

# SLEEP SCIENCE: SLEEP, SLEEPINESS, AND SLEEPLESSNESS

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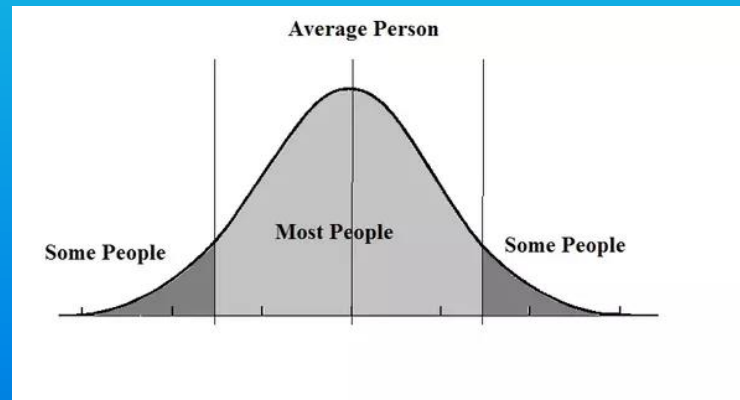


**questions?  
comments?**

## individual differences

Biological characteristics are normally distributed.

The average American male is 5'10" tall.  
Someone 5'8" does not have a height disease.



**SLEEP IS A BIOLOGICAL CHARACTERISTIC**

# Course Outline

1 & 2. sleep: normal sleep overview

3 & 4. sleepiness: why do we get sleepy

5 & 6. sleeplessness: sleep disorders

bias: behavioral sleep medicine



# Sleep

you are busy when you are asleep





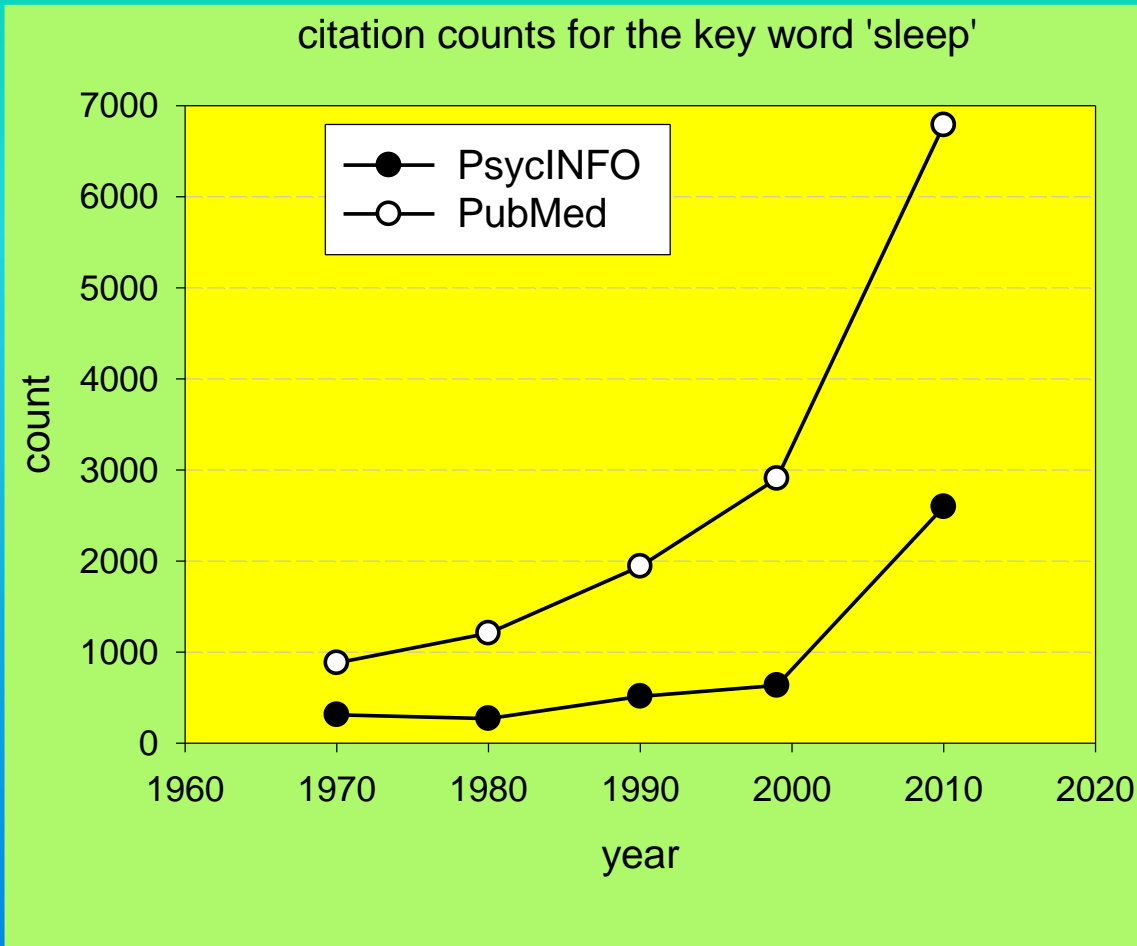
# **sleep research: an overview**

### Key Events in The History of (Behavioral) Sleep Medicine

1. Circa 1900, Freud's interpretation of dreams
2. circa 1930, electrical measurement of the brain, EEG
3. circa 1950, sleep research with animals
4. 1953, discovery of REM
5. 1957, modern description of 5 sleep stages
6. Beginnings of clinical applications of sleep research
  - a. circa 1960, benzodiazepines introduced for anxiety and sleep
  - b. 1964, Stanford University Narcolepsy clinic
  - c. 1965, discovery of sleep apnea
7. 1966 beginning of CBTi
8. 1977, first accredited sleep disorders center
9. 1978, first sleep journal, Sleep
10. 1981, introduction of CPAP
11. 1990, International Classification of Sleep Disorders
12. 2003, psychological sleep journal, Behavioral Sleep Medicine
13. 2010, Society of Behavioral Sleep Medicine

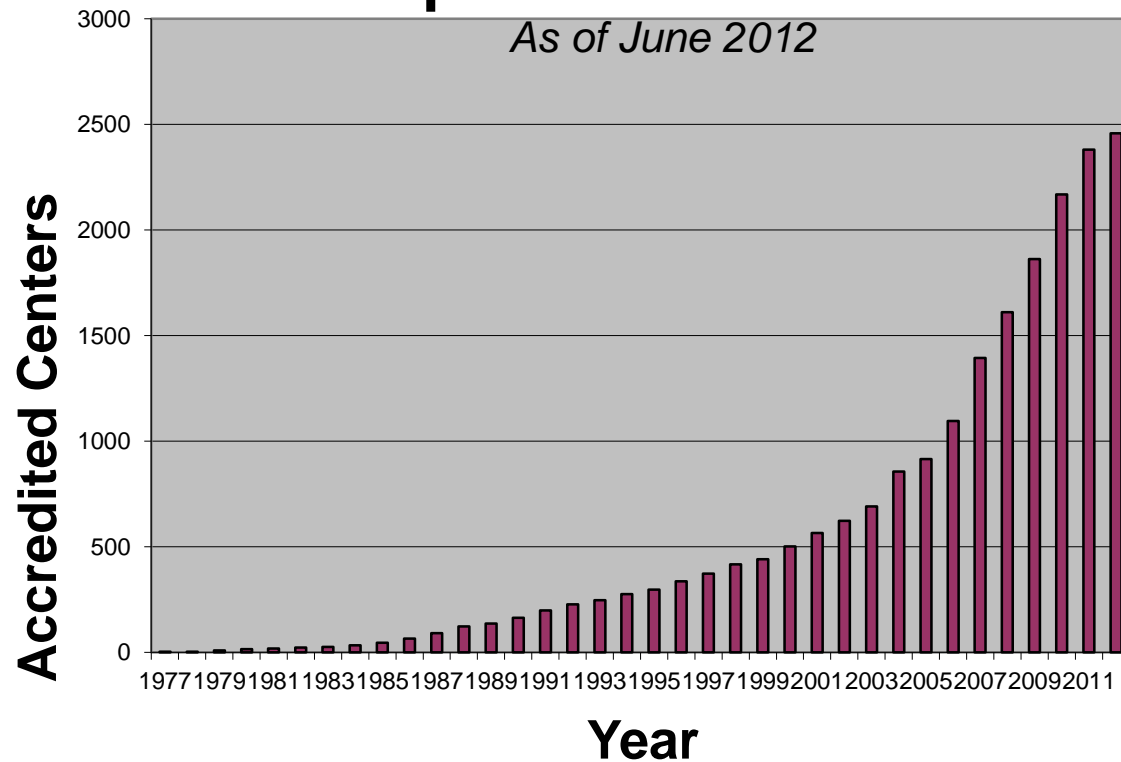


## types of sleep research



- animal
- genetics
- measurement
- epidemiology
- characteristics of normal sleep
- characteristics of sleep disorders
- treatment of sleep disorders
- sleep affects on functioning
- children vs adults vs elderly
- men vs women
- sleep in different races

# Growth of AASM-Accredited Sleep Disorders Centers



Source: American Academy of

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sleepeducation.org/find-a-facility | accredited sleep centers in tennessee

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SLEEP PRODUCT GUIDE


ESSENTIALS IN SLEEP

- Insomnia
- Sleep Apnea
- Jet Lag
- Narcolepsy
- Restless Legs Syndrome
- Shift Work
- Snoring
- In-Lab Sleep Study
- Home Sleep Apnea Testing
- CPAP
- Healthy Sleep Habits

SLEEP DISORDERS BY CATEGORY

- Insomnias
- Hypersomnias
- Sleep Breathing Disorders

Map Satellite



We were able to locate 42 sleep centers in your area.

Sleep Disorders Center at Lincoln Medical Center  
Lincoln Medical Center  
106 Medical Center Boulevard  
Fayetteville, TN 37334  
25.39 miles  
View Map  
Get Directions

Type here to search

Desktop 7:21 AM 5/7/2019

12 Accredited Sleep Disorders Centers within 25 miles of Nashville

**Nashville:**

- 👉 Center for Sleep at Midtown STHS
- 👉 Sleep Disorders Center at Centennial Medical Center
- 👉 Vanderbilt Sleep Disorders Center
- 👉 TriStar Skyline Sleep Disorders Center

**Hermitage:**

Summit Center for Sleep Health

**Hendersonville:**

Tennessee Comprehensive Lung and Sleep Center  
Serenity Sleep Lab

**Franklin:**

- 👉 Vanderbilt Sleep Disorders Center – Franklin
- 👉 Sleep Center at Williamson Medical Center

**Mt. Juliet:**

- 👉 Center for Sleep @ Hermitage STHS

**Smyrna:**

- 👉 TriStar StoneCrest Center for Sleep Medicine

**Gallatin:**

Sumner Highpoint Health Systems

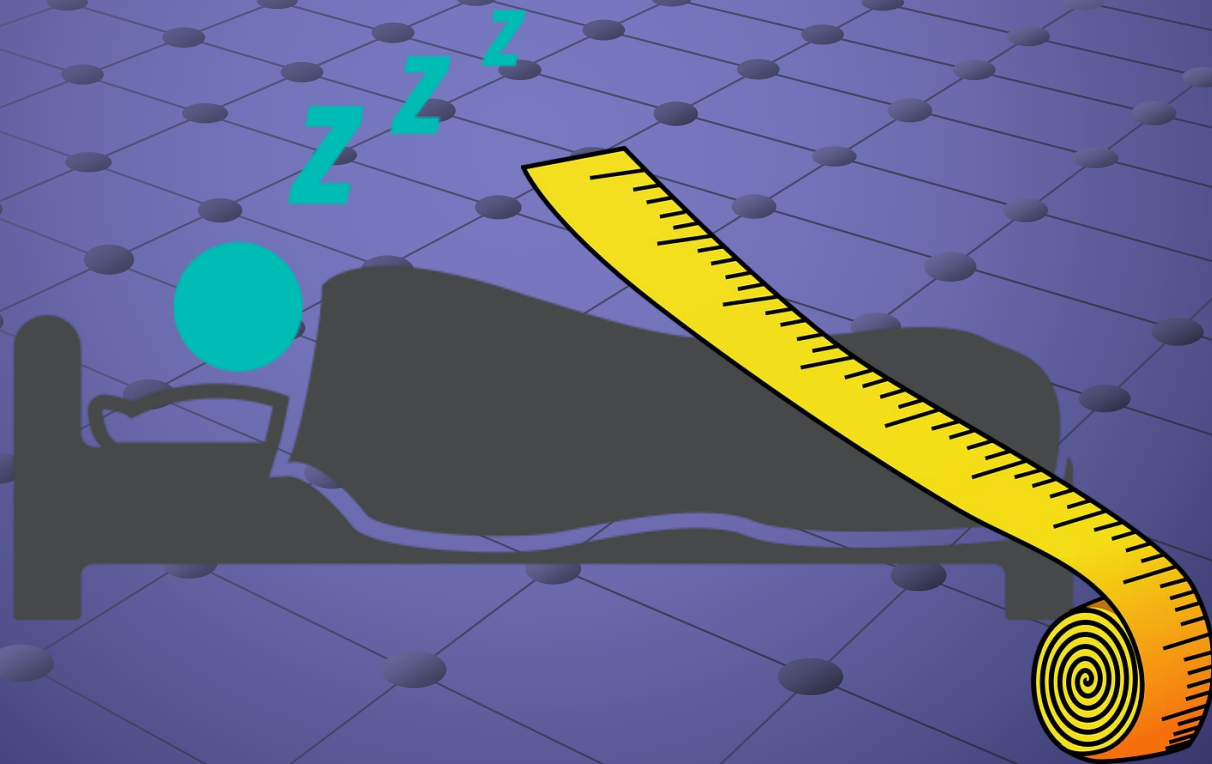
# sleep societies

- ❧ American Academy of Sleep Medicine
- ❧ Sleep Research Society
- ❧ Society of Behavioral Sleep Medicine
- ❧ Many others
  - dentists
  - sleep techs
  - states
  - countries

## 7 sleep journals

year started	Journal
1978	Sleep
1992	Journal of Sleep Research
1997	Sleep Medicine Reviews
2000	Sleep Medicine
2003	Behavioral Sleep Medicine
2005	Journal of Clinical Sleep Medicine
2015	Sleep Health

# sleep measurement





# sleep terms

## ☞ sleep stages

- ☐ N1, nonREM stage 1
- ☐ N2, nonREM stage 2
- ☐ N3, nonREM stage 3
- ☐ REM, rapid eye movement

## ☞ sleep parameters

- ☐ SOL, sleep onset latency
- ☐ WASO, wake time after sleep onset
- ☐ NWAK, number of awakenings
- ☐ TWAK, terminal wake time
- ☐ TST, total sleep time
- ☐ TIB, time in bed
- ☐ SE, sleep efficiency percent

# Assessment Methods

## ⌘ polysomnography (PSG)

- ☐ all night

- ☐ MSLT

- ☐ MWT

## ⌘ actigraphy

## ⌘ sleep diary

PSG: all night

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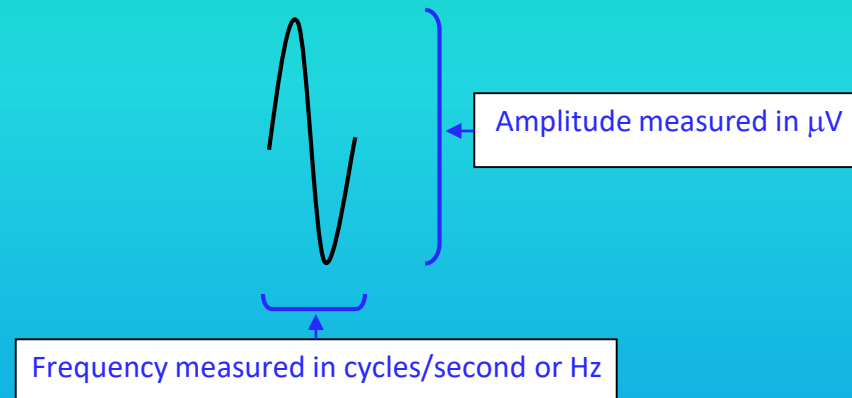










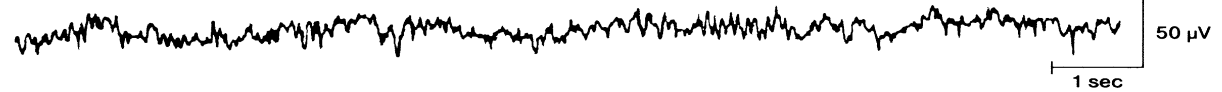


This is a single EEG wave, sometimes called a cycle. A cycle begins at the midline, departs upward then downward, and then returns to the midline to complete one cycle.

Cycles are characterized by their frequency or how many occur within a second, also called Hz. High frequency waves appear narrow and low frequency waves wide. A second characteristic is the height of the wave from peak to trough termed amplitude.

**Awake**

**Awake:** low voltage – random, fast



**Drowsy**

**Drowsy:** 8 to 12 cps – alpha waves



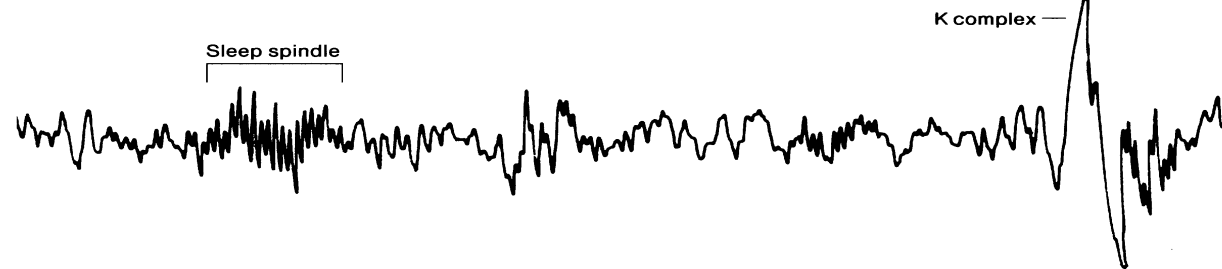
**Stage 1**

**Stage 1:** 3 to 7 cps – theta waves



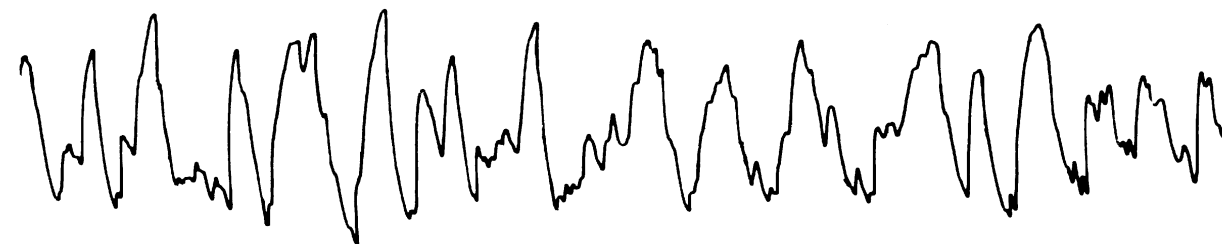
**Stage 2**

**Stage 2:** 12 to 14 cps – sleep spindles and K complexes



**Stage  
3 & 4**

**Delta sleep:** (stages 3 and 4)  $\frac{1}{2}$  to 2 cps – delta waves  $>75 \mu$ V

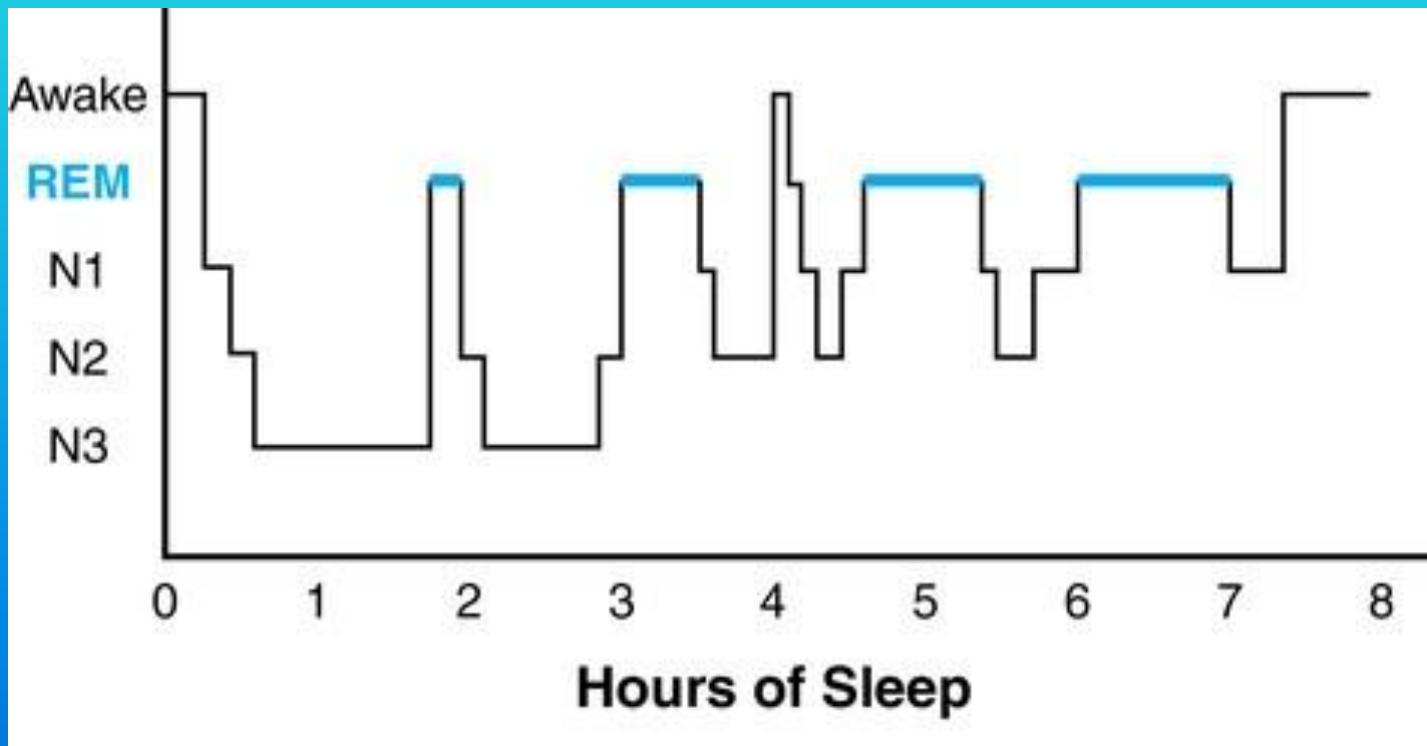


**Stage  
REM**

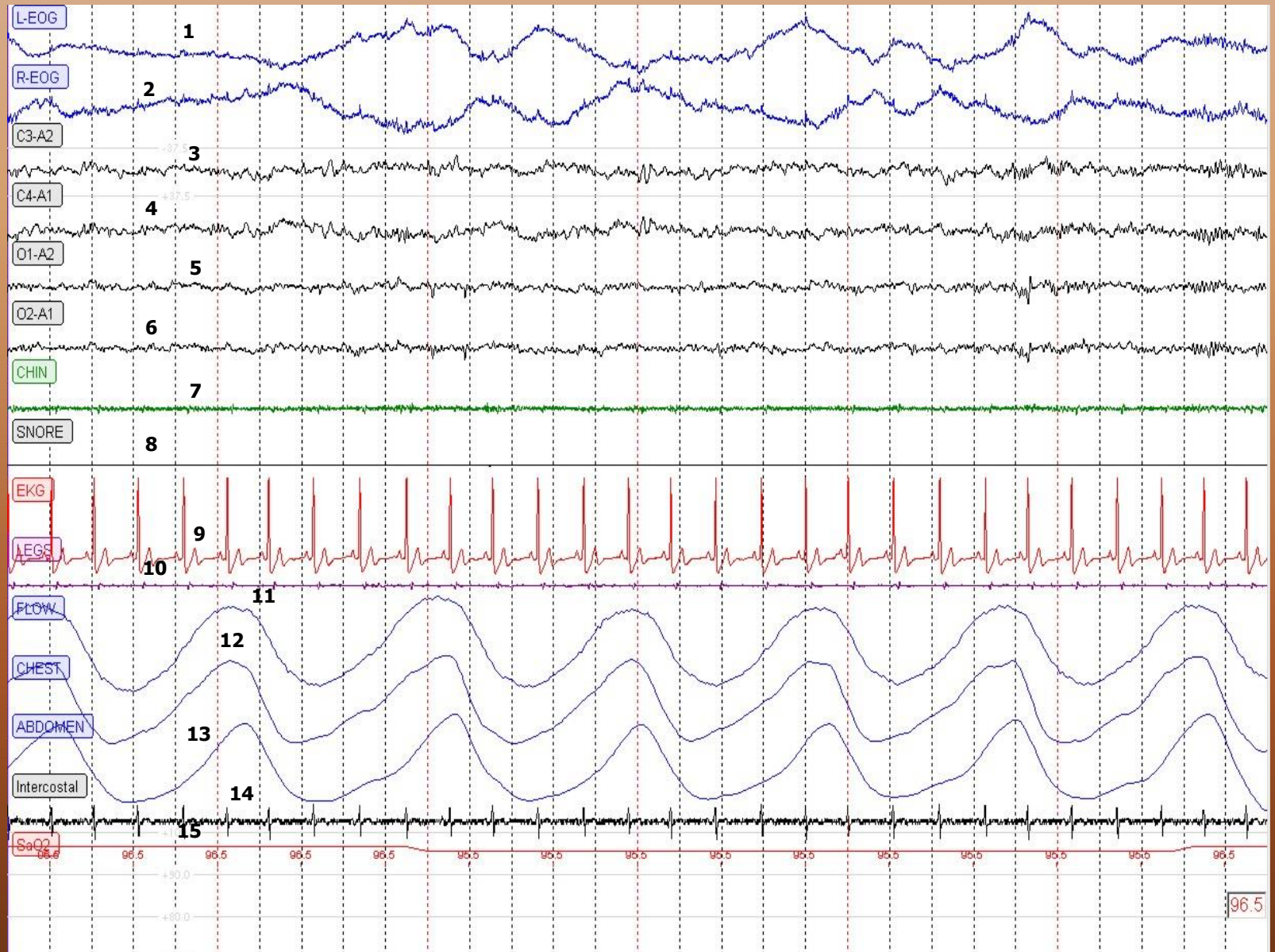
**REM sleep:** low voltage – random, fast with sawtooth waves



## hypnogram: normal middle-aged adult



# N1



# PSG: MSLT

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## multiple sleep latency test: go to sleep

- ❧ 4-6 nap opportunities
- ❧ reclined in street clothes
- ❧ commence 2 hours after morning awakening
- ❧ repeat at 2 hour intervals
- ❧ 20 min limit if no sleep
  - 15 min of sleep monitoring after sleep onset
  - REM?
  - SOL > 10 min: normal
  - SOL < 8 min: EDS



# PSG: MWT



## **maintenance of wakefulness test: stay awake**

- ❧ 4 nap opportunities
- ❧ comfortably seated in street clothes
- ❧ commence 2 hours after morning awakening
- ❧ repeat at 2 hour intervals
- ❧ 40 min if no sleep
  - terminated with sleep onset
  - SOL > 30 min: normal
  - SOL < 8 min: EDS

actigraphy

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# what is actigraphy

## ⌘ motion sensor

- piezoelectric accelerometer
  - converts movement to electricity
- wrist movement is proxy for sleep/wake
- objective assessment
- long-term monitoring
- does not restrict activity

## ⌘ features

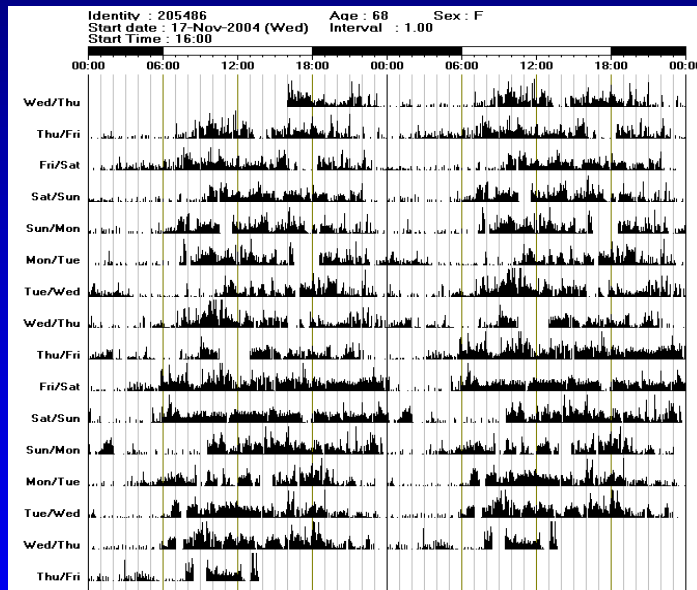
- small, light "wristwatch"
- light sensor
- event marker
- alarm
- collect self-report data

## ⌘ incompetent, uncooperative, unreliable subject

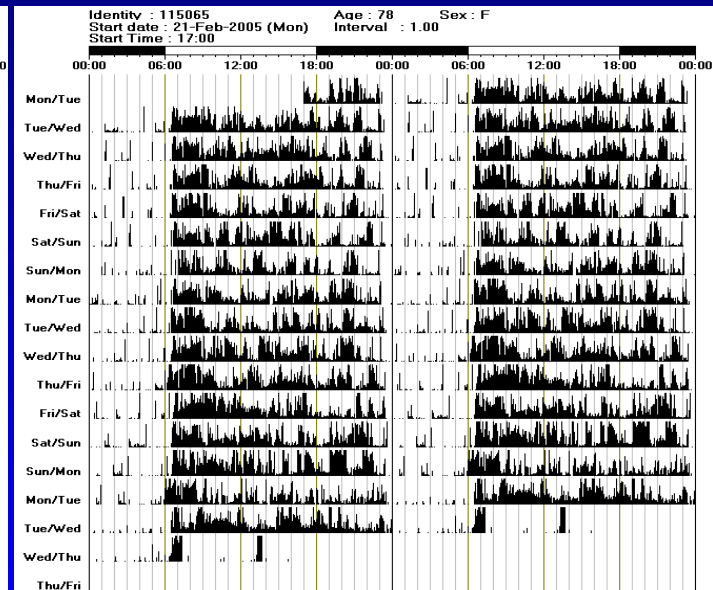
- nursing home
- intensive care unit
- infants
- teens
- suspect insomnia reports

# Actigraphy in insomnia patient and healthy control subject

**Insomnia patient (68 yr. F)**

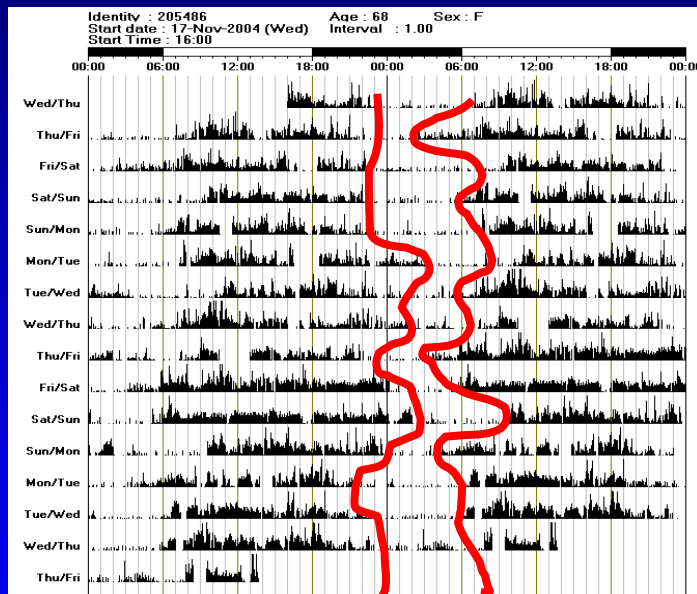


**Control subject (78 yr. F)**



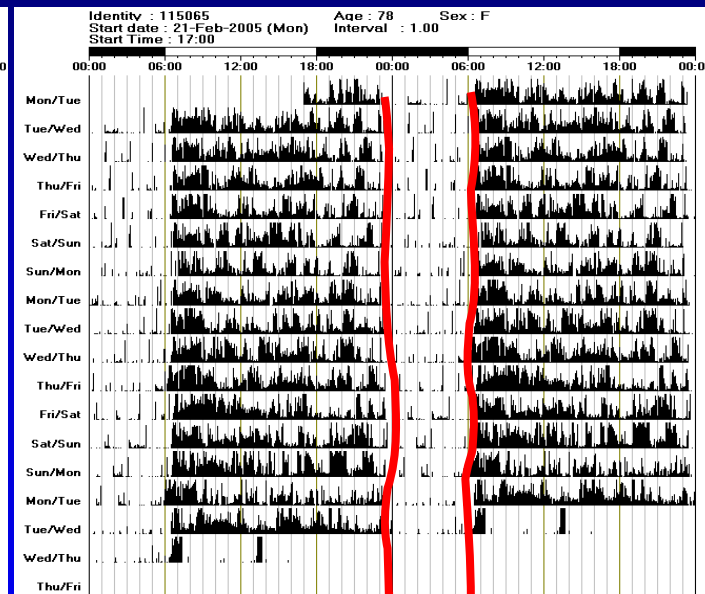
# Actigraphy in insomnia patient and healthy control subject

**Insomnia patient (68 yr. F)**



- Lower level of overall activity
- Irregularity of sleep “window”
- Inactive periods in day

**Control subject (78 yr. F)**



- Higher level of overall activity
- Regular sleep “window”
- Few inactive periods in day



# sleep diary



PRINT  
THIS FORM



SLEEP DISORDERS CENTER AT Trinitas Regional Medical Center  
210 Williamson Street, Elizabeth, New Jersey 07202  
Phone: 908-994-8694, Fax: 908-994-8697, Email: [Sleep@Trinitas.org](mailto:Sleep@Trinitas.org)

#### SLEEP DIARY

Leave the times you are awake blank. Shade in the times when you sleep. Put a downward arrow when you lie down to sleep. Put an upward arrow when you awaken. Complete this log in the morning and the evening. **Do not complete this log during the night.** Please enter any comments on the back. **Please bring this diary when you come for an appointment.**

SAMPLE:													
DATE	6AM	8AM	10AM	12PM	2PM	4PM	6PM	8PM	10PM	12AM	2AM	4AM	6AM
August 16		↑				↓			↓				

FIRST WEEK													
DATE	6AM	8AM	10AM	12PM	2PM	4PM	6PM	8PM	10PM	12AM	2AM	4AM	6AM

SECOND WEEK													
DATE	6AM	8AM	10AM	12PM	2PM	4PM	6PM	8PM	10PM	12AM	2AM	4AM	6AM

Ref: Effectiveness and Cost-effectiveness of an Educational Intervention for Practice Teams to deliver Problem Focused Therapy for Insomnia: Pilot Cluster Randomised Trial

## TWO WEEK SLEEP DIARY

### INSTRUCTIONS:

1. Write the date, day of the week, and type of day: Work, School, Day Off, or Vacation.
2. Put the letter "C" in the box when you have coffee, cola or tea. Put "M" when you take any medicine. Put "A" when you drink alcohol. Put "E" when you exercise.
3. Put a line (I) to show when you go to bed. Shade in the box that shows when you think you fell asleep.
4. Shade in all the boxes that show when you are asleep at night or when you take a nap during the day.
5. Leave boxes unshaded to show when you wake up at night and when you are awake during the day.



SAMPLE ENTRY BELOW: On a Monday when I worked, I jogged on my lunch break at 1 PM, had a glass of wine with dinner at 6 PM, fell asleep watching TV from 7 to 8 PM, went to bed at 10:30 PM, fell asleep around Midnight, woke up and couldn't get back to sleep at about 4 AM, went back to sleep from 5 to 7 AM, and had coffee and medicine at 7:00 in the morning.

Today's Date	Day of the week	Type of Day Work, School, Off, Vacation	Noon	1PM	2	3	4	5	6PM	7	8	9	10	11PM	Midnight	1AM	2	3	4	5	6AM	7	8	9	10	11AM
sample	Mon.	Work		E					A				I									C	M			
	Mon	Work	C										I										C		C	
	Tue	Work							A				I										C		C	
	Wed	Work											I										C			
	Thur	Work				C							I										C			
	Fri	Work	C									A	A	A	A	I										
	Sat	Off		C									I												C	
	Sun	Off											I										C			
	Mon	Work	C						A				I										C			
	Tue	Work											I										C		C	
	Wed	Work	C										I													
	Thur	Work																								
	Fri	Work											A	A	A	A	I									
	Sat	Off	C		C			E							I										C	
	Sun	Off												I												

week 1

week 2

# consensus sleep diary

## Sleep Diary Instructions

### General Instructions

**What is a Sleep Diary?** A sleep diary is designed to gather information about your daily sleep pattern.

**How often and when do I fill out the sleep diary?** It is necessary for you to complete your sleep diary every day. If possible, the sleep diary should be completed within one hour of getting out of bed in the morning.

**What should I do if I miss a day?** If you forget to fill in the diary or are unable to finish it, leave the diary blank for that day.

**What if something unusual affects my sleep or how I feel in the daytime?** If your sleep or daytime functioning is affected by some unusual event (such as an illness, or an emergency) you may make brief notes on your diary.

**What do the words "bed" and "day" mean on the diary?** This diary can be used for people who are awake or asleep at unusual times. In the sleep diary, the word "day" is the time when you choose or are required to be awake. The term "bed" means the place where you usually sleep.

**Will answering these questions about my sleep keep me awake?** This is not usually a problem. You should not worry about giving exact times, and you should not watch the clock. Just give your best estimate.

### Item Instructions

Use the guide below to clarify what is being asked for each item of the Sleep Diary.

*Date:* Write the date of the morning you are filling out the diary.

1. *What time did you get into bed?* Write the time that you got into bed. This may not be the time that you began "trying" to fall asleep.

2. *What time did you try to go to sleep?* Record the time that you began "trying" to fall asleep.

3. *How long did it take you to fall asleep?* Beginning at the time you wrote in question 2, how long did it take you to fall asleep.

4. *How many times did you wake up, not counting your final awakening?* How many times did you wake up between the time you first fell asleep and your final awakening?

5. *In total, how long did these awakenings last?* What was the total time you were awake between the time you first fell asleep and your final awakening. For example, if you woke 3 times for 20 minutes, 35 minutes, and 15 minutes, add them all up (20+35+15= 70 min or 1 hr and 10 min).

6. *What time was your final awakening?* Record the last time you woke up in the morning.

7. *What time did you get out of bed for the day?* What time did you get out of bed with no further attempt at sleeping? This may be different from your final awakening time (e.g. you may have woken up at 6:35 a.m. but did not get out of bed to start your day until 7:20 a.m.)

8. *How would you rate the quality of your sleep?* "Sleep Quality" is your sense of whether your sleep was good or poor.

9. *In total, how long did you nap or doze?* Estimate the total amount of time you spent napping or dozing, in hours and minutes. For instance, if you napped twice, once for 30 minutes and once for 60 minutes, and dozed for 10 minutes, you would answer "1 hour 40 minutes." If you did not nap or doze, write "N/A" (not applicable).

10. *Comments* If you have anything that you would like to say that is relevant to your sleep feel free to write it here.

# Consensus Sleep Diary-Core

ID/Name: \_\_\_\_\_

Sample								
Today's date	4/5/11							
1. What time did you get into bed?	10:15 p.m							
2. What time did you try to go to sleep?	11:30 p.m							
3. How long did it take you to fall asleep?	55 min.							
4. How many times did you wake up, not counting your final awakening?	3 times							
5. In total, how long did these awakenings last?	1 hour 10 min.							
6. What time was your final awakening?	6:35 a.m.							
7. What time did you get out of bed for the day?	7:20 a.m							
8. How would you rate the quality of your sleep?	<input type="checkbox"/> Very poor <input checked="" type="checkbox"/> Poor <input type="checkbox"/> Fair <input type="checkbox"/> Good <input type="checkbox"/> Very good	<input type="checkbox"/> Very poor <input type="checkbox"/> Poor <input type="checkbox"/> Fair <input type="checkbox"/> Good <input type="checkbox"/> Very good	<input type="checkbox"/> Very poor <input type="checkbox"/> Poor <input type="checkbox"/> Fair <input type="checkbox"/> Good <input type="checkbox"/> Very good	<input type="checkbox"/> Very poor <input type="checkbox"/> Poor <input type="checkbox"/> Fair <input type="checkbox"/> Good <input type="checkbox"/> Very good	<input type="checkbox"/> Very poor <input type="checkbox"/> Poor <input type="checkbox"/> Fair <input type="checkbox"/> Good <input type="checkbox"/> Very good	<input type="checkbox"/> Very poor <input type="checkbox"/> Poor <input type="checkbox"/> Fair <input type="checkbox"/> Good <input type="checkbox"/> Very good	<input type="checkbox"/> Very poor <input type="checkbox"/> Poor <input type="checkbox"/> Fair <input type="checkbox"/> Good <input type="checkbox"/> Very good	<input type="checkbox"/> Very poor <input type="checkbox"/> Poor <input type="checkbox"/> Fair <input type="checkbox"/> Good <input type="checkbox"/> Very good
9. In total, how long did you nap or doze?	1 hour 30 min.							
10. Comments (if applicable)	I have a cold							



## sleep diary measures

Acronym	Description	Computation
SOL	sleep onset latency	#3
NWAK	number awakenings	#4
WASO	wake time after sleep onset	#5
TWAK	terminal wake time	#7 – #6
SQR	sleep quality rating	#8 [1 to 5]
TIB	time in bed	#7 – #2
TST	total sleep time	TIB – SOL, WASO, TWAK
SE	sleep efficiency %	$TST \div TIB \times 100$
NAP	nap time	#9

Just under 50 million wearable devices were shipped in 2015 and over 125 million units are expected to ship in 2019.

– Forbes



## sleep trackers

Beautyrest	moreFit Fitness Tracker
Beddit	Nokia Sleep
Biostrap	Oura
Emfit	Pyle Fitness Tracker
EverSleep	ResMed S+
FITBAND	SevenHugs HugOne
Fitbit	Sleep Shepherd Blue
Fitmaker Fitness Tracker	SleepScore
Garmin Vivosmart	Thim
LETSCOM Fitness Tracker	Viatom Sleep Oxygen Monitor
Lintelek Fitness Tracker	Withings
Lookee Sleep Monitor	Zeeq

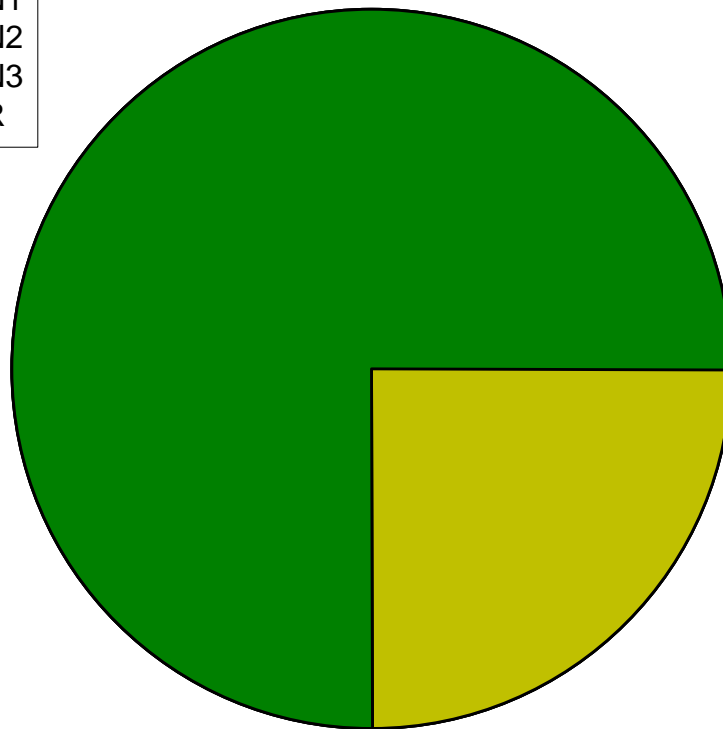
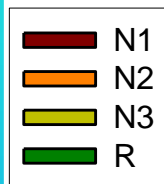


**normal sleep**

# normal adult sleep [highly variable]

- ③ 7.5 hr TST
- ③ SOL < 15 min, WASO < 15 min, SE > 90%
- ③ sleep stage distribution
  - N1: 5%
  - N2: 50%
  - N3: 20%
  - REM: 25%
- ③ sleep stage pattern
  - N3 congregates in the first third of night
  - REM congregates in the second half of night
  - sleep cycle (4 stages) is 90 min
- ③ REM characteristics
  - REM emerges from N1 or N2
  - EEG of N1 but as deeply asleep as N3
  - cognitive activity
  - body immobilization
  - sexual arousal

normal middle-aged adult





to be continued