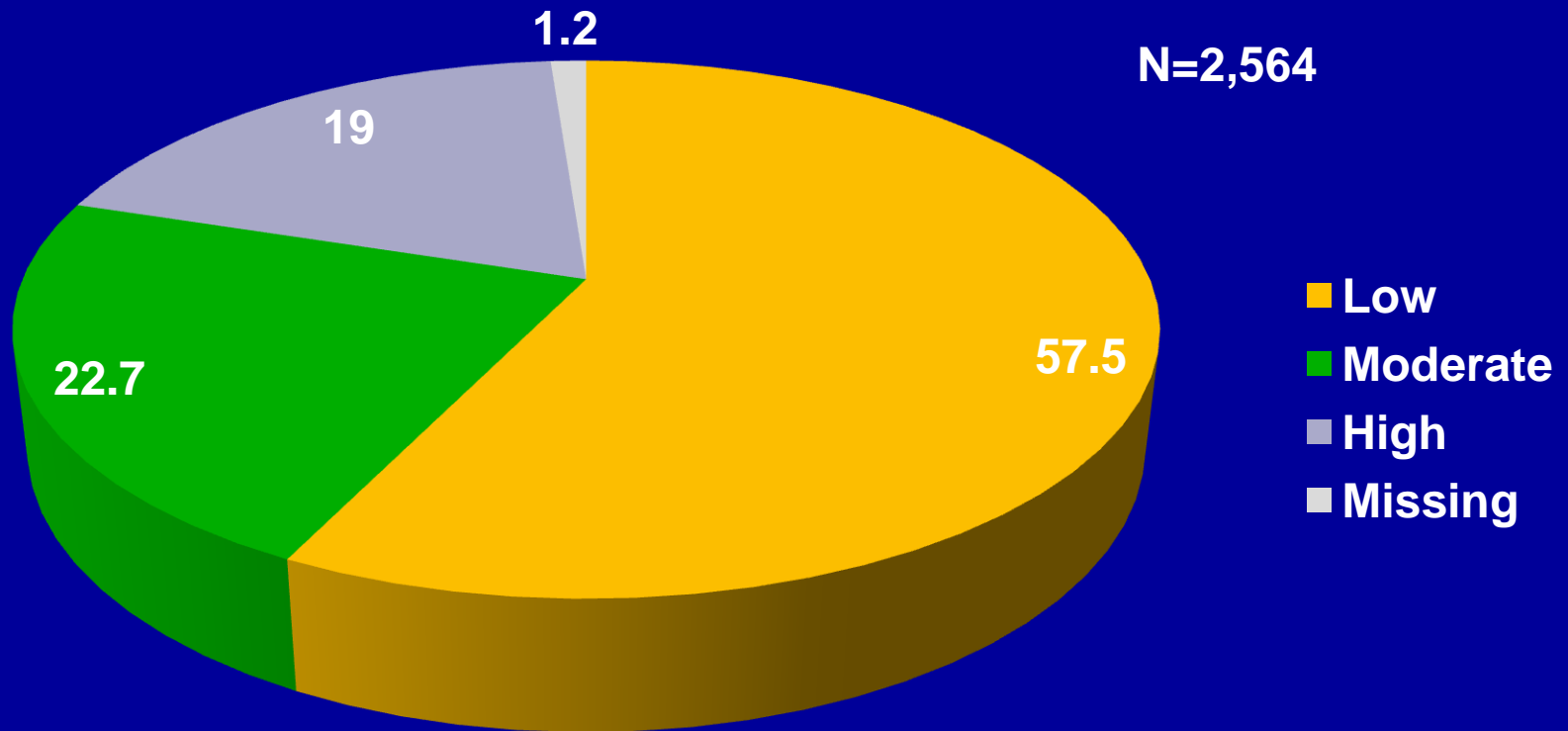
	Sleep Duration			
	< 6 h N=331	6-7 h N=900	7-8 h N=780	>8 h N=432
Age, y	42.8 (7.4)	40.8 (7.4)*	41 (7)*	41 (6.6) * †
Gender M:F	252:79	689:211	552:228	289:143
BMI	24.2 (3.5)	24 (3.9)	23.8 (3.6)	24.2 (3.9)
Waist (cm)	80.9 (9.5)	78.4 (9.2)	78.3 (8.7)	79.3 (9.7)
Obesity, n	186 (56%)	446 (50%)	391 (50%)	229 (53%)
Central obesity, n	153 (46%)	387 (43%)	326 (42%)	193 (45%)

\*P <0.05 vs <6 h, † P <0.05 >8h vs <6h



# Physical activity level

Percentage of each physical activity level





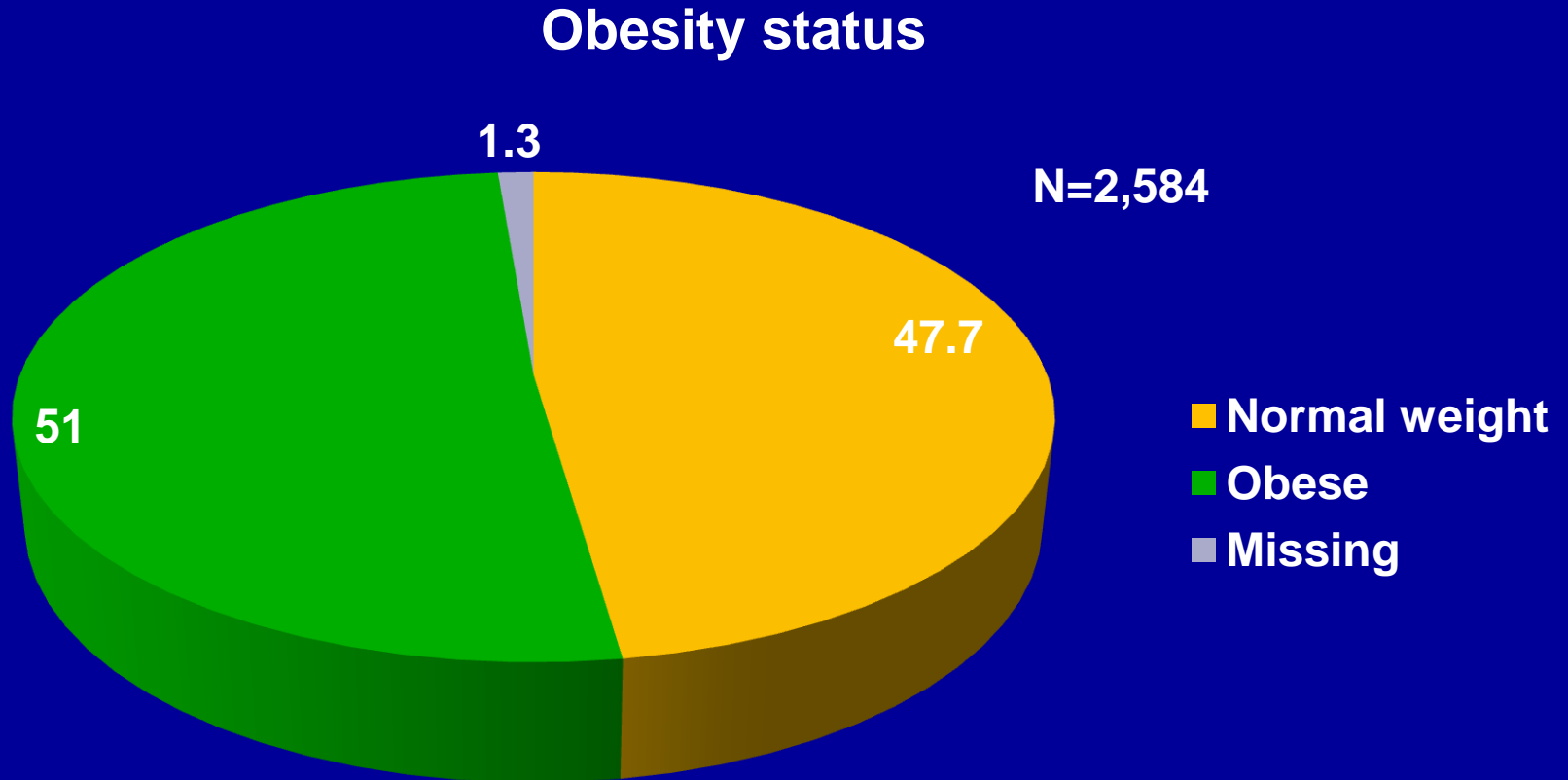
# Physical activity level by sleep duration

	Sleep Duration				P value
	< 6 h N=331	6-7 h N=900	7-8 h N=780	>8 h N=432	
Physical activity					
• Low	185 (56%)	509 (56.6%)	445 (57%)	272 (63%)	0.08
• Moderate	74 (22.4%)	202 (22.4%)	198(25.4%)	89 (20.6%)	
• High	72 (21.8%)	189 (21%)	137(17.6%)	71 (16.4%)	
Physical activity					
• Moderate-intensity (MET-min/wk)	51 (27.3)	22.8 (3.9)	38.2 (7.6)	51.8 (38.5)	NS
• Vigorous-intensity (MET-min/wk)	272 (35.3)	339 (29.5)	242 (22.2)	250 (40.9)	0.05
Total physical activity	323 (33.3)	212 (17.8)	278 (19.1)	278 (26.9)	NS
• Sedentary (min/d)	286 (13.8)	316 (9.2)	294 (8.9)	302 (12.7)	NS





# Percentage of obesity



Obesity was defined as  $BMI \geq 25 \text{ kg/m}^2$

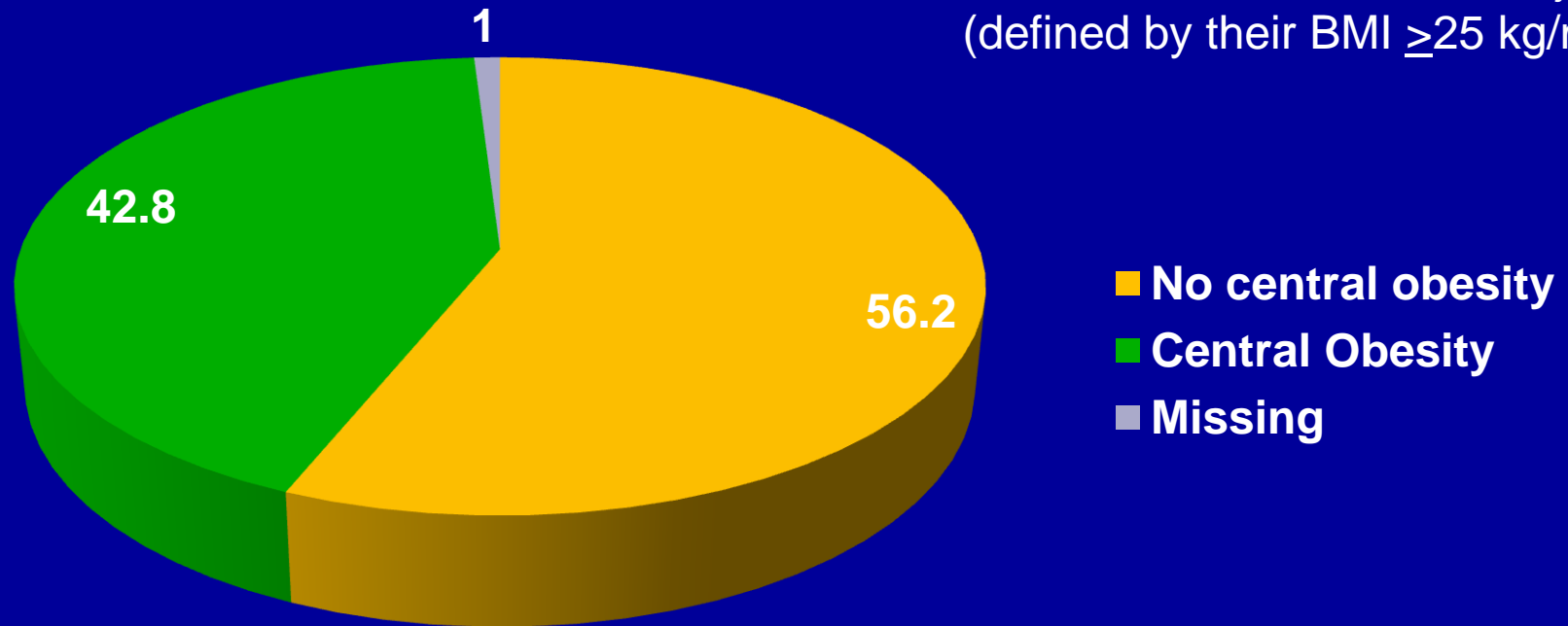
(Grundy FM et al. Circulation 2005;112:2735-2752)



# Percentage of central obesity

## Central obesity\*

Found in 75% of obese subjects  
(defined by their BMI  $\geq 25$  kg/m<sup>2</sup>)

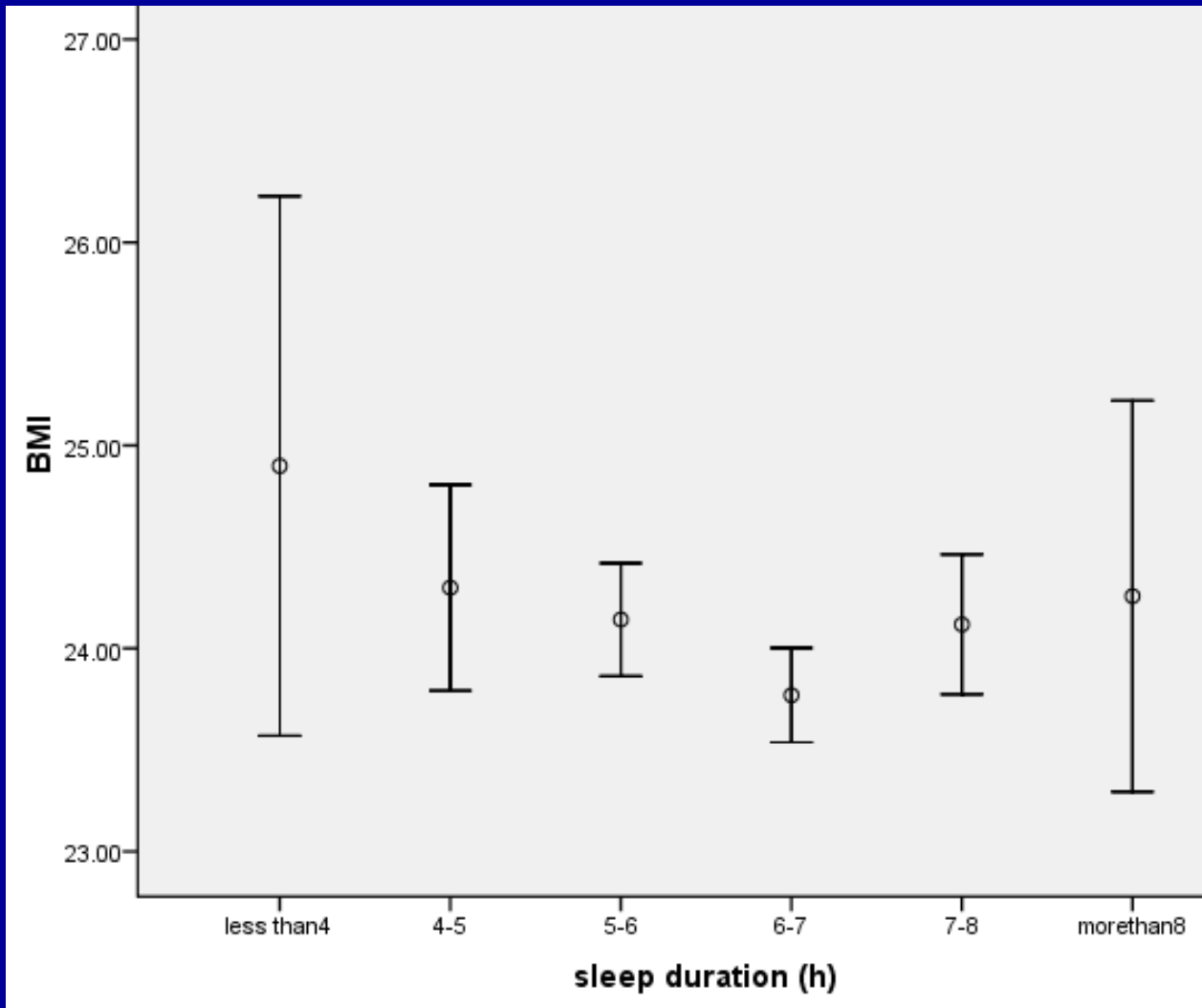


Central obesity was defined as waist circumference  $\geq 90$  cm in male,  $\geq 80$  cm in female

(Grundy FM et al. Circulation 2005;112:2735-2752)



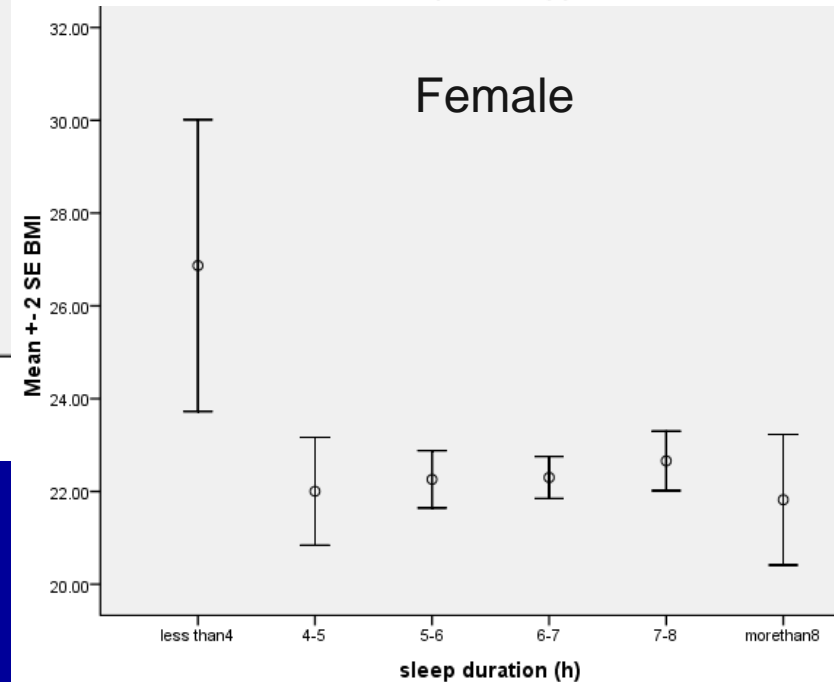
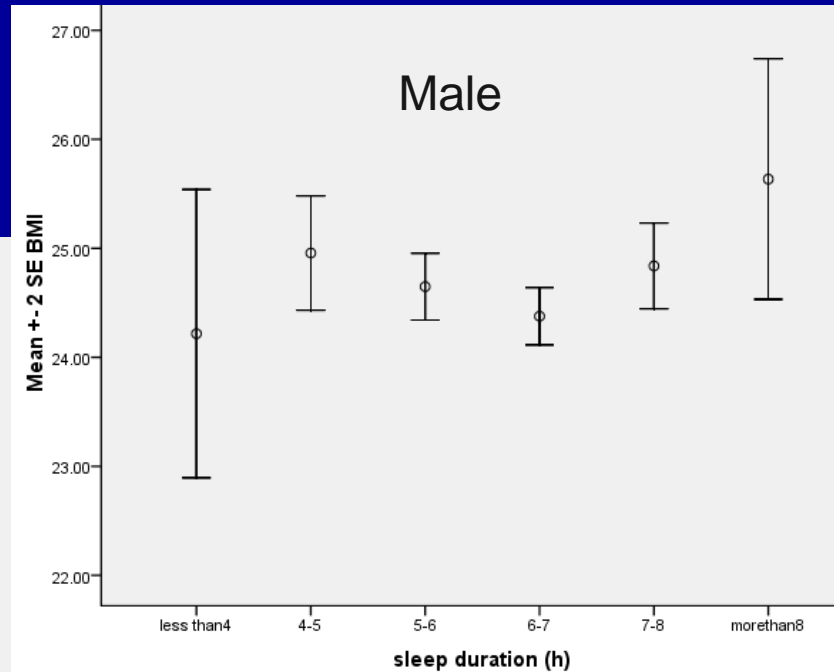
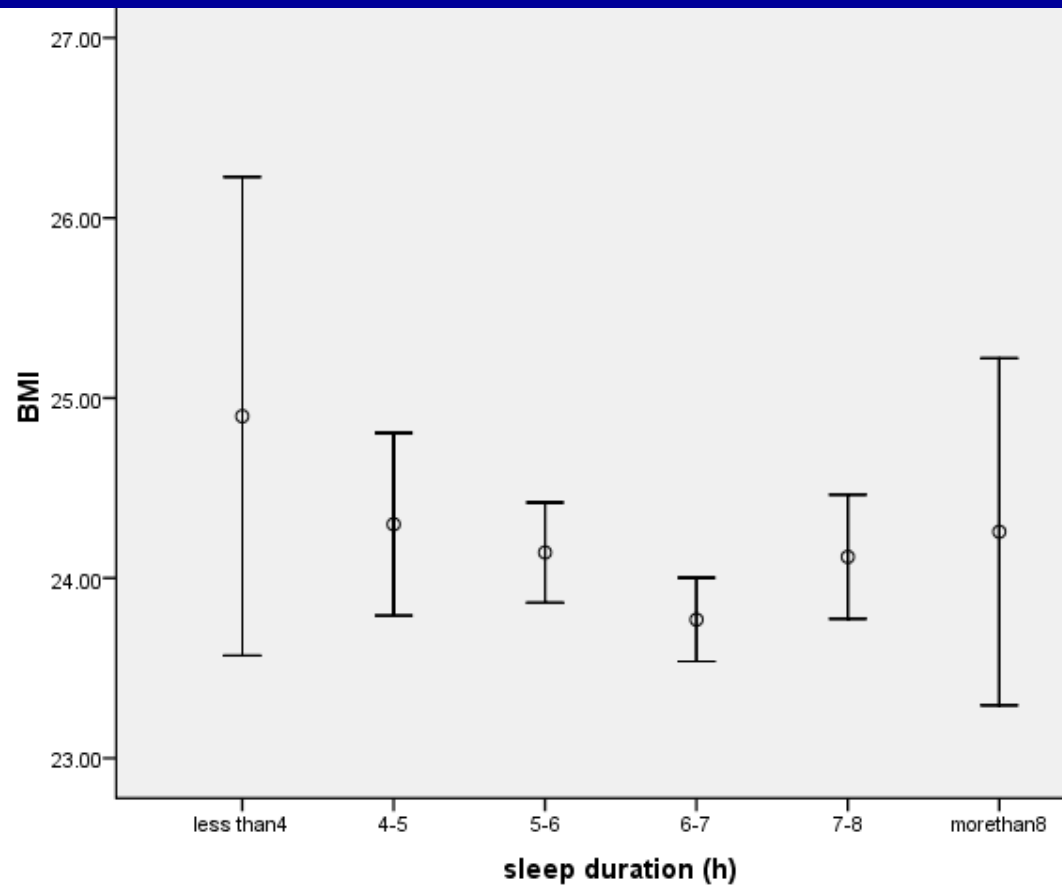
# Association between sleep duration and BMI



Data are expressed as mean  
Error bars represent 95% CI



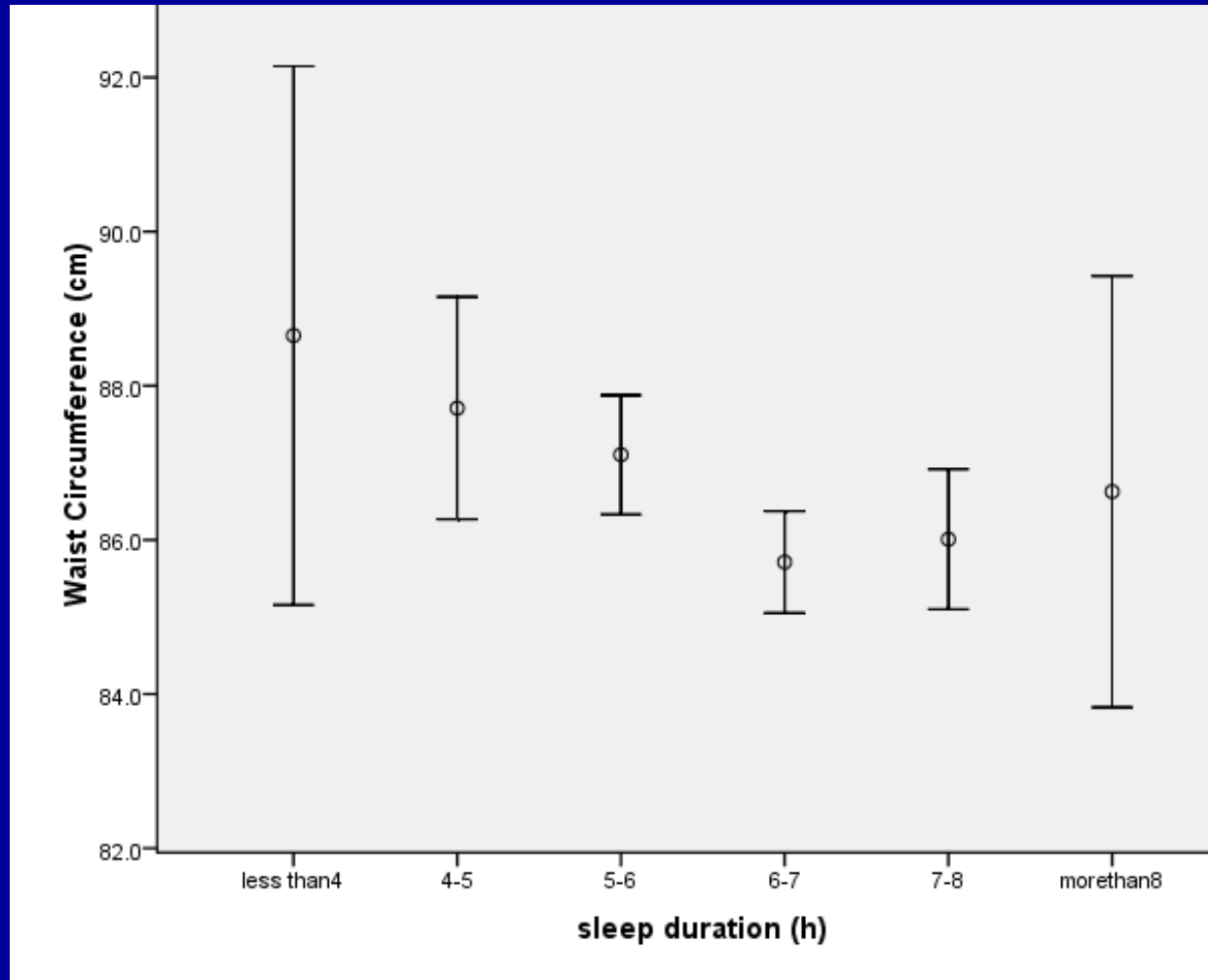
# Association between sleep duration and BMI



Data are expressed as mean  
Error bars represent 95% CI



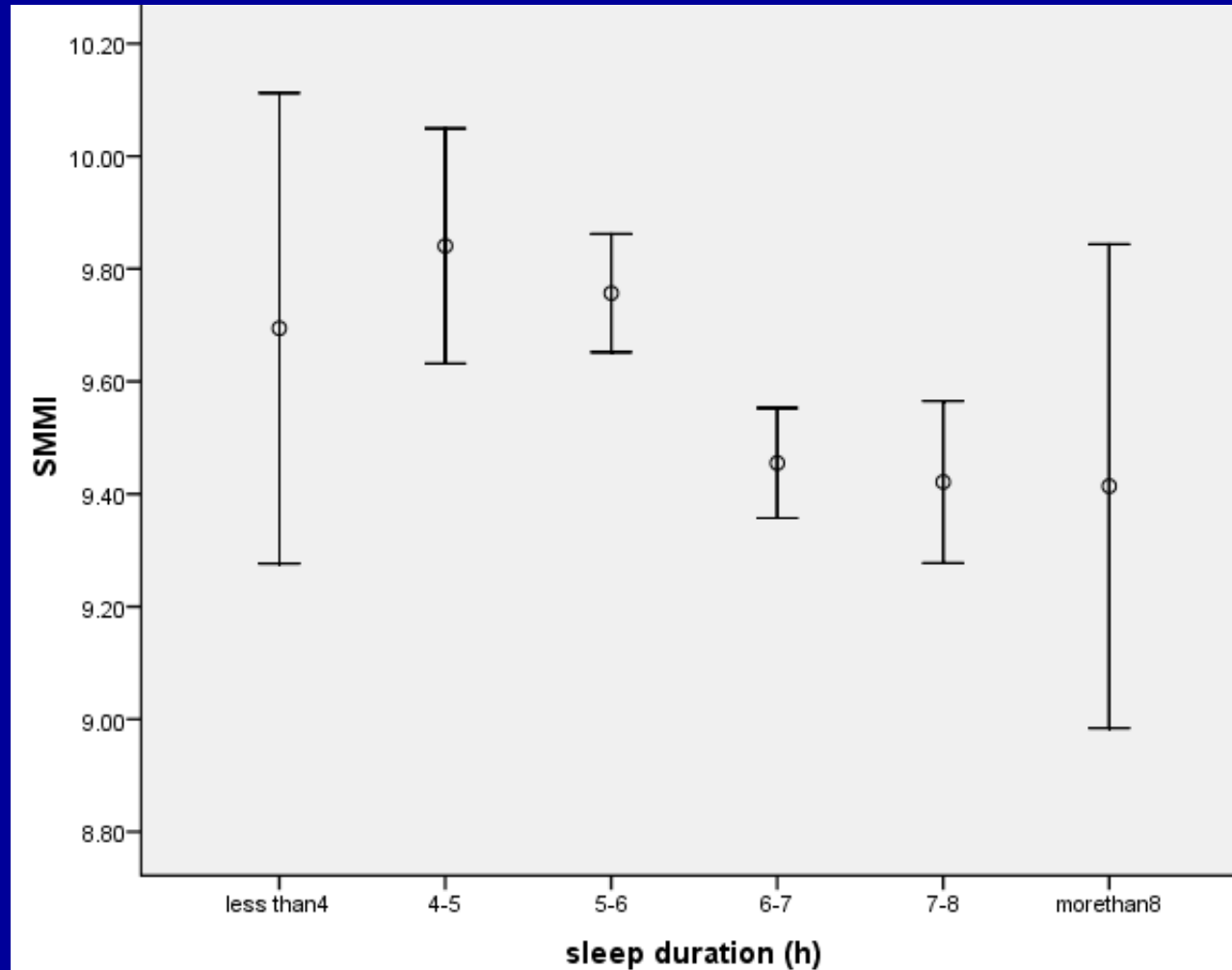
# Association between sleep duration and waist circumference



Data are expressed as mean  
Error bars represent 95% CI



# Association between sleep duration and Skeletal muscle mass index (SMMI)

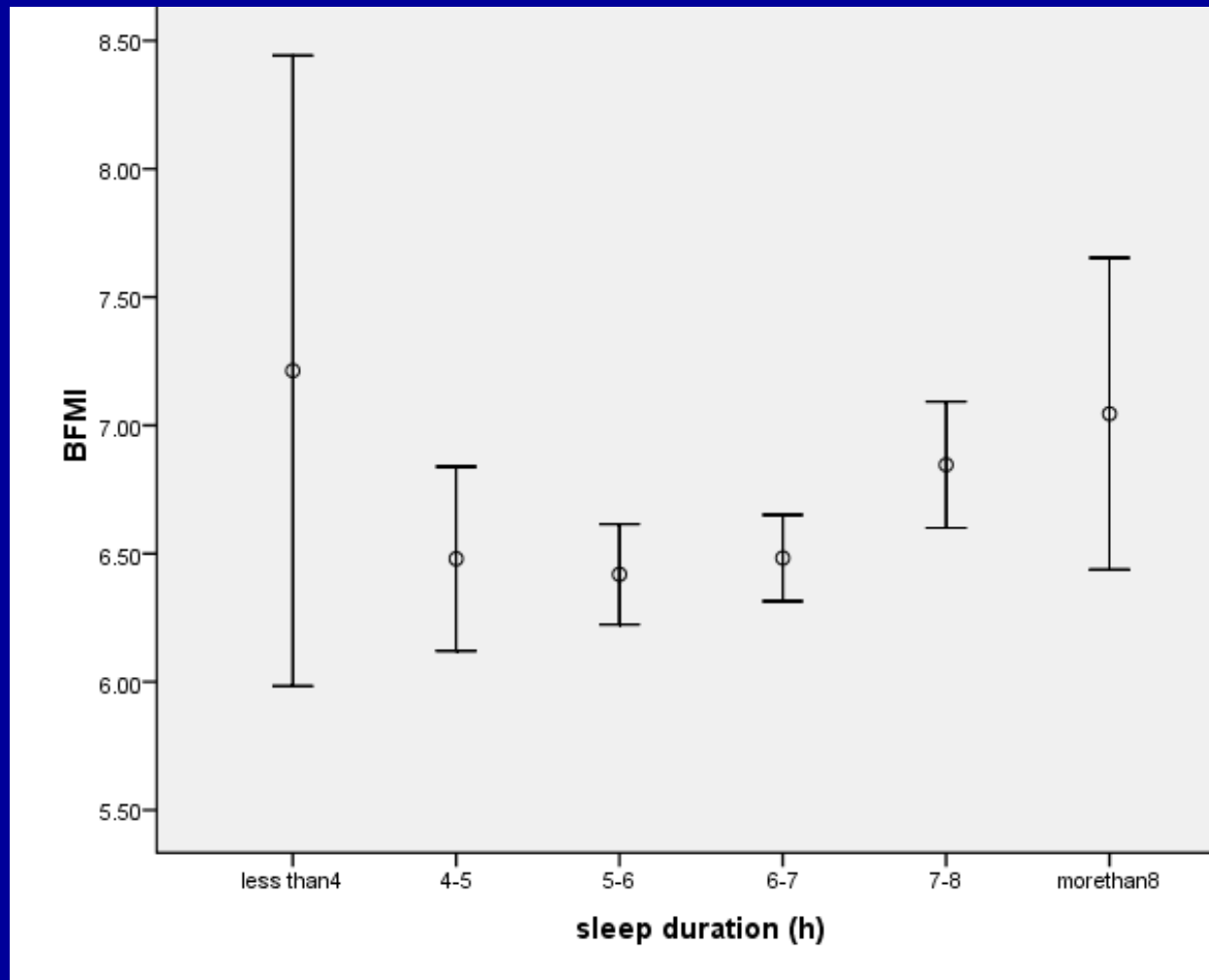


Data are expressed as mean  
Error bars represent 95% CI





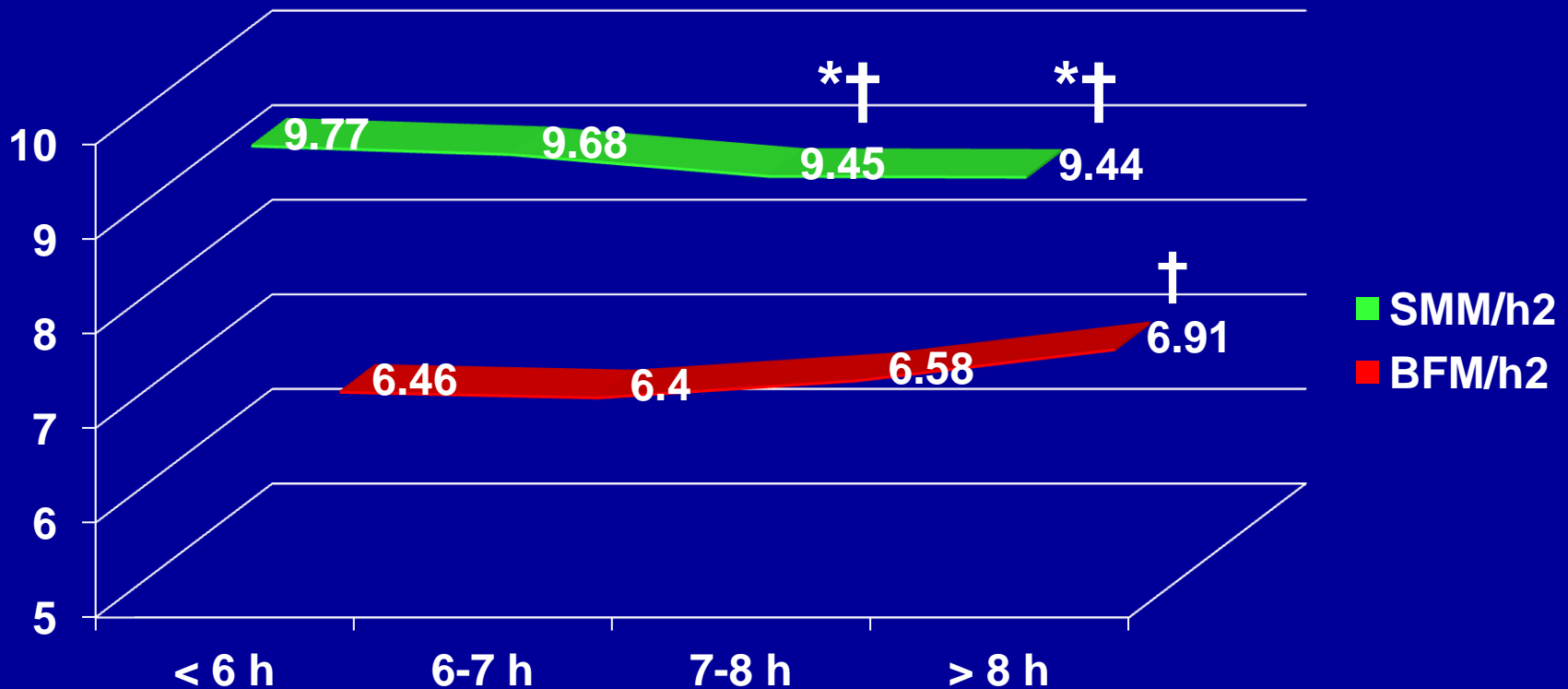
# Association between sleep duration and body fat mass index (BFMI)



Data are expressed as mean  
Error bars represent 95% CI



# Skeletal muscle mass index and body fat mass index stratified by sleep duration category



Data are expressed as mean

\*  $p < 0.05$  vs < 6 h

†  $p < 0.05$  vs < 6-7 h



# Univariate analysis

## Association between duration of sleep and obesity

Factor	OR (95% CI)	P-value
Sleep duration		
< 6 h	1.27 (0.98-1.64)	0.072
6-7 h	0.97 (0.80-1.18)	0.78
7-8 h	1	
> 8 h	1.12 (0.88-1.4)	0.35
Gender		
Female	1	
Male	3.34 (2.77-4.0)	<0.0001
Age (yr)		
20-34	1	
35-49	1.56 (1.25-1.93)	<0.0001
50-64	1.92 (1.43-2.56)	<0.0001
Physical activity level		
Low	0.68 (0.55-0.84)	<0.0001
Moderate	0.72 (0.56-0.91)	0.007
High	1	



# Univariate analysis

## Association between duration of sleep and obesity

Factor	OR (95% CI)	P-value
Smoking status		
None	0.7 (0.55-0.88)	0.003
Former smoker	1.5 (1.12-2.0)	0.07
Current smoker	1	
Associated diseases		
Sleep disorder		
No	1	
Snorer	3.5 (2.9-4.3)	<0.0001
OSA	3.3 (2.5-4.5)	<0.0001
Metabolic syndrome		
No	1	
Yes	17.1(11.0-26.6)	<0.0001
Co-morbid disease		
No	1	
At least 1	1.9 (1.4-2.6)	<0.0001
Medications		
on DM drug	3.1 (1.7-5.4)	<0.0001
on anti-HT drug	3.6 (2.5-5.1)	<0.0001
on lipid lowering drug	3.6 (2.5-5.3)	<0.0001



# Multivariate analysis

## Association between duration of sleep and obesity

Factor	Obesity OR (95% CI)	p-value
Male gender	3.3 (1.9-5.8)	<0.0001
Presence of metabolic syndrome	14.9 (6.4-34.3)	<0.0001
Physical activity Moderate-intensity	0.5 (0.3-0.9)	0.02
Sleep disorders		
Snorer	2.6 (1.6-4.5)	<0.0001
OSA	2.3 (1.2-4.6)	0.02

P-value adjusted for sleep duration, age, gender, smoking status, income, education level, metabolic syndrome, co-morbid diseases, snoring, OSA symptoms, and medications used



# Discussion

- In this cross-sectional analysis, U-shape association was found between sleep duration and the following:
  - BMI
  - waist circumference
  - body composition: body fat mass index
- U-shape association between sleep duration and BMI was demonstrated in male but the association disappeared in female.
- U-shape association between sleep duration and waist circumference and between sleep duration and BFMI is independent of gender.



# Discussion

- No clear pattern of association between sleep duration and skeletal muscle mass index was demonstrated.
- The strength of this study:
  - Controlling for several possible covariates :
    - medical co-morbid diseases, snoring and sleep apnea, and socioeconomic status (education level, income)



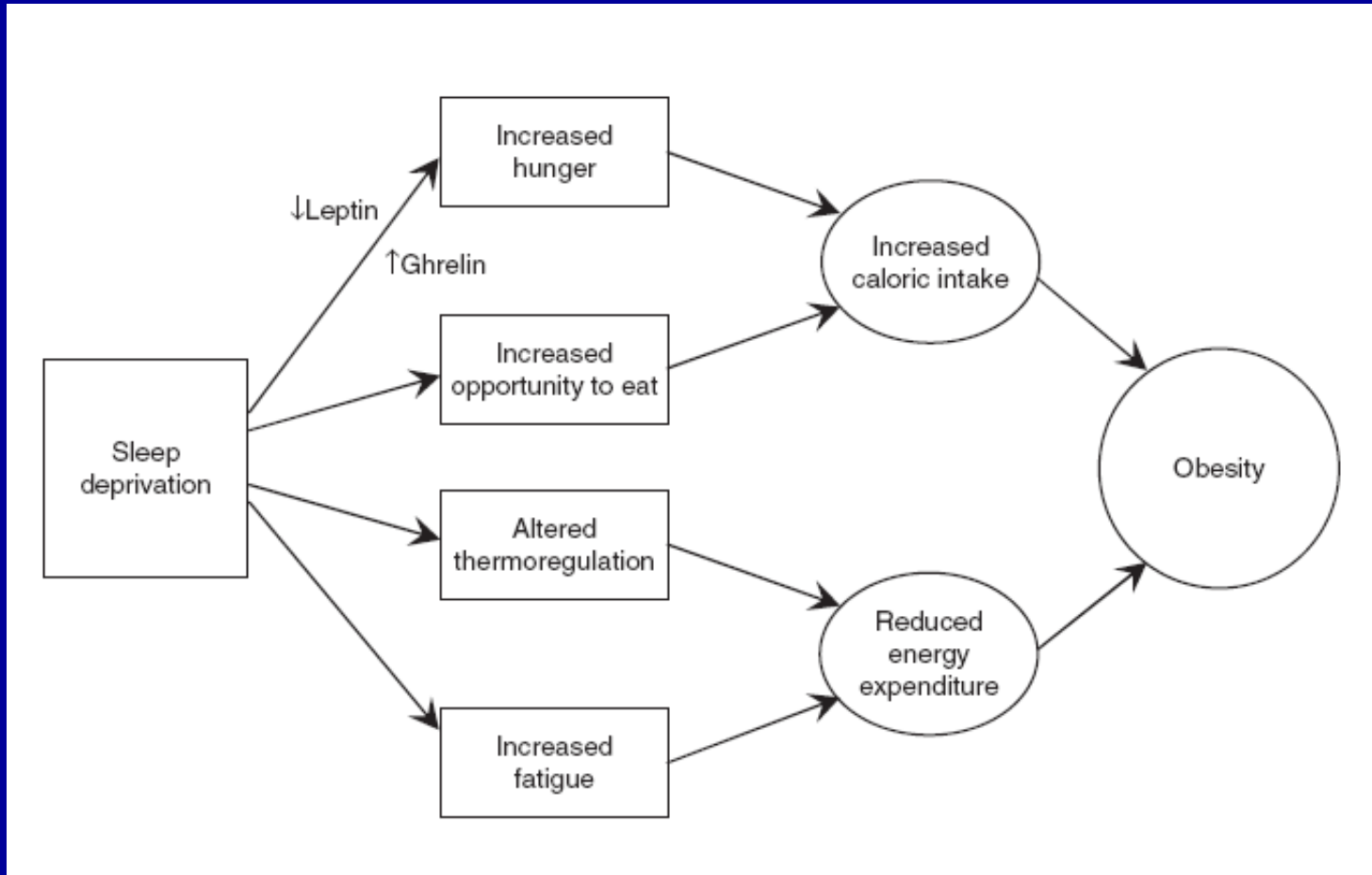
# Cross-sectional studies of sleep duration and weight in adults

	Sample size	Country	Age of participant	Nature of relationship with obesity
Coronary Artery Risk Development in Young Adults (CARDIA), Lauderdale 2006	669	USA	38-50	No association
Sleep Heart Health Study, Gottlieb 2005	1486	USA	70+8.3 SD	No association
Wisconsin Sleep Cohort, Taheri 2004	1024	USA	30-60	U shape (nadir 7-8h)
Cancer Prevention Study II-females, Kripke 2002	636095	USA	30-102	U shape
Males, Kripke 2002	480841	USA	30-102	No association
Japan Collaborative Cohort Study on cancer, Tamakoshi 2004	104010	Japan	40-79	No association
Hordaland Health Study, Bjorvatn, 2007	8860	Norway	40-45	U shape
Working Scottish Men and Women, Heslop 2002	6797	Scotland	18-65	Negative linear
NHANES I, 2005	3682	USA	32-49	Negative linear
Better Health for Better Hong Kong Study, Males, Ko 2007	2353	Hong Kong	17-83	Negative linear
Females, Ko 2007	2440	Hong Kong	17-83	No association
Study of Health in Pomernaria, Wolff 2007	2383	Germany	20-79	Slight irregular U shape
Massachusetts Male Aging, Yaggi 2006	1139	USA	40-70	No association
Quebec Family Study, Chaput 2007	740	Quebec	21-64	U shape
Zurich Psychiatric Risk Factor Cohort, Hasler 2004	367	Switzerland	40	No association





# Discussion



Complex mechanism by which sleep deprivation may predispose to obesity



# Discussion

- Limitation of the study:
  - Reliability and validity of technique to assess the sleep duration: retrospective recall, a single report, features of sleep
  - Measures of body weight, height, waist circumference, and body compositions
- Longitudinal study to establish the temporal sequence and causal relation between short or long sleep duration and later obesity or changes in body compositions.



# Ramathibodi Hospital Mahidol University



## Thank you

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