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What is sleepiness?

Association between subjective and objective sleepiness with cognitive function

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Anger Disgust Joy Fear Sadness

From a movie booklet of “INSIDE OUT”,
by Pixar Animation Studios and Walt Disney Pictures (2015)

From a movie booklet of “INSIDE OUT”,
by Pixar Animation Studios and Walt Disney Pictures (2015)

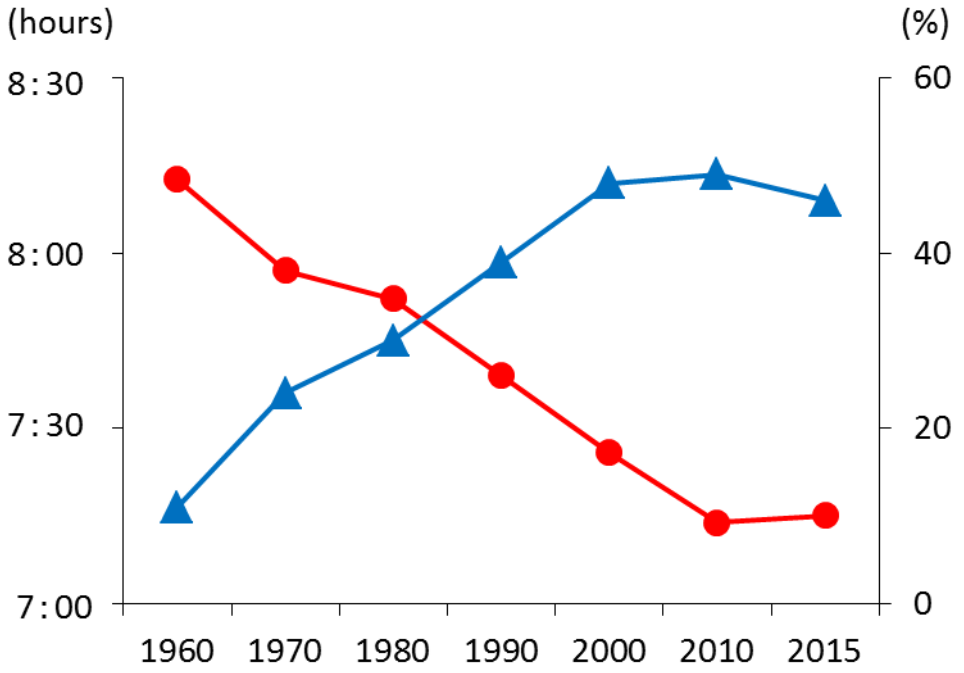
Sleep consolidates long-term memories

Sleep is an important aspect of one’s daily life, and about one-third of a person’s life is spent sleeping.

Changes of sleep habits among Japanese during past 60 years

Mean sleep duration on weekdays

Percentage those who stay awake after 11 PM



NHK survey (1960-2015)

Insufficient sleep is associated with modern lifestyle factors, and leads to sleepiness, cognitive dysfunction, adverse effects on performance at school and work.

Outline

1. Measurement of sleepiness
2. Insufficient sleep and daytime sleepiness
3. Sleepiness and accidents
4. Sleepiness among children and adolescents

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Various methods assessing daytime sleepiness

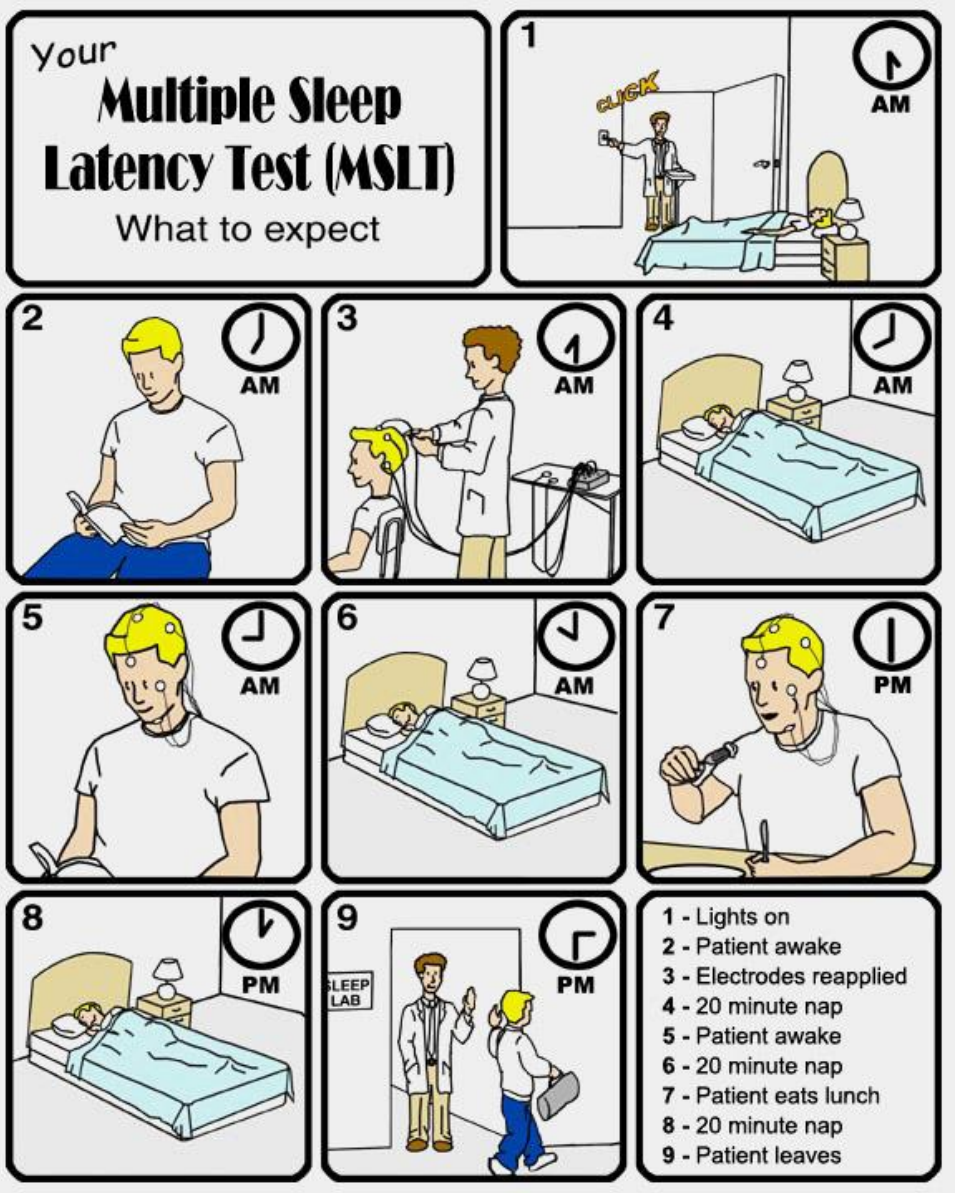
Objective measures

- The Multiple Sleep Latency Test (MSLT)
- Psychomotor Vigilance Task (PVT)
- Ocular variables

Subjective measures

- The Epworth Sleepiness Scale (ESS)
- Stanford Sleepiness Scale (SSS)
- Visual Analog Scale (VAS)

The Multiple Sleep Latency Test (MSLT)



Polysomnography (PSG) to assess nighttime sleep quality and quantity

The MSLT is a full-day test that consists of five scheduled naps (20 min) at 8, 10, 12, 14, 16

ORA® Oral Surgery, Sleep Disorder & Implant Studio

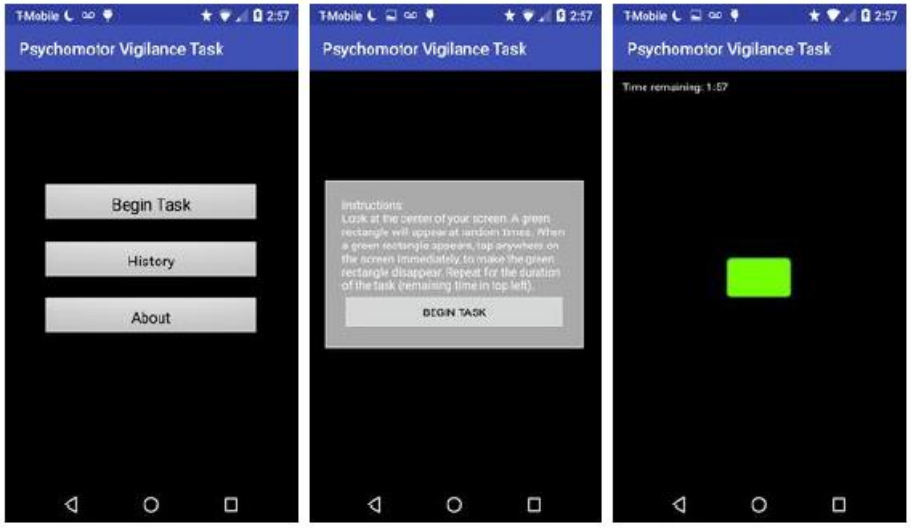
Psychomotor Vigilance Task (PVT)

sustained-attention, reaction-timed task

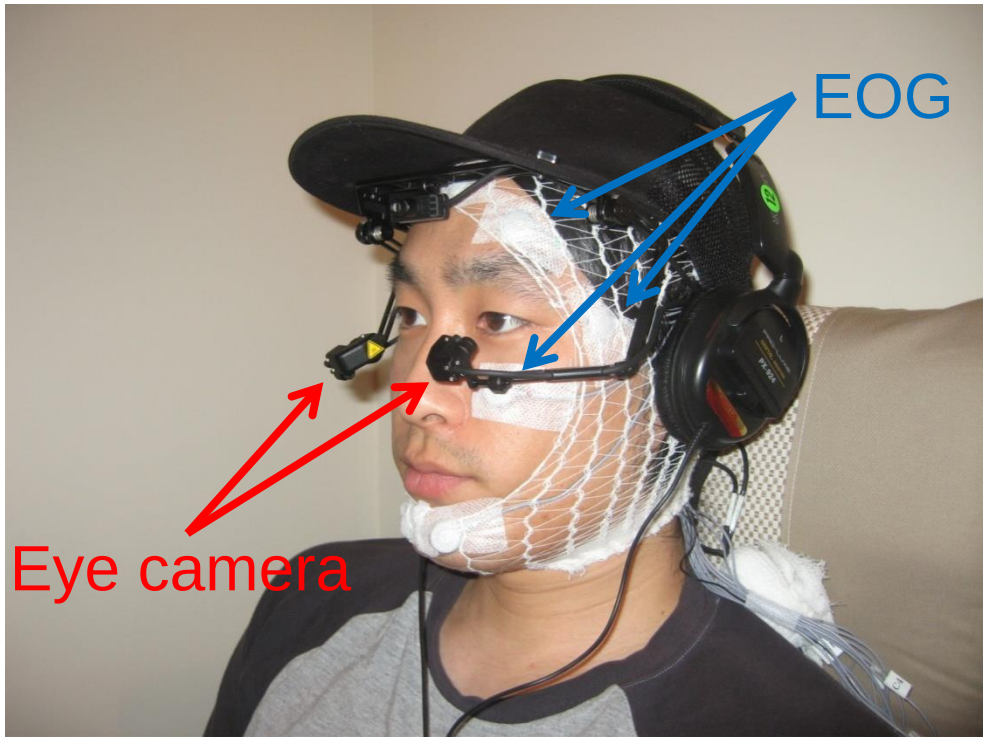
press a button as soon as the light appears (randomly every few seconds for 5–10 minutes).

To measure of sleepiness by counting the number of lapses

Smartphone application available



Ocular variables



A cap-type head sensor and an eye-tracking system
(EMR-9; NAC Image Technology Inc., Tokyo, Japan)

the detection capability of ocular variables for decreased vigilance or falling asleep

Decreased blink frequency and pupil diameter, increased percentage of eyelid closure time (PERCLOS),

Komada et al., *IATSS Research*, 2013

The Epworth Sleepiness Scale (ESS)

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently try to work out how they would have affected you. Use the following scale to choose the *most appropriate number* for each situation:

0 = would *never* doze
1 = *slight* chance of dozing
2 = *moderate* change of dozing
3 = *high* chance of dozing

Situation	Chance of dozing
Sitting and reading	_____
Watching TV	_____
Sitting, inactive in a public place (e.g. a theater or a meeting)	_____
As a passenger in a car for an hour without a break	_____
Lying down to rest in the afternoon when circumstances permit	_____
Sitting and talking to someone	_____
Sitting quietly after a lunch without alcohol	_____
In a car, while stopped for a few minutes in the traffic	_____

A list of 8 situation
Add up the values of your responses
Total score: 0-24

Interpretation:

- 0-7: no problem
- 8-9: average amount of daytime sleepiness.
- 10-15:You may be excessively sleepy depending on the situation. You may want to consider
- seeking medical attention.
- 16-24:You are excessively sleepy and should consider seeking medical attention

Johns et al., *Sleep* 1991

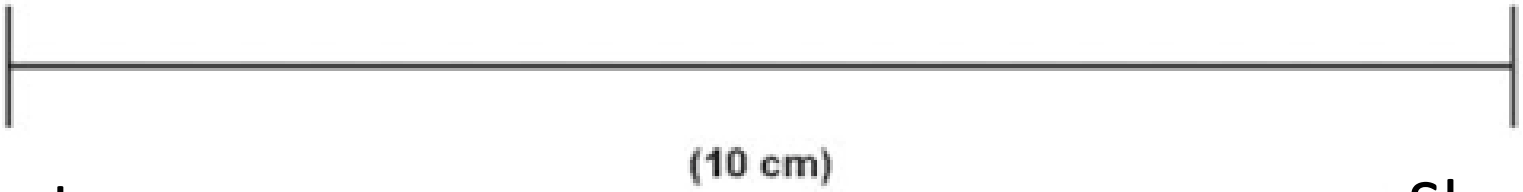
Stanford Sleepiness Scale (SSS)

Using the 7-point scale below pick what best represents how you are feeling and note the corresponding number on the chart below.

Degree of Sleepiness	Scale Rating
Feeling active, vital, alert, or wide awake	1
Functioning at high levels, but not fully alert	2
Awake, but relaxed; responsive but not fully alert	3
Somewhat foggy, let down	4
Foggy; losing interest in remaining awake; slowed down	5
Sleepy, woozy, fighting sleep; prefer to lie down	6
No longer fighting sleep, sleep onset soon; having dream-like thoughts	7
Asleep	X

Hoddes et al., *Psychophysiology* 1972; 1973

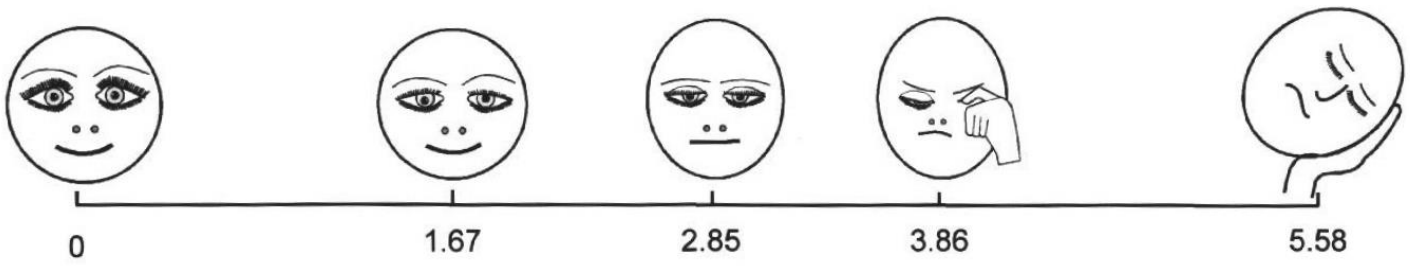
Visual Analog Scale (VAS)



Alert

Sleepy

A Pictorial Sleepiness Scale



Maldonado et al., *Sleep* 2004

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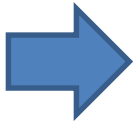
Chronic insufficient sleep or sleep loss is a common problem in modern industrial societies.

The current length of sleep time for the working population is about one hour shorter than it was 50 years ago, which leads to a substantially less rested feeling in the morning.



Insufficient Sleep Syndrome (ICSD 3rd)

What ?? Prevalence??

Diagnostic Criteria of Insufficient Sleep Syndrome

Criteria A-F must be met

A. The patient has daily periods of irrepressible need to sleep or daytime lapses into sleep or, in the case of prepubertal children, there is a complaint of behavioral abnormalities attributable to sleepiness.

B. The patient's sleep time, established by personal or collateral history, sleep logs, or actigraphy[1] is usually shorter than expected for age.[2]

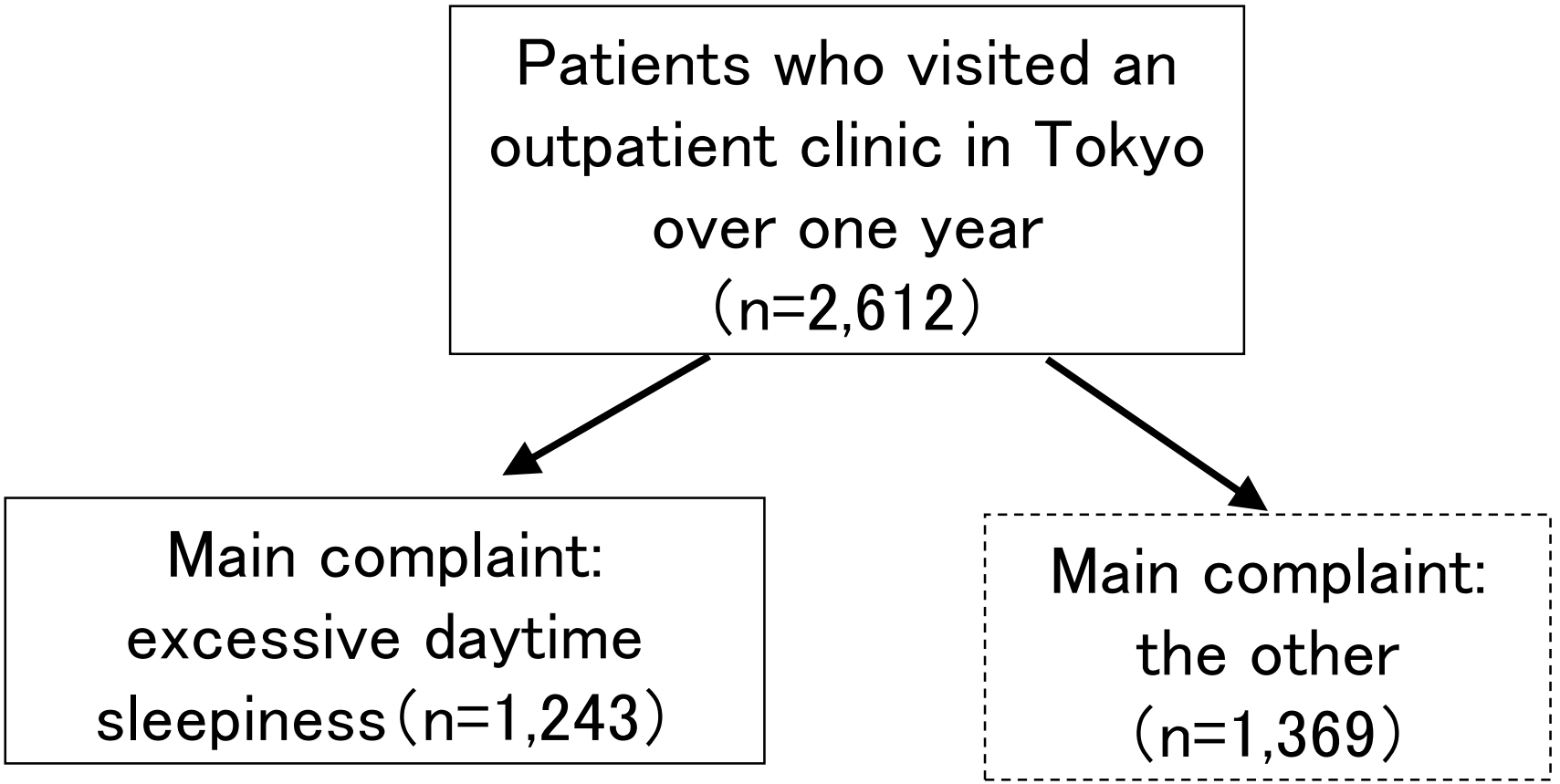
C. The curtailed sleep pattern is present most days for at least three months.

D. The patient curtails sleep time by such measures as an alarm clock or being awakened by another person and generally sleeps longer when such measures are not used, such as on weekends or vacations.

E. Extension of total sleep time results in resolution of the symptoms of sleepiness.

F. The symptoms are not better explained by another untreated sleep disorder, the effects of medications or drugs, or other medical, neurologic, or mental disorder.

International Classification of Sleep Disorders (Third edition)



male/female = 903/340

Average age = 37.6±14.0 y

Medical interview, PSG, MSLT, Sleep dairy

Diagnoses of the patients with excessive daytime sleepiness

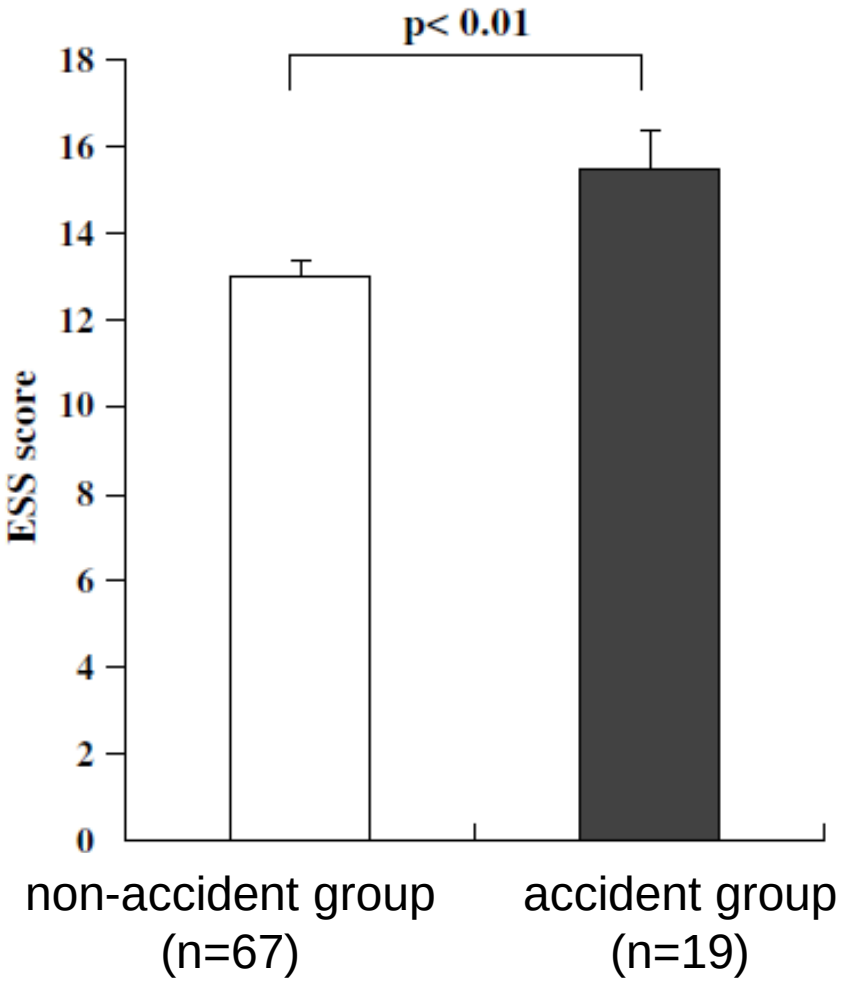
Diagnosis	*n*	%
Obstructive sleep apnea syndrome	431	34.7
Idiopathic hypersomnia	136	10.9
Narcolepsy	109	8.8
Behaviorally induced insufficient sleep syndrome	88	7.1
Circadian rhythm sleep disorders	76	6.1
Sleep disorders associated with mental disorders	54	4.3
Periodic limb movement disorder or restless legs syndrome	33	2.7
Insomnia	30	2.4
Parasomnias	14	1.1
Long sleeper	12	1.0
Recurrent hypersomnia	3	0.2
More than two diseases causative for daytime sleepiness	69	5.6
(of which ISS + other hypersomnia)	25	2.0
Undiagnosed	188	15.1

Characteristics of ISS patients (n=88)

- ✓ ESS score at first visit: 13.6 [3.4] points
- ✓ Patients who experienced traffic accidents or near miss in the past 5 years: 22%
- ✓ Sleep duration on weekday: 5.5 [0.8] hour
- ✓ Sleep duration on weekend: 7.9 [1.6] hour
- ✓ Difference between sleep duration between weekday and weekenda: 2.4 [1.6] hour

Komada et al., *Sleep Med*, 2008

The comparison of ESS scores between the accident group and the non-accident group.



Komada et al., *Sleep Med*, 2008

Comparison of the descriptive variables among the five groups with major hypersomnia disorder

	Age at first visit	Onset age	ESS score	Sleep duration
ISS	30.2	28.6	13.6	5.5
SAS	45.1	-	12.5	6.1
IHS	31.4	19.2	14.3	6.3
NA	31.0	17.2	15.7	6.4
CRSWD	27.7	18.9	12.4	7.8

Komada et al., *Sleep Med*, 2008

- ✓ A large number of patients were unaware that their sleep duration was insufficient.
- ✓ People with severe cases of sleep disorder are at high risk of accidents.

Komada et al., *Sleep Med*, 2008

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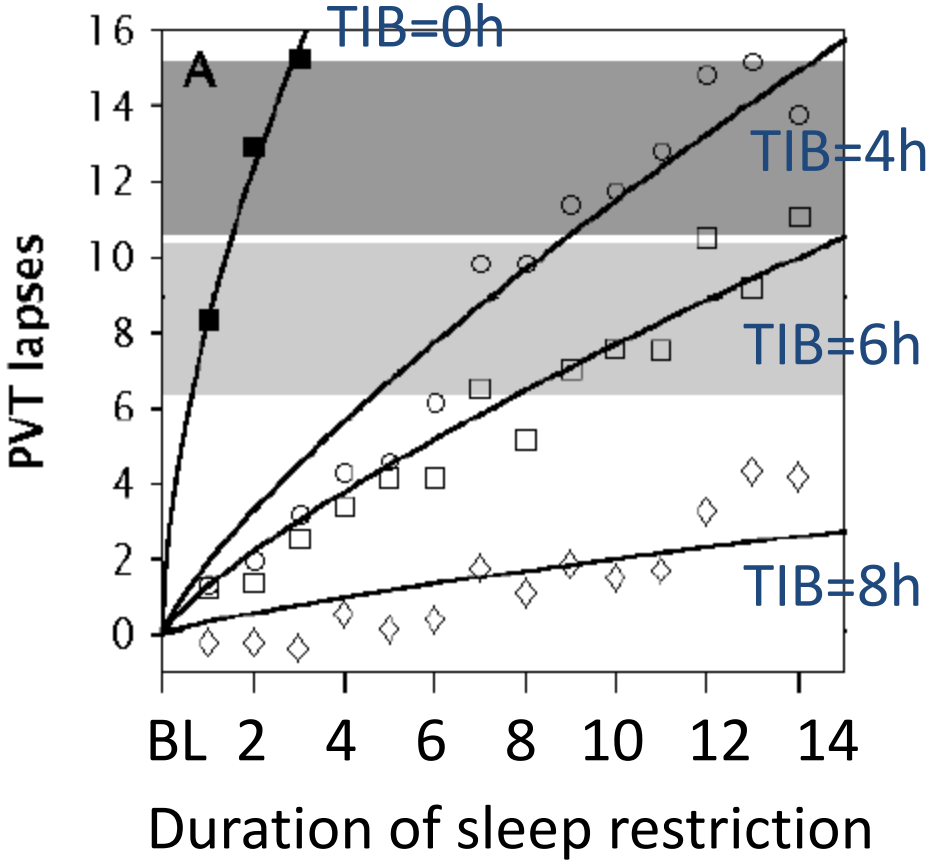
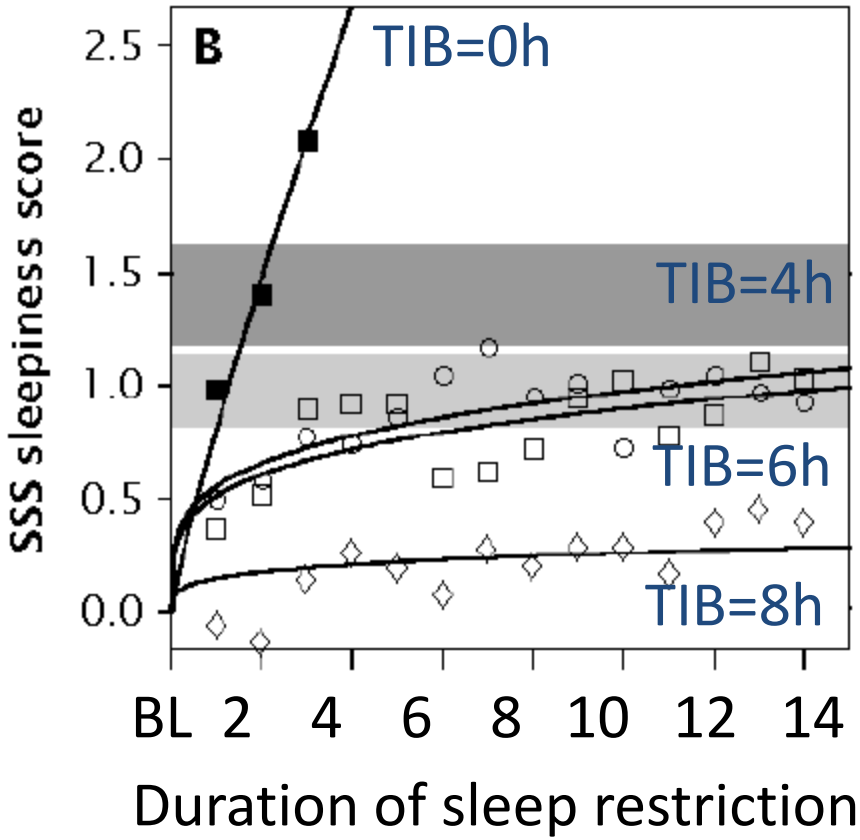
PVT lapses



ESS sleepiness score



Van Donge et al., *Sleep*, 2003

Control group
Age and sex matched
n=600

Male drivers with OSAS
(Obstructive Sleep Apnea)
n=616
46.3 [10.1] years

the rate of motor vehicle accidents
in the preceding 5 years

?

	Control group		OSAS group		
	Mean	SD	Mean	SD	*p value*
Age	45.5	[9.8]	46.3	[10.1]	*ns*
BMI	23.4	[2.9]	27.4	[4.7]	*<.0001*

Comparison of both motor vehicle accident (MVA) and doze off at the wheel between control group and OSAS group

	Control		OSAS				
	n	%	n	%	χ^2	*p value*	*Odds ratio (95%CI)*
MVA							
yes	28	4.7	75	12	22.1	*<.01*	2.36 (1.62-3.44)
no	572	95	541	88			
Doze off at the wheel							
yes	49	8.2	356	58	337.0	*<.01*	13.20 (10.01-17.41)
no	551	92	260	42			

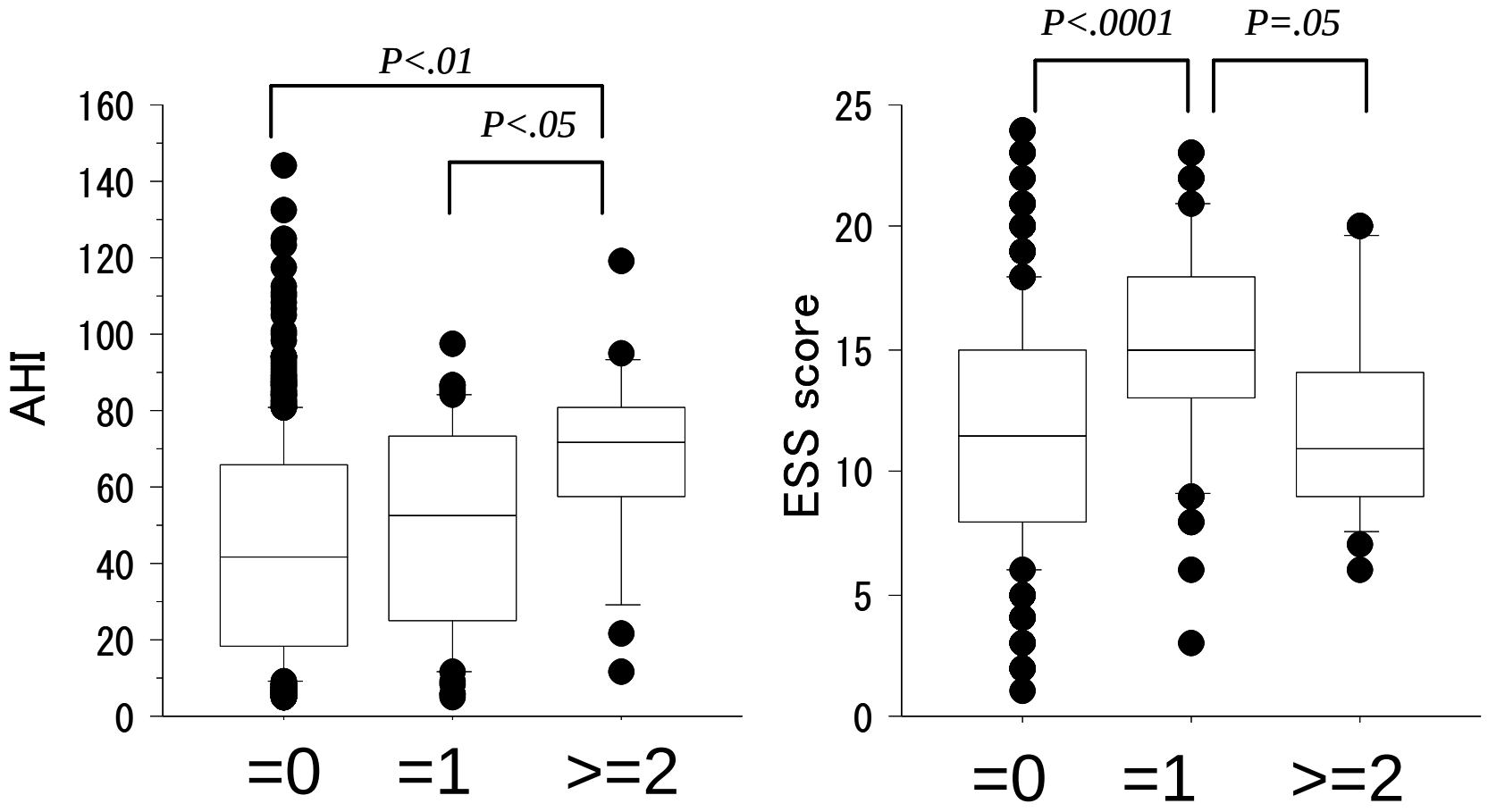
Komada et al., *Tohoku J Exp Med*, 2009

Associated factors of motor vehicle accident (MVA)

	All	MVA		Univariate Relative Risk (95% CI)[*1]		*P*	Multivariate Relative Risk (95% CI)		*P*
	n	n	%						
Age									
<47	305	39	12.8			*ns*			*ns*
≥47	311	36	11.6						
Sleep length									
<6.5hr	191	23	12.0			*ns*			*ns*
≥6.5hr	417	51	12.2						
ESS score									
<11	256	17	6.6						
≥11, <16	228	28	12.3	1.97	(1.05-3.70)	*<.05*	3.75	(2.54-5.54)	*<.0001*
≥16	132	30	22.7	4.14	(2.18-7.83)	*<.0001*	9.35	(5.31-16.46)	*<.0001*
AHI									
<15	123	9	7.3						
≥15, <30	119	11	9.2			*ns*			*ns*
≥30, <60	182	19	10.4			*ns*			*ns*
≥60	192	36	18.8	2.92	(1.35-6.31)	*<.01*	2.48	(1.46-4.19)	*<.001*

Komada et al., *Tohoku J Exp Med*, 2009

Number of car accidents within 5 years



Komada et al., *Tohoku J Exp Med*, 2009

- ✓ The accidents among sleep disorders patients was significantly higher than that among healthy controls.
- ✓ Subjective excessive daytime sleepiness and severity of obstructive sleep apnea syndrome are independently associated with the occurrence of accidents.
- ✓ Self-reported measures tend to underestimate the severity of sleepiness

Komada et al., *Tohoku J Exp Med*, 2009

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TABLE 1. *The Epworth sleepiness scale*

THE EPWORTH SLEEPINESS SCALE

Name: _____

Today's date: _____ Your age (years): _____

Your sex (male = M; female = F): _____

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently try to work out how they would have affected you. Use the following scale to choose the *most appropriate number* for each situation:

0 = would *never* doze
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Situation	Chance of dozing
Sitting and reading	_____
Watching TV	_____
Sitting, inactive in a public place (e.g. a theater or a meeting)	_____
As a passenger in a car for an hour without a break	_____
Lying down to rest in the afternoon when circumstances permit	_____
Sitting and talking to someone	_____
Sitting quietly after a lunch without alcohol	_____
In a car, while stopped for a few minutes in the traffic	_____

Thank you for your cooperation

Johns et al., Sleep 1991

the Pediatric Daytime Sleepiness Scale (PDSS)

Pediatric Daytime Sleepiness Scale (PDSS)

Please answer the following questions as honestly as you can by circling one answer only:

1. How often do you fall asleep or get drowsy during class periods?
Always Frequently Sometimes Seldom Never

2. How often do you get sleepy or drowsy while doing your homework?
Always Frequently Sometimes Seldom Never

*3. Are you usually alert most of the day?
Always Frequently Sometimes Seldom Never

4. How often are you ever tired and grumpy during the day?
Always Frequently Sometimes Seldom Never

5. How often do you have trouble getting out of bed in the morning?
Always Frequently Sometimes Seldom Never

6. How often do you fall back to sleep after being awakened in the morning?
Very often Often Sometimes Seldom Never

7. How often do you need someone to awaken you in the morning?
Always Frequently Sometimes Seldom Never

8. How often do you think that you need more sleep?
Very often Often Sometimes Seldom Never

Scoring	4	3	2	1	0

***Reverse score this item**

Drake et al., *Sleep* 2003

the Pediatric Daytime Sleepiness Scale (PDSS)

Russian version

Детская Шкала Дневной Сонливости (PDSS)

Баллы: 4 = Всегда 3 = Часто 2 = Иногда 1 = Редко 0 = Никогда

Ответьте на следующие вопросы как можно точнее, выбрав только один ответ:

1. **Как часто вы засыпаете или чувствуете сонливость во время занятий?**
   Всегда Часто Иногда Редко Никогда
2. **Как часто вы засыпаете или чувствуете сонливость, выполняя домашнее задание?**
   Всегда Часто Иногда Редко Никогда
3. *** Чувствуете ли Вы себя обычно бодрым большую часть дня?**
   Всегда Часто Иногда Редко Никогда
4. **Как часто Вы чувствуете себя уставшим и раздражительным в течение дня?**
   Всегда Часто Иногда Редко Никогда
5. **Как часто Вы испытываете трудности пробуждения по утрам?**
   Всегда Часто Иногда Редко Никогда
6. **Как часто Вы снова засыпаете после того как проснетесь утром?**
   Всегда Часто Иногда Редко Никогда
7. **Как часто Вам нужна посторонняя помощь чтобы проснуться утром?**
   Всегда Часто Иногда Редко Никогда
8. **Как часто вы думаете что Вам не хватает сна?**
   Всегда Часто Иногда Редко Никогда

Randler et al., *Heliyon* 2019

Japanese version

子どもの日中眠気尺度 (PDSS 日本語版)

下に書いてある質問の答えを1つだけ選んで、○をつけてください。
できるだけ正直に答えてください:

1. 授業中、眠くなったり、寝てしまうことは、ありますか？
   (4) いつもある (3) よくある (2) ときどきある (1) あまりない (0) ぜんぜんない
2. 宿題をしているとき、眠くなったり、うとうとすることは、ありますか？
   (4) いつもある (3) よくある (2) ときどきある (1) あまりない (0) ぜんぜんない
3. 一日のうちほとんどの時間、しっかり目覚めていますか？
   (0) いつも、しっかり目覚めている
   (1) ほとんどいつも、しっかり目覚めている
   (2) ときどき、しっかり目覚めている
   (3) しっかり目覚めていることは、あまりない
   (4) しっかり目覚めていることは、ぜんぜんない
4. 昼間、疲れたり、イライラしたりすることは、ありますか？
   (4) いつもある (3) よくある (2) ときどきある (1) あまりない (0) ぜんぜんない
5. 朝、ふとん(ベッド)からなかなか出られないことは、ありますか？
   (4) いつもある (3) よくある (2) ときどきある (1) あまりない (0) ぜんぜんない
6. 朝、いちど目が覚めてから、また寝てしまうことは、ありますか？
   (4) とてもよくある (3) よくある (2) ときどきある (1) あまりない (0) ぜんぜんな
7. 朝、誰かに起こしてもらわないと起きられないことは、ありますか？
   (4) いつもある (3) よくある (2) ときどきある (1) あまりない (0) ぜんぜんない
8. 寝足りないと思うことは、ありますか？
   (4) とてもよくある (3) よくある (2) ときどきある (1) あまりない (0) ぜんぜんな

Komada et al., *Chronobiol Int* 2016

Questionnaire survey for children

- ✓ 493 students aged 11- to 16- year-old;
  73 elementary school children,
  102 junior high school students,
  318 high school students
  (46.2% boys)

- ✓ The teachers distributed the questionnaires to students. Each student completed them during school hours. The teachers collected them (response rate=99.4%).

Analysis

- Mid-sleep on school days

= Wakeup time – Bedtime on school days

- Mid-sleep on free days

= Wakeup time – Bedtime on free days

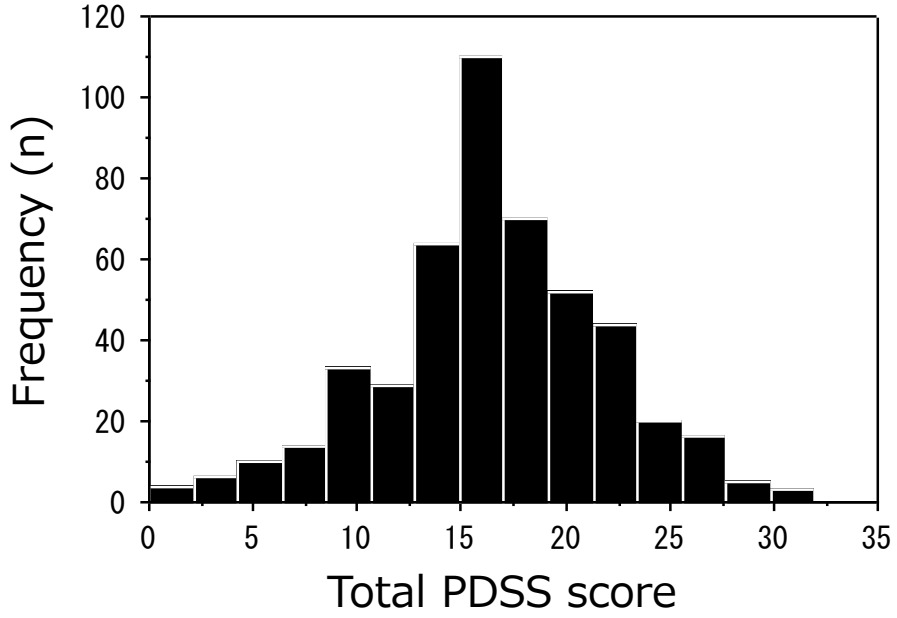
- Social jetlag (SJL)

= Mid-sleep on free days – Mid-sleep on school days

- Excessive daytime sleepiness

= PDSS score >=17

Frequency distribution of PDSS score



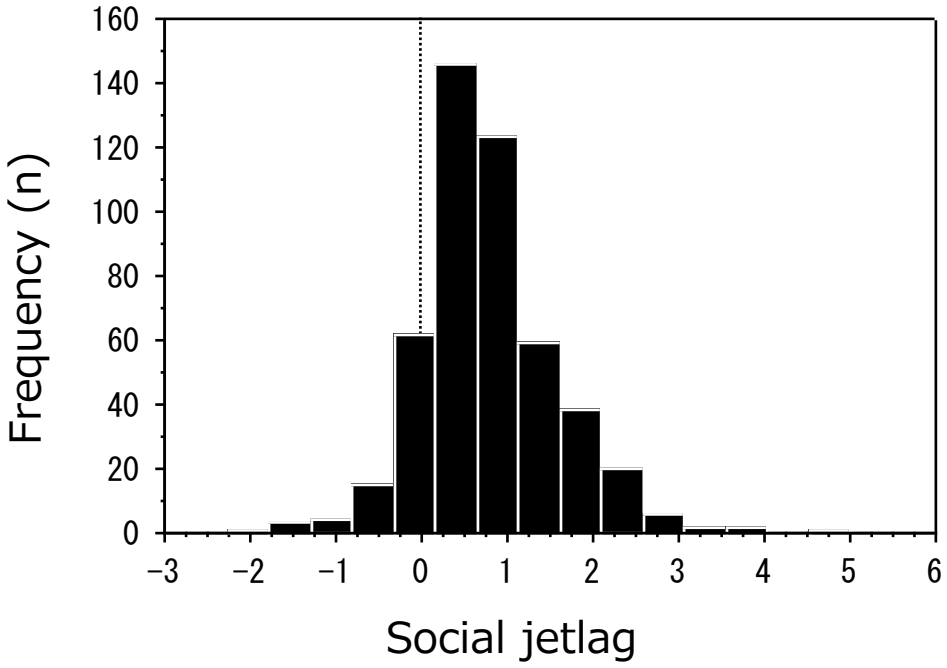
- ✓ Mean value [SD] of PDSS
  16.6 [5.4] point

  15.3 [6.2] (Drake et al. *Sleep* 2003) USA
  15.7 [5.9] (Perez-Chada et al., *Sleep* 2007) Argentina
  16.6 [5.7] (Rhie et al., *Korean J Pediatr* 2011) Korea

- ✓ Chronbach's α=0.772

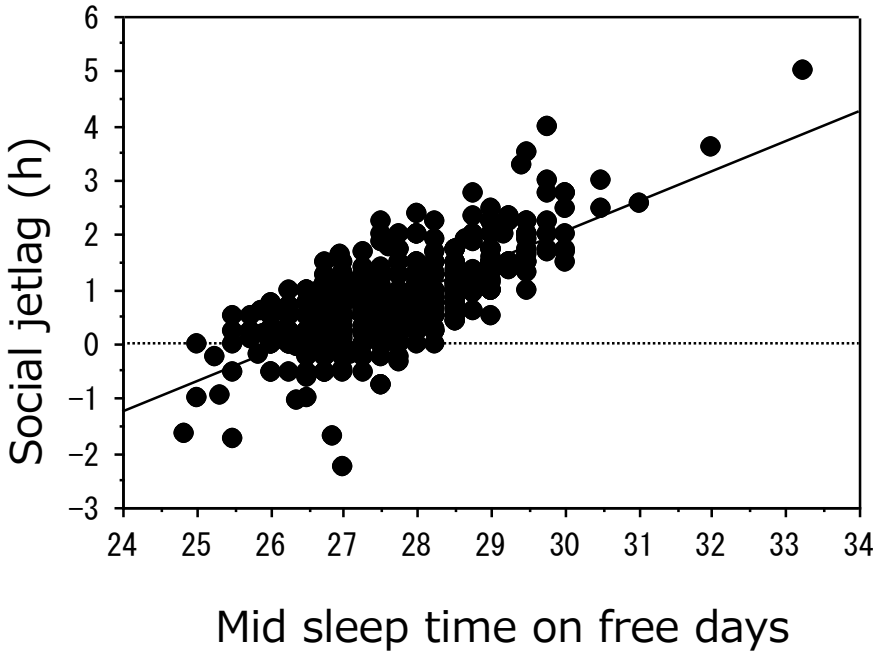
Komada et al., *Chronobiol Int* 2016

Frequency distribution of social jetlag



✓ Mean value [SD] of social jetlag
48.0 [49.2] min, range: -2.3h – 5.0 h

The relationship between mid sleep time and social jetlag

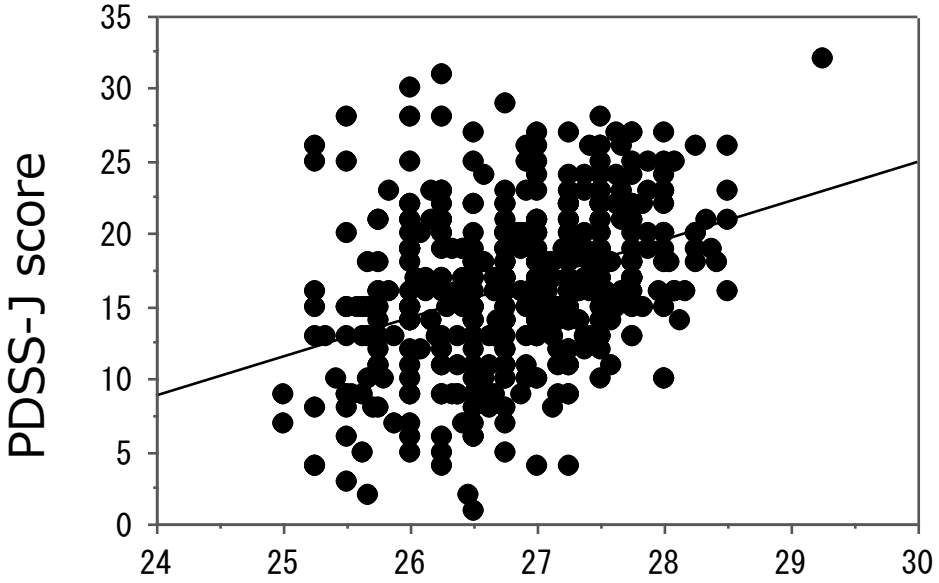


(r=0.72, p<0.001)

Later chronotype show larger social jetlag

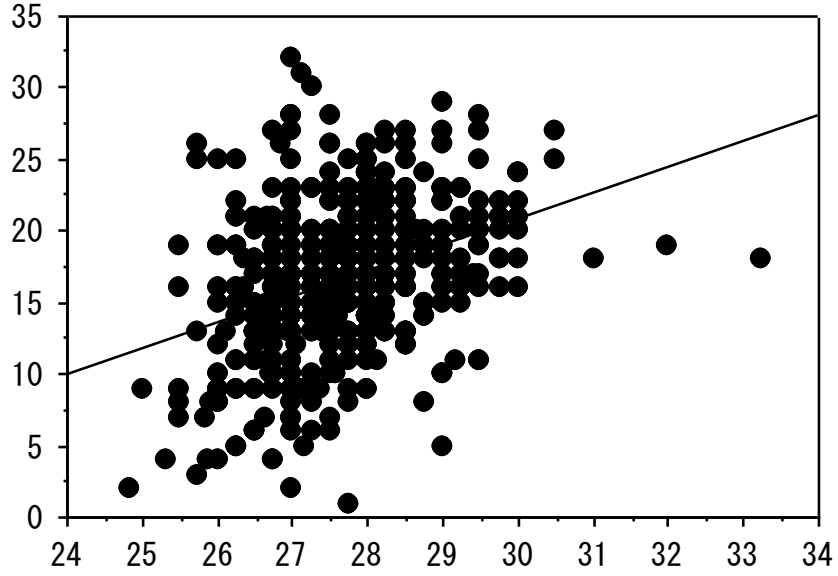
Komada et al., *Chronobiol Int* 2016

Relationships between mid-sleep time and PDSS score



Mid-sleep time on school days

(r=0.37, p<0.01)



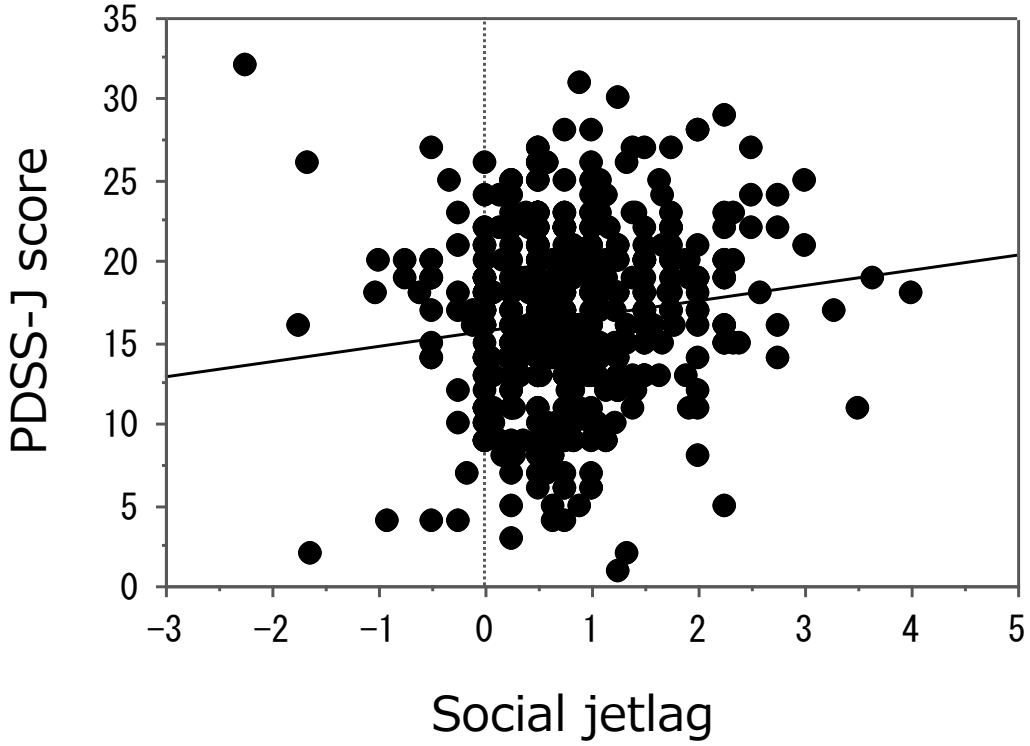
Mid-sleep time on free days

(r=0.36, p<0.01)

Individuals with later chronotype showed stronger daytime sleepiness

Komada et al., *Chronobiol Int* 2016

Relationships between social jetlag and PDSS score



SJL: r=0.14, p<0.01
Absolute SJL: r=0.29, p<0.01

Daytime sleepiness was correlated with social jetlag

Komada et al., *Chronobiol Int* 2016

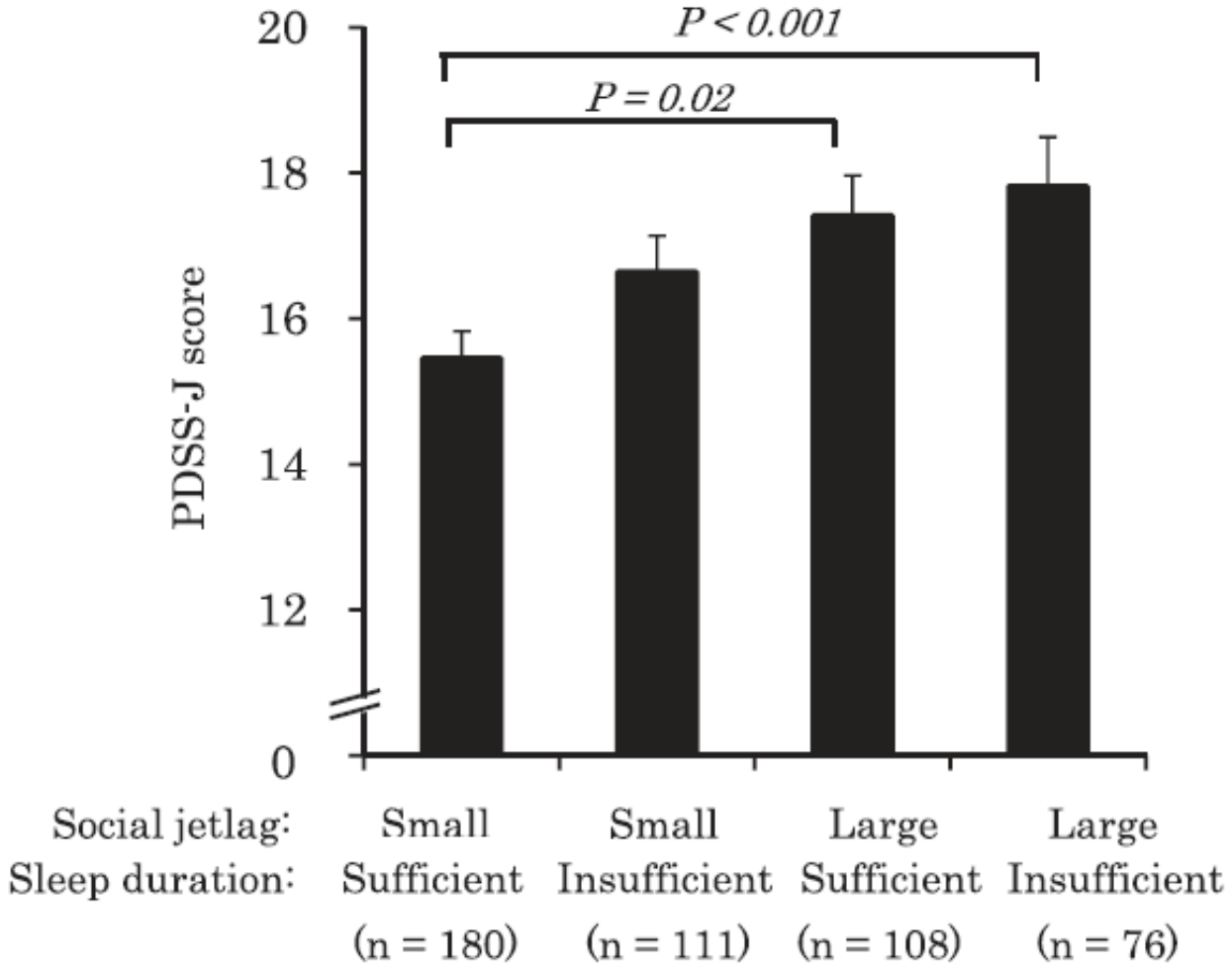
Associated factors of excessive daytime sleepiness

	Univariate			Multivariate		
	Exp(B)	95% CI	*p*	Exp(B)	95% CI	*p*
Age	1.30	1.12–1.50	*0.001*	1.13	0.95–1.35	*ns*
Sex (female)	0.70	0.47–1.06	*ns*	0.85	0.55–1.30	*ns*
Sleep duration on schooldays	1.81	1.52–2.16	*0.001*	0.73	0.59–0.90	*0.004*
Midpoint of sleep on schooldays	1.85	1.38–2.48	*0.001*	1.23	0.86–1.76	*ns*
Social jetlag (absolute SJL)	1.39	1.06–1.83	*0.017*	1.40	1.05–1.86	*0.02*

Both Short sleep duration and social jetlag were independently associated with excessive daytime sleepiness

Komada et al., *Chronobiol Int* 2016

Comparison of PDSS-J score among the four groups categorized by social jetlag and sleep duration



Komada et al., *Chronobiol Int* 2016

Conclusion

- ✓ Insufficient sleep syndrome and sleep apnea syndrome seriously impair waking neurobehavioral function and cause traffic accidents in healthy adults.

- ✓ Participants were largely unaware of increasing cognitive deficits, which may explain why the impact of chronic sleep impairment on cognitive functions is often assumed to be benign.

Thank you for your attention!