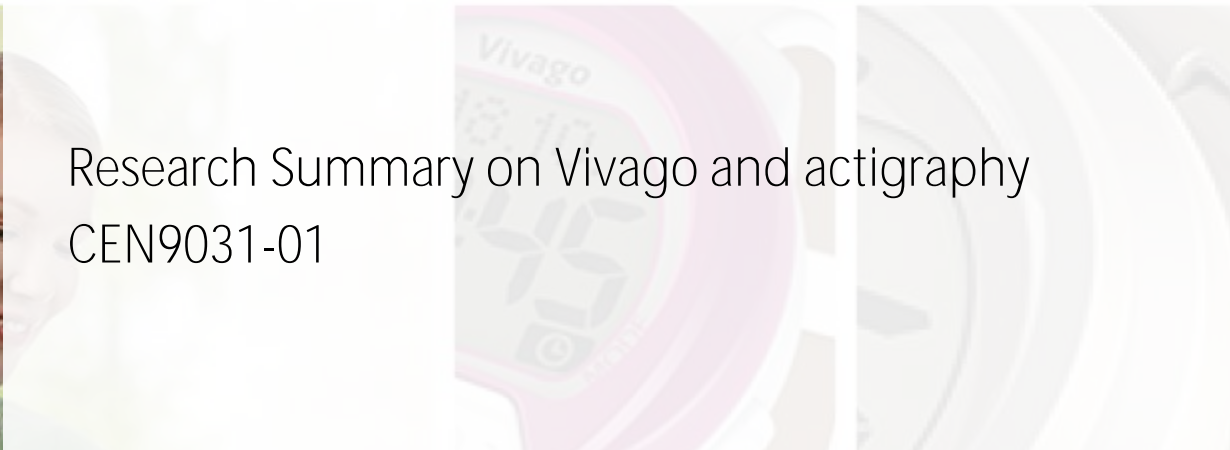




Vivago

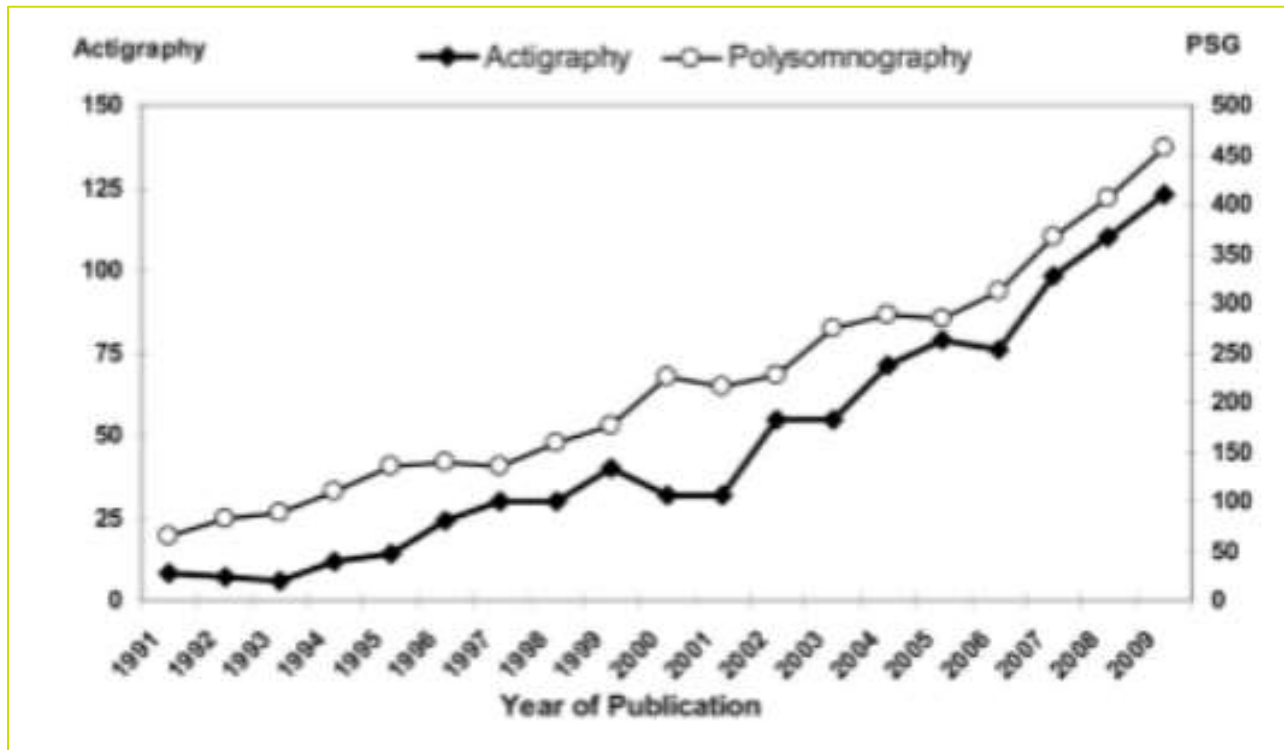


Popular field of study

- Almost 30,000 articles on sleep and circadian rhythm published annually
- Some 20 to 30 medical associations and publications concentrate in sleep alone
- A few influential publications in this area:
 - Sleep
 - Journal of Clinical Sleep Medicine
 - Sleep Medicine
 - Journal of Sleep Research
 - Sleep Medicine Research

Studies with actigraphy

An explosion in studies with actigraphy (Sadeh, 2011)



How to search for studies

PubMed

Google Scholar

Whitepapers

- Softer form of clinical evidence
- Often scientific approach but does not fulfill all criteria for peer-reviewed publications
 - Small sample size
 - Methodology (case studies etc.)
 - Company funded
 - Internal research report

Coming next

- Actigraphy and sleep
- Circadian rhythm and ageing
- Mood disorders: depression and bipolar syndrome
- Pain
- Rehabilitation
- Neurodegenerative diseases

Actigraphy and sleep

- How poor sleep affects us
- Actigraphy in sleep research
- Polysomnography
- Introduction to a few articles

Poor sleep is common

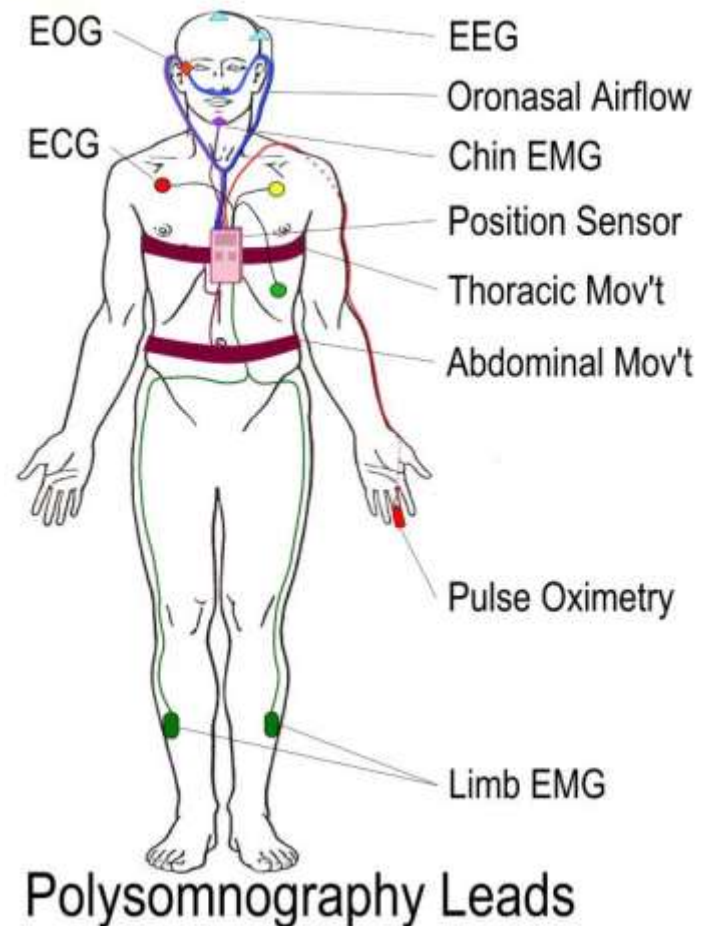
- One in three suffer from temporary sleeplessness
- 40-70% of seniors have occasional sleeping problems
- The likelihood of poor sleep increases with stress, ageing, and illness
- Sleeplessness is one of the factors leading to institutionalised care. It is also more common in care institutions than home.

How poor sleep affects us

- Bad sleep correlates with lower perceived wellbeing
- More depression
- Common in bipolar disorder
- Connection to accidents and falls
- Sometimes a sign of (worsening) dementia
- Increased risk of heart and vascular disease
- High mortality and morbidity

Measuring sleep with polysomnography, PSG

- Discriminating between sleep and wake, as well as different sleep phases
- Based on several parameters:
 - EEG (electroencephalogram)
 - EMG (electromyography)
 - EOG (electro-oculography)



Measuring sleep with actigraphy

- Actigraphy is the most commonly used technology for measuring sleep, circadian rhythm and physical activity
- High correlation with polysomnography with healthy subjects, lower with insomniacs and other special populations
- Actigraphy is sensitive but not very specific
 - At best when measuring long-time trend
 - Comparing different subjects' data may not be worthwhile
 - Immobility labeled as sleep

The role and validity of actigraphy in sleep medicine: an update. Sadeh, A., Sleep Med Rev. 2011 Aug; 15(4): 259-67

Measuring circadian rhythm with actigraphy

- Actigraphy is applicable for
 - the follow-up of sleep and activity rhythms
 - the documentation of the effectiveness of care, as changes in medication are often reflected in the circadian rhythm
- Actigraphy is also the only available method suitable for long-term follow-up and patient groups that do not tolerate PSG.

The role of actigraphy in the study of sleep and circadian rhythms, Ancoli-Israel, S., Cole, R., Alessi, C., Chambers, M., Moorcroft, W. and Pollak, C. P. Sleep, 2003, 26: 342–392.

A guide to the appropriate use of actigraphy by American Academy of Sleep Medicine (AASM)

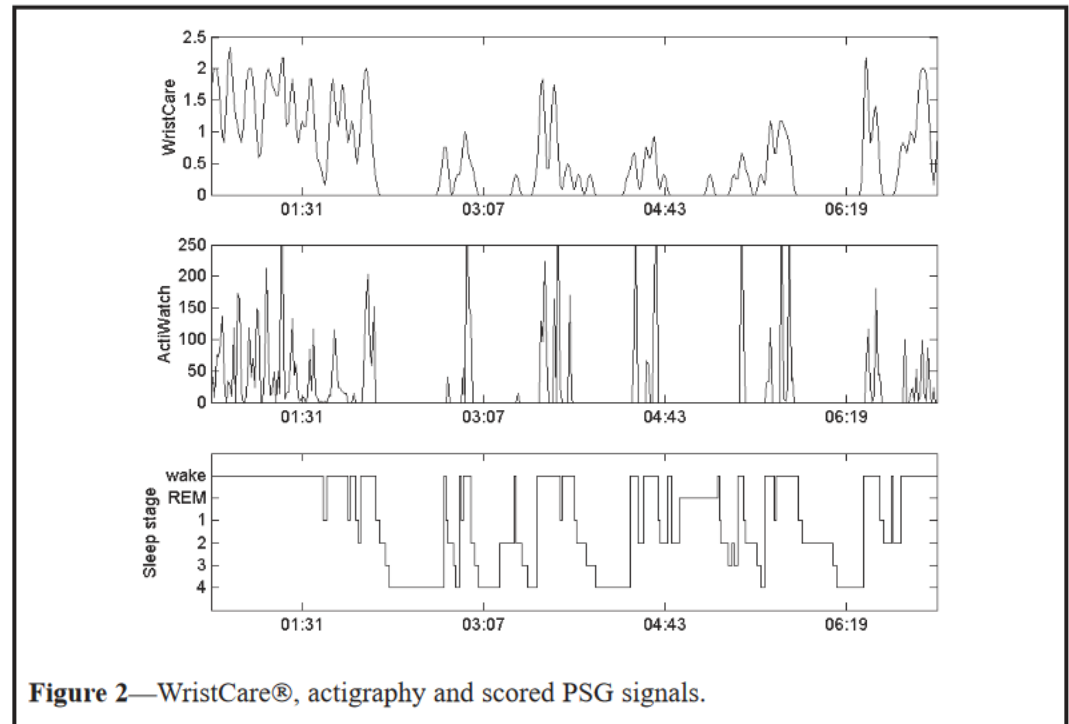
- Indications for actigraphy
 - Estimating of sleep patterns
 - Obstructive sleep apnea
 - Older adults
 - Children
 - Insomnia and hypersomnia
- Assessing response to therapy
- Diagnostic tool

Practice parameters for the use of actigraphy in the assessment of sleep and sleep disorders. An update for 2007, T. Morgenthaler, C. Alessi, L. Friedman, J. Owens, V. Kapur, B. Boehlecke, T. Brown, A. Chesson Jr, J. Coleman, T. Lee-Chiong, J. Panzer ja T.J. Swick: Sleep Vol 30, No 4, pp. 519-529, 2007.

Vivago and sleep

“The performance of the WristCare can be assumed to be well comparable to actigraphy in sleep/wake studies.”

Automatic Sleep-Wake and Nap Analysis with a New Wrist Worn Online Activity Monitoring Device Vivago WristCare, Lötjönen et al, Sleep 01/2003



Summary: actigraphy and sleep

- How reliable is actigraphy when measuring sleep and circadian rhythms?
 - Sadeh
 - Ancoli-Israel
- What can actigraphy be used for?
 - Morgenthaler: indications
- How does Vivago compare to other brands of actigraphy?
 - Lötjönen

Circadian rhythm and aging

- Healthy and demented seniors
- Supporting the circadian rhythm of the elderly
- Introduction to a few research articles

Functional capacity

- Resident Assessment Instrument, RAI
- Changes in the sleep-wake rhythm correlate with changes taking place in perceived wellbeing
- Regular daytime napping and nocturnal awakenings are an indication of deteriorated functioning

Strong association of the rest-activity rhythm with well-being in demented elderly women, S.S. Carvalho-Bos, R.F. Riemersma-van der Lek, J. Waterhouse, T. Reilly ja E.J.W. van Someren: Amer. J Geriatric Psychiatry, vol 15, no 2, pp. 92-100, 2007

Martin JL, Webber AP, Alam T, Harker JO, Josephson KR, Alessi CA. Daytime sleeping, sleep disturbance, and circadian rhythms in the nursing home. American Journal of Geriatric Psychiatry. 2006;142:121-129.

- Differences in circadian rhythms of the healthy and demented seniors
- A significant correlation between daily activity and functionality

Telemetric activity monitoring as an indicator of long-term changes in health and well-being of older people

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P.Paavilainen, I.Korhonen, M.Partinen. Telemetric activity monitoring as an indicator of long-term changes in health and well-being of older people. Gerontechnology 2005;4(2) 77-85. Background Supporting independent living for older people is essential not only for the older people themselves, but also for the social and health care sectors. For this reason, there exists a need for unobtrusive telicare

- More activity during daytime and more variance in activity patterns are associated with a better functioning status.
- external stimuli such as facility activities and weather affect the behavior of older individuals, and these influences might differ according to subjects' levels of functioning.

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ORIGINAL RESEARCH

ASSOCIATION BETWEEN CONTINUOUS WEARABLE ACTIVITY MONITORING AND SELF-REPORTED FUNCTIONING IN ASSISTED LIVING FACILITY AND NURSING HOME RESIDENTS

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Wearable Monitoring of Physical Functioning and Disability Changes, Circadian Rhythms and Sleep Patterns in Nursing Home Residents

Juho Merilahti, Petteri Viramo, and Ilkka Korhonen, *Senior Member, IEEE*

- longitudinal analysis, 12-18 months
- Compare actigraphy parameters and physical functioning

TABLE I
FREQUENCIES OF RAI'S FUNCTIONING ASSESSMENT SCALE'S SCORES IN CROSS-SECTIONAL ANALYSIS (N OF SAMPLES = 31, N OF SUBJECTS = 16)

Score	Activities of Daily Living	Pain scale	Depression Rating Scale	Cognitive Performance scale
0	7	14	14	13
1	4	9	7	4
2	7	8	1	0
3	2	0	4	1
4	2	-	4	0
5	7	-	0	11
6	2	-	1	2

Supporting the circadian rhythm of seniors

- The ability to maintain a stable circadian rhythm weakens with age.
- Bright light, melatonin, exercise etc (zeitgebers) are ways of re-activating suprachiasmatic nucleus and restoring the circadian rhythm
- The second paper proposes a way of doing this with regularly repeated zeitgebers

- *Circadian and sleep disturbances in the elderly. Van Someren EJW. Experimental Gerontology 2000; 25: 1229-1237*
- *Van Someren EJW, Riemersma-Van Der Lek RF. Live to the rhythm, slave to the rhythm. Sleep Medicine Reviews. 2007;116:465-484.*

Falls

Disturbed circadian rhythm in the elderly is a known risk factor for falls and, consequently, hip fractures caused by falls.

- *Actigraphy-measured sleep characteristics and risk of falls in older women, Stone KL, Ancoli-Israel S, Blackwell T, et al. Arch Intern Med. 2008; 168(16): 1768-1775.*
- *Stone KL, Ewing SK, Lui LY, et al. Self-reported sleep and nap habits and risk of falls and fractures in older women: the study of osteoporotic fractures. J Am Geriatr Soc. 2006; 54(8): 1177-1183.*
- *Brassington GS, King AC, Bliwise DL. Sleep problems as a risk factor for falls in a sample of community-dwelling adults aged 64-99 years. J Am Geriatr Soc. 2000; 48(10): 1234-1240.*
- *Avidan AY, Fries BE, James ML, Szafara KL, Wright GT, Chervin RD. Insomnia and hypnotic use, recorded in the minimum data set, as predictors of falls and hip fractures in Michigan nursing homes. J Am Geriatr Soc. 2005;53(6):955-962.*

Summary: Circadian rhythm and aging

Correlation between circadian rhythm and functional capacity

- Vivago: Paavilainen and Merilahti and their groups
- Other actigraphs: Carvalho-Bos and Martin

Supporting the functional capacity of the elderly by supporting their circadian rhythm

- Van Someren!

Prevention of falls

- Stone, Brassington, Avidan

Depression and bipolar syndrome

- The effect of mood disorders on circadian rhythm
- The effect of circadian rhythm on mood disorders

Activity monitoring and psychiatric disorders

- Connection between physical activity and psychiatric disorders
- The amount of activity correlated with the level of depression and mirrored recovery
- *“Activity monitoring is a valuable research tool, with the potential to aid clinicians in diagnosis and in prediction of treatment response.”*

Teicher M.H., Actigraphy and motion analysis: new tools for psychiatry. Harv Rev Psychiatry. 1995;3:18–35.

Depression

- Sleep and circadian rest-activity rhythms in depressed outpatients
- 7 consecutive days of all-day actigraphic activity monitoring while engaging in usual activities
- Shorter and more fragmented sleep emerged as significant predictors of depression
- *“By simultaneously measuring sleep and rest-activity rhythm parameters, actigraphy might serve as an objective diagnostic aid for depression.”*

24-h activity rhythm and sleep in depressed outpatients, Hori H, Koga N, Hidese S, Nagashima A, Kim Y, Higuchi T, Kunugi H, J Psychiatric Res 2016 Jun; 77:27-34

Depression and sleep

- Data from 1215 nondepressed interns
- The impact of sleep loss and work hours on depression
- Depression rates were highest among interns with both sleep disturbance and short sleep.
- Elevated medical error rates were reported by physicians sleeping ≤ 6 hr per night, working ≥ 70 weekly hours, and who were acutely or chronically depressed.

Sleep Disturbance and Short Sleep as Risk Factors for Depression and Perceived Medical Errors in First-Year Residents. Kalmbach D.A, Arnedt T, Song P.X, Guille C, Sen S. Sleep 2017, vol 40, issue 3

Sleep duration & symptoms of bipolar disorder

- 2024 bipolar patients
- The quality of sleep and its associations with mood, function, and quality of life
- Short sleep duration in bipolar disorder was associated with more severe symptoms
- Both short and long sleep duration were associated with poorer function and quality of life compared to normal sleep duration

Gruber J., Harvey A.G., Wang P.W., Brooks J.O., Thase M.E., Sach G.S., Ketter T.A.: Sleep functioning in relation to mood, function, and quality of life at entry to the Systematic Treatment Enhancement Program for Bipolar Disorder (STEP-BD). J. Affect. Disord, 2009 Apr; 114 (1-3): 41-9

Sleep and circadian rhythm in bipolar disorder (BD)

- Writers stress the importance of monitoring sleep in bipolar disorder, also between episodes.
- *“--- actigraphy is a valid instrument for estimating sleep and wakefulness in a bipolar population, despite sedating medication use and the presence of clinical sleep disturbance (insomnia).”*
- Full article: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3549461/>

Kaplan K.A., Talbot L.S., Gruber J, Harvey A.G. Evaluating sleep in bipolar disorder: comparison between actigraphy, polysomnography, and sleep diary. Bipolar Disord. 2012;14:870–879

Summary, mood disorders

Sleep and daytime activity should be monitored in depression and bipolar disorder

- Teicher: connection between physical activity and psychiatric disorders established in the 80's already
- Hori: actigraphy is a valid diagnostic tool for depression
- Gruber: the amount of sleep correlates with the symptoms of bipolar disorder
- Kaplan: important to monitor sleep in BD patients, even between episodes

Pain

- Vivago measures sleep and activity
- Sleep reflects pain
- Pain reflects sleep

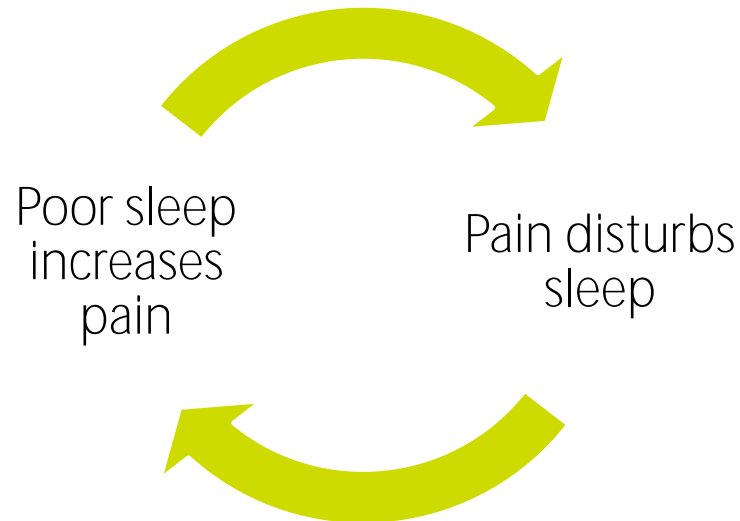
Pain disturbs sleep

The sleep of middle-aged patients with widespread pain is comparable to that of insomnia patients.

Okura, K., Lavigne, G., Huynh, N., Manzini, C., Filipini, D., Montplaisir, J. Comparison of sleep variables between chronic widespread musculoskeletal pain, insomnia, periodic leg movements syndrome and control subjects in a clinical sleep medicine practice. Sleep Medicine 2008, 9: 352-361.

It also goes the other way

“Management of sleep disturbance may be an important treatment objective with possible benefits beyond the improvement in sleep.”



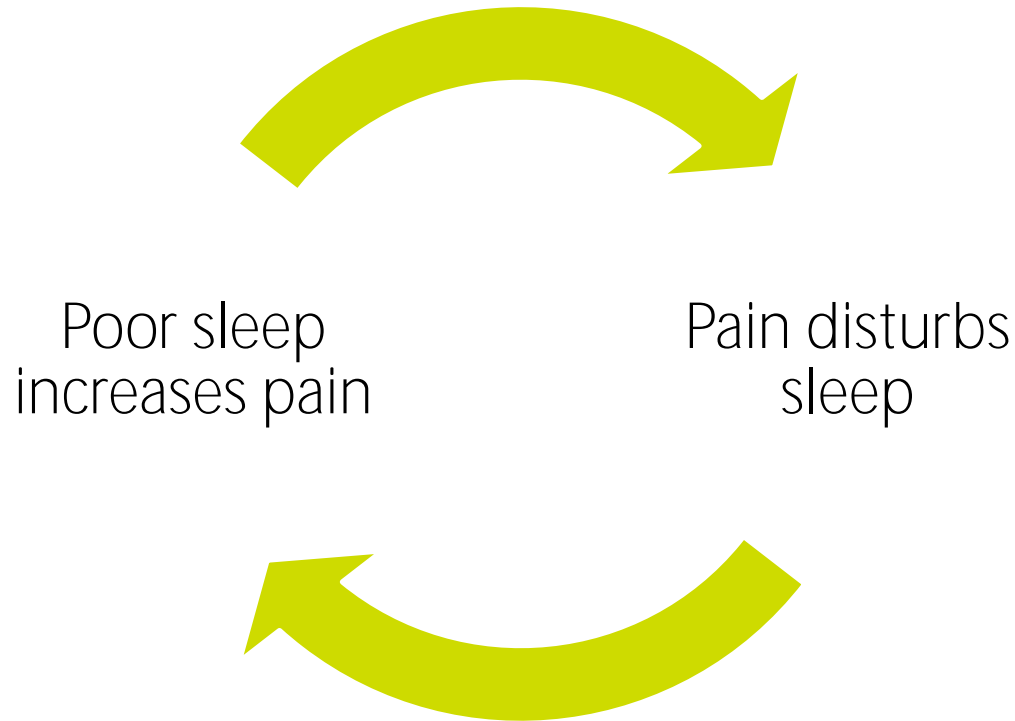
Smith, MT, Haythornthwaite JA. How do sleep disturbance and chronic pain inter-relate? Insights from the longitudinal and cognitive-behavioral clinical trials literature. Sleep Medicine Rev 2004 8: 119-132

Poor sleep increases pain

- Daily assessment of hours slept and the reported frequency of pain symptoms
- Hours of reported sleep on the previous night predicted the current day's pain.
- “Night-to-night changes in sleep affect pain report, illuminating the importance of considering sleep when assessing and treating pain.”

Edwards RR, Almeida DM, Klick B, Haythornthwaite JA, Smith MT . Duration of sleep contributes to next-day pain report in the general population. Pain 2008, 137: 202-207.

Summary, sleep and pain



Sleep Disturbance and Nonmalignant Chronic Pain: A Comprehensive Review of the Literature L.A. Menefee, M.J.M. Cohen, W.R. Anderson, K. Doghramii, E.D. Frank, H. Lee

<https://onlinelibrary.wiley.com/doi/full/10.1046/j.1526-4637.2000.00022.x>

Rehabilitation

Sleep, daytime activity and circadian rhythm and pain in the process of rehabilitation

Daytime sleeping, less functional recovery

- 245 elderly patients, post-acute recovery
- Participants reported bad sleep during rehabilitation (compared to their premorbid sleep)
- Sleep disturbance itself didn't seem to affect functional recovery

But

- More daytime sleeping was a significant predictor of less functional recovery at 3 months

More Daytime Sleeping Predicts Less Functional Recovery Among Older People Undergoing Inpatient Post-Acute Rehabilitation. Alessi C.A, Martin J.L, Webber A.P, Alam T, Littner M.R, Harker J.O, Josephson K.R. Sleep, Volume 31, Issue 9, 1 September 2008, Pages 1291–1300

Recovery after hip surgery

- Patients monitored with actigraphy during rehabilitation
- Follow-up after 3 and 6 months
- Activity during therapy was in line with the physical therapist's participation score, and predicted recovery
- Actigraphy had predictive value for future functional outcomes

Patient Participation and Physical Activity During Rehabilitation and Future Functional Outcomes in Patients After Hip Fracture. Talkowski J.B., Lenze E.J, Munin M.C, Harrison C, Brach J.S. Physical Medicine and Rehabilitation, April 2009, vol 90, Issue 4, pages 618–622

Traumatic brain injury (TBI)

Traumatic brain injury often causes fatigue, and measuring sleep is essential. Subjects with brain injury are less capable of reporting the level of their sleep than healthy controls.

“Actigraphy may prove useful to supplement self-report measures of sleep following TBI. More work is required to understand the accuracy of these measures in this population”

Actigraphic Assessment of Sleep Disturbances following Traumatic Brain Injury. Sinclair K.L, Ponsford J, Rajaratnam S.M.W. Behavioral Sleep Medicine, 2014, vol 12, issue 1, pages 13-27

Stroke and motor paresis

- Actigraphy in the evaluation of post-stroke motor activity
- Subjects wore two actigraphs, one in each wrist at four time points after stroke: 24–36 h, 5–7 days, 3 months, and 6 months
- Significant and positive correlation with Scandinavian Stroke scale, the Barthel Index, the Rankin Scale Score and with the Motoricity Index

“Our results suggest that actigraphy is a useful tool in the objective evaluation of motor activity after stroke. Moreover, actigraphy covers additional aspects that are not reflected by the usual stroke scales in a clinical situation.”

Actigraphy – A Useful Tool for Motor Activity Monitoring in Stroke Patients.

Reiterer V, Sauter C, Klösch G, Lalouschek W, Zeitlhofer J. Eur Neurol 2008; 60: 285-291

Summary, rehabilitation

Prognosis of recovery

- Daytime napping: Alessi et al.
- Activity during therapy: Talkowski et al.

Need to monitor sleep after traumatic brain injury

- Sinclair et al.

Correlation of actigraphy and the most common indices for functional rehabilitation

- Reiterer et al.

Neurodegenerative disease

- Dementia
- Alzheimer's
- Parkinson's

Sleep and circadian rhythm disruption in psychiatric and neurodegenerative disease

- Brain disorders and abnormal sleep have a common mechanistic origin
- Many co-morbid pathologies that are found in brain disease arise from a destabilization of sleep mechanisms
- The stabilization of sleep may be a means by which to reduce the symptoms of — and permit early intervention of — psychiatric and neurodegenerative disease

Sleep and circadian rhythm disruption in psychiatric and neurodegenerative disease. Katharina Wulff, Silvia Gatti, Joseph G. Wettstein, Russell G. Foster Nature Reviews Neuroscience volume 11, pages 589–599 (2010)

Sleep-wake changes and cognition

- Earlier research indicates that sleep and neurocognitive features are related
- Sleep-wake changes are predictive of cognitive decline, psychiatric symptoms, quality of life, need for institutional care and caregiver burden
- Early intervention methods are needed to detect cognitive decline of older people
- Further studies are needed.

Sleep-wake changes and cognition in neurodegenerative disease. Sharon L., Naismith SL, Lewis SJ, Rogers NL. Prog Brain Res 2011;190:21-52. doi: 10.1016/B978-0-444-53817-8.00002-5.

Parkinson's disease, PD

- Sleep disturbance is common in Parkinson's disease.
- Sleep disturbances may come in various forms.
- Treatment of Parkinson's disease should address any underlying factors, such as depression or anxiety.
- The patient's status should be thoroughly assessed in PD, including the quality of their sleep.
- 1 to 2 weeks' sleep diary, polysomnography or actigraphy are suggested.

Sleep disorders in Parkinson's disease, Thorpy MJ, Clin Cornerstone 2004; 6 Suppl 1A:S7

Summary, neurodegenerative diseases

A wide variety of diseases and conditions, which seem to share a common mechanistic origin with sleep-wake regulation

- Dr. Wulff

Sleep-wake changes are predictive of cognitive decline

- Dr. Sharon

Sleep disturbance is common in Parkinson's disease, need to monitor sleep

- Dr. Thorpy

Summary

An abundance of research

Vivago



Thank you!
www.vivago.com
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