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Sleep Disturbances are Consequences or Mediators between Socioeconomic Status and Health: A Scoping Review

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ABSTRACT

The variations in socioeconomic status (SES) between different social classes of a population correspond to differences in accessibility to all resources available and able to improve global health. SES can influence global health trajectory for an individual or a community, depending if SES is low or high. Sleep is sensitive to environmental stimuli, as well as living conditions. Plenty of studies linked sleep complaints with mood disorders, allostatic load or circadian disruption; but very few or none investigated deeply what happened earlier to sleep depending of SES. While SES is now known as one of the main determinants for a good health and a good aging, its influence on sleep disorders (SD) is not well understood. SES is a concept, not directly observable but estimated using indicators like income, education, occupational status and area of living. Even if recent evidence suggested that few of SES indicators like occupational status are linked with sleep disturbances, the relation between SES and health in general with sleep as an outcome or a mediator is not well documented. This scoping review synthetized studies which investigated physiological and psychological mechanisms resulting from a low SES and linked them with sleep disturbances as consequences or as mediators. This review also explore a possible role played by sleep in the relation between socioeconomic status and health inequalities.

Keywords: sleep disorders; socioeconomic status; mediator; allostatic load; health; scoping review

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INTRODUCTION

Sleep disorders (SD) are among the most studied neurological outcomes in past two decades. They have many psychosocial aetiologies like lifestyle, night shift, sporadic daily stressors or environmental stress. They are linked to physiological dysfunctions of internal clock, circadian cycle or hormonal systems involved, like dopaminergic system and melatonin [1-5]. SD are often associated with age related comorbidities. For children and adolescents, they are associated with poor school performance and breathing abnormalities [6-8], for adolescents an association was reported between SD and anxiety [9]; and for adults there seems to be strong association between SD and other neurological outcomes like depression, cognitive impairment and circadian disruption [10-12]. Current literature lacks significant information as it relates to socioeconomic factors associated with the sleep disorders. There is lack of data on the interaction between macroenvironment of the individual and its effect of health outcomes, even if health inequities existed in several situations. Socioeconomic status (SES) indicators (i.e. income, household, education, neighborhood, lifestyle) can affect the global health of a community [13-16]. In addition, SES can influence the development of SD in the same community. The variations in SES between different social classes of a population correspond to differences in accessibility to resources to improve global health [13,17]. While SES is now known as one of the main determinant for a good health and aging, its influence on sleep disorders is not well understood. The impact of SES can not be observed or measure directly. It is estimated by different parameters as income, education and occupational status [13]. These characteristic of SES makes it difficult to predict its influence on clinical outcomes, such as sleep impairment, on a quantitative basis. This theoretical review explores some theories linking environment and sleep disorders, with different patterns associated to SES and specifically the socioeconomic gradient. A model of interaction is proposed to summarize and conceptualize these interactions and to promote further research on these topics.

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1- Influence of objective and perceived low socioeconomic status on sleep disturbances

The existence of a socioeconomic gradient drives the development of social inequalities, but also health inequalities [13]. Few researchers have explored these theories in the last decade and have tried to understand if these associations can be deleterious for the individuals or the community. While assessing psychological and socioeconomic health status of community-dwelling older adults in Taiwan and comparing the psychological and socioeconomic health inequalities among people of different age, gender, marital status, and exercise habits, Chen et al. found that the major psychological and socio-economic health concerns were sleep disturbances and financial burden for all the groups [18]. Studies have suggested that younger and older adults had better psychological well-being, but the data was not convincing [12,19,20]. It may be because the allostatic load side effects takes time before their manifestation [21-23], and also because there are many trajectories created by the socioeconomic gradient which may leads to different health impairments for the same community [24-26]. Their findings were in line with Van Cauter and Spiegel, who discussed their hypothesis in 1999, suggesting that the adverse effect of low SES on health may partly be mediated by decrements in sleep duration and quality [27]. Van Cauter and Spiegel et al. also suggested that chronic sleep debt caused by low SES was partially associated with metabolic diseases. Their theories aligned with those of Hall and Bromberger, who in their investigation on stress–sleep–health relationship, suggested the impact of the chronic stress of lower SES on subjective sleep complaints [28]. Hall and Bromberger found that poverty was associated with subjective sleep complaints in middle-aged irrespective of age, race and education. Chronic stress associated with lower SES mediate the association of poverty with poor sleep. A gradient of health which could be physical, psychological or cultural; exists and this last is influenced by the perceived or the contextual low SES of an individual or a category of people [13,24,25,29,30]. .

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Associations between objective and subjective SES were compared with psychological and physical variables by Adler et al., who concluded that psychological perceptions of lower social status contribute to the SES-health gradient and have significant relationships with stress, sleep disturbances and metabolic diseases [31]. Regardless, low SES is a perception of an individual or an objective evidence, the low SES drive a global decline in sleep quality [31]. During the following decade until now, many others studies performed all around the world on similar topics just confirmed this influence of SES in the sleep health regardless of age, ethnicity, occupational status and country [24,32-43] Friedman et al. confirmed that SES would be associated with objectively measured sleep quality, even after controlling for related covariates (health status, psychosocial features) [38]. They found that, there were behavioral and biological implications of social ladder and sleep quality in health processes, and a negative association existed among sleep disorders, low SES and chronic morbidities. Later study by Goodin et al., Green et al. and Okun et al confirmed the same findings [44-46]. Goodin et al. showed that lower perceived social status are often associated in some societies like USA with ethnicity and has a negative influence on sleep quality in subjects with poor social class mainly African and Asian Americans [44]. Their results was verified by Green et al. who studied longitudinally patterns of insomnia symptoms aging population and examined the influence of gender and profession. They found that chronic symptoms of stress expressed by difficulties in maintaining and initiating sleep were influenced by social factors in a 20 years longitudinal paper [45]. Okun et al. evaluated the effect of SES on measures of sleep quality, continuity, and quantity in a large cohort of one hundred and seventy pregnant women at 10-20 weeks gestation. They concluded that low SES was associated with poorer sleep quality and fragmented sleep [46]. In summary, low SES, lower income, aging and difficulty to access health can increases the risks of sleep disturbances.

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2- Influence of sleep disturbances on health outcomes

Chiang JJ et Al. has showed that, experimentally induced sleep loss and sleep fragmentation can have both short and long term health consequences, mainly by altering the activity of major neuroendocrine systems, such as the autonomic sympatho-adrenal system and the hypothalamic-pituitary-adrenal (HPA) axis, affecting the mechanisms regulating stress responsiveness [47]. Caroll JE et Al. in the same trend established an association between allostatic load and sleep impairment [48]. Carroll JE et Al. measured 22 biomarkers and included them in an allostatic load score, representative of 7 different physiological systems which were the cardiovascular system (systolic blood pressure, pulse pressure, and heart rate), lipid metabolic system (triglycerides, high density lipoprotein (HDL), low density lipoprotein (LDL), body mass index, and waist-hip ratio), glucose metabolic system (fasting blood glucose, glycosylated hemoglobin, and the homeostasis model of assessment of insulin resistance (HOMA-IR)), immune system (inflammatory markers: C-reactive protein, Interleukin (IL)-6, e-Selectin, intracellular adhesion molecule-1, and fibrinogen), sympathetic nervous system (SNS; Urinary norepinephrine and epinephrine), parasympathetic nervous system (PNS; heart rate variability: standard deviation of R-R intervals, low frequency (LF) and high frequency (HF) spectral power), and hypothalamic-pituitary-adrenal system (urinary cortisol and serum dehydroepiandrosterone sulfate (DHEA-S)) [48]. They found that self-reported poor sleep quality with either short or long sleep duration is associated with dysregulation in physiological set points across regulatory systems, leading to elevated multisystem biological risk. Vgontzas et al. found that a modest daily restriction of sleep by 2 hours per night for 1 week in young healthy men and women is associated with significant increase in sleepiness, decrements in psychomotor performance, and increased secretion of the proinflammatory cytokines IL-6 and/or TNFα [49]. Their research also demonstrated that increased sleepiness and decreased performance occurred despite SWS preservation in terms of absolute amounts or increase as a percentage of total sleep [49]. Ekstedt et al. further linked microarousals with elevated levels of cortisol, lipids,

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heart rate, and blood pressure, as well as self-reported work-related stress, showing possible metabolic and cardiovascular contributions [50,51]. Roman et al. found chronic sleep restriction may lead to changes in neurotransmitter receptor systems and neuroendocrine reactivity in a manner similar to that seen in depression, that's means chronic stress and sleep loss may partly via different pathways, change the brain into a direction as it is seen in mood disorders [52]. They also found evidence for a desensitization of the (5-HT)1A receptor system after chronic sleep restriction in rats, providing implications for altered brain serotonergic neurotransmission and subsequent mood disorders [53]. To resume, inadequate sleep has been related to a wide range of negative functional outcomes, including somatic and psychosocial health, school performance and risk taking behaviour [49,54-58].

Meta-analyses of observational cohort studies on the association between cardiovascular diseases and sleep components has provided consistent results for a higher incidence of hypertension [59], heart disease [60,61], obesity [62], and diabetes [63]. The embedded mechanisms may include increased insulin resistance, altered hormonic appetite signalling (elevated ghrelin and lowered leptin, peptide YY, and glucagon-like peptide-1 levels), and increased caloric intake leading to impaired glucose metabolism and weight gain [60,62,63].Yin J et al. recently demonstrated that both short and long sleep duration is associated with an increased risk of all-cause mortality and cardiovascular events [61]. Pathophysiological mechanisms responsible for these associations are thought to be the autonomic and HPA axis dysregulation and the subsequent stimulation of pro-inflammatory pathways, as indicated by the increased levels of inflammatory cytokines and cortisol after sleep restriction [47,53]. Furthermore, Sauvet et al. discovered early effects of acute sleep deprivation on endothelial function before the increase in sympathetic activity. Their findings demonstrated that total sleep deprivation induces a reduction in endothelial-dependent vasodilation and this endothelial dysfunction was independent of blood pressure and sympathetic activity; but associated with nitric oxide synthase and cyclooxygenase pathway alterations resulting from sleep impairments [64]. Their results were confirmed in a

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randomized trial performed by Calvin et al. who found that in healthy individuals, moderate sleep restriction causes endothelial dysfunction [65].

Finally, circadian disruption caused by light exposure at night and desynchronised feeding schedules, as in shift workers, can alter the homeostasis of cellular metabolism, induce inflammation and contribute to tumorigenesis and cancer development [66]. Experimental animal studies have shown that chronodisruption, either by environmental cues or by physical and genetic manipulation of the suprachiasmatic nucleus, promotes cancer growth in tumor models [10].

3- Mediation of the socioeconomic status-health gradient by sleep disturbances

Like many other concepts, SES and its impact on health outcomes have different expression and different time frame from one individual to another, even among the members from the same community or from same socioeconomic background [13,42,67-71]. This is a manifestation of health gradient, which is affected by the structure of the society, the social position occupied by individuals and their ability to aggregate resources useful for their own well-being [72-74]. Etindele et al. presented brain disorders as a complex combination, resulting from a diversity of psychosocial, physiological and environmental risk factors modifying neuronal networks, and leading to cognitive impairment, suicidal ideation and associated outcomes such as mood disorders and sleep disorders [11,12,22,75]. According to previous reports, these factors reveal systematic trends in the distribution of health issues each person is exposed in their lifetime; leading to chronic conditions during aging or financial burden due to significant comorbidities from middle-age to elderly life [13,24,30]. Tomfohr et al explored this theory by measuring the association between SES in childhood and adult sleep and analyzing adult sleep according to race [76]. They also evaluated if there is any associations between SES, race and sleep are influenced by factors such as health practices and current social status. The experimental

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design was mixed, with a combination of interviews and polysomnography; allowing researchers to obtain perceived or self-reported measures and quantitative measures. They found that participants with lower childhood SES spent more time in Stage 2 sleep and less time in slow-wave sleep than those with higher childhood SES. Their findings showed that women from low childhood SES had more difficulties to fall asleep compared with women with high SES. Their sample was representative with women from different social class or ethnicity; black participants spent less time in slow-wave sleep than white participants. An interaction of Age X Race was identified in the prediction of subjective sleep quality, confirming the influence of age in the relation to SES and SD.

Since SES influences sleep outcomes and poor sleep has direct effects on health, as we described earlier, researchers have further focused on the hypothesis that SD partly mediates the negative SES-health gradient. In earlier studies, Mulatu and Schooler identified significant longitudinal and reciprocal connections between SES (with his indicators like income, type of job and daily living) and self-reported general health with sleeping behaviour serving as significant mediator variable, and they found an inverse association between SES and sleep duration, despite the fact that low SES predicted poorer overall health [77]. More precisely, their results indicated that social background, job, and psychological characteristics are predictive of health outcomes both directly and indirectly and that job conditions and psychological characteristics have these effects even after a lapse of 20 years [78]. On the other hand, Moore et al. found a significant role for poor sleep quality instead of quantity in explaining poor perceived physical and mental health of low-income subjects [79]. Contoyannis and Jones explained later this perception of sleep impairment by employing complex statistical methods to estimate the effects of lifestyle and socioeconomic factors on health outcomes. They concluded that over 75% of the total effect of lifestyle factors on the SES-health gradient is masked when they are only considered exogenous variables; accounting for endogeneity, sleeping the recommended amount of hours has a much larger positive impact on general health [80]. Sekine et al. tested the

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hypothesis that sleep quality mediates the relationship between SES and health related quality of life and identified significant gender differences, concluding that the influence of SES is more evident on the physical and particularly mental health of men rather than women [24]. In a more recent research on children, insomnia complaints were proven as mediator of the association between low perceived family economy and self-reported mental health problems [81].

Prather AA et al. showed that sleep duration and efficiency mediates the negative relation between perceived social ranking and susceptibility to common cold. They found that shorter sleep duration, measured behaviourally using actigraphy prior to viral exposure, was associated with increased susceptibility to the common cold [82]. Kumari et al. studied dysregulation of the HPA axis associated with disadvantaged social position in working populations and also among retired older people. They found that sleep behaviors and lower income mediates the effect of occupational status on the cortisol secretion [83]. Hawkley et al. investigated the implications of SES on physiological dysregulation. They found that sleep disturbances mediates the effects of SES in a middle to early old-age population, influencing and worsening the association between allostatic load and SES [84].

All these findings reveal implication and mediating influence that social conditions and their determinants exerts on global health in the life course in general, and often through some sleep disorders [45,67,68,85-87]. This is true for every society, developing country or low and middle-income countries. Epidemiology of populational health demonstrated that influence of SES is present for children, adolescents and old people; regardless of someone living in developed country like USA or low-income region like Sub-Saharan Africa [45,67,68,85-87]. Lo and Lee explored sleep disturbances among seniors by investigating the prevalence of poor sleep quality, the relationship between sleep quality and health-related quality of life, and associated factors of good sleepers in different age group [88]. They found a negative association between poor quality and short-term sleep with a healthy quality of life and stated that such association worsens with aging [88]. Similar

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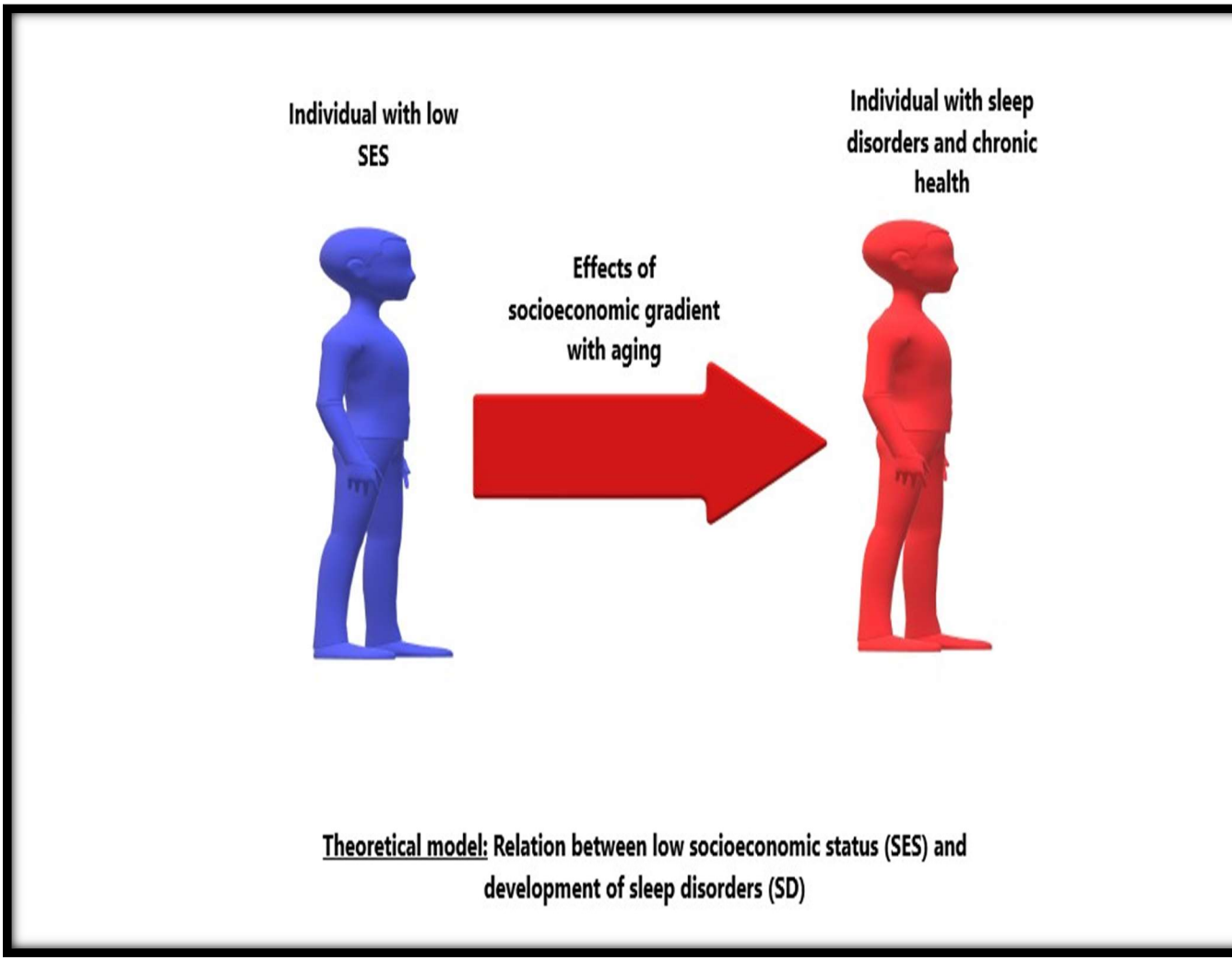
conclusions were seen by Green et al. who studied patterns of insomnia symptoms on elderly population and examined on how they vary according to gender and profession, using data of three cohorts followed for 20 years [45]. They found that chronic symptoms of insomnia expressed by difficulties in maintaining and initiating sleep are influenced by social factors [45]. Sleep disturbances appears, regardless of context; associated to SES. Sleep disorders are the result of a progressive accumulation of chronic stress (also named allostatic load) and they are also a predictive sign that an individual has reached his social resilience limit, as depicted in the figure 1.



Theoretical model: Relation between low socioeconomic status (SES) and development of sleep disorders (SD)

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4- Conclusions and future research

SD mechanisms remain unknown and external stimuli originating from environment complicates our general understanding. The existence of a socioeconomic gradient was newly recognized as a determinant of health, but sleep was not linked until recently with SES and clinical outcomes related to sleep impairment. More than the other stressors, the relation between SES and SD should be investigated. Living conditions and social class influences the development of health outcomes like SD by inducing allostatic load from the childhood until aging. Mood disorders, as well as metabolic diseases may be associated with this progressive decrease on the global health of people and sleep seems to be a good indicator of this decline. Until now SES is a concept indirectly observable, but with a clear definition and use of quantitative measures like polysomnography and hormonal controls, future investigations will improve our comprehension of this socioeconomic gradient and can help us to link the clinical outcomes observed with a direct or indirect effect of SES.

References

1. Baron KG, Reid KJ. Circadian misalignment and health. Int Rev Psychiatry. 2014 Apr;26(2):139-54.
2. Borbely AA. Sleep regulation. Introduction. Hum Neurobiol. 1982;1(3):161-2.
3. Diez-Garcia A, Garzon M. [Regulation of the phases of the sleep-wakefulness cycle with histamine]. Rev Neurol. 2017 Mar 16;64(6):267-277.
4. Ferri L, Filardi M, Moresco M, Pizza F, Vandi S, Antelmi E, et al. Non-24-Hour Sleep-Wake Rhythm Disorder and Melatonin Secretion Impairment in a Patient With Pineal Cyst. J Clin Sleep Med. 2017 Oct 04.
5. Leger D, Ogrizek P. [Review on sleep and awakening disorders]. Rev Med Interne. 2012 Sep;33(9):525-31.
6. Felden EP, Leite CR, Rebelatto CF, Andrade RD, Beltrame TS. [Sleep in adolescents of different socioeconomic status: a systematic review]. Rev Paul Pediatr. 2015 Dec;33(4):467-73.
7. Panossian L, Daley J. Sleep-disordered breathing. Continuum (Minneap Minn). 2013 Feb;19(1 Sleep Disorders):86-103.
8. Friberg D, Lundkvist K, Li X, Sundquist K. Parental poverty and occupation as risk factors for pediatric sleep-disordered breathing. Sleep Med. 2015 Sep;16(9):1169-75.
9. Kliewer W, Lepore SJ. Exposure to violence, social cognitive processing, and sleep problems in urban adolescents. J Youth Adolesc. 2015 Feb;44(2):507-17.
10. Jagannath A, Taylor L, Wakaf Z, Vasudevan SR, Foster RG. The genetics of circadian rhythms, sleep and health. Hum Mol Genet. 2017 Oct 1;26(R2):R128-r138.
11. Etindele Sosso FA, Raouafi S. Brain Disorders: Correlation between Cognitive Impairment and Complex Combination. Mental Health in Family Medicine. 2016;12:215-222.
12. Sosso FE. Neurocognitive Game between Risk Factors, Sleep and Suicidal Behaviour. Sleep Science. 2017;10(2017):41-46.
13. Phelan JC, Link BG, Tehranifar P. Social conditions as fundamental causes of health inequalities: theory, evidence, and policy implications. J Health Soc Behav. 2010;51 Suppl:S28-40.
14. Grandner MA, Jackson NJ, Izci-Balserak B, Gallagher RA, Murray-Bachmann R, Williams NJ, et al. Social and Behavioral Determinants of Perceived Insufficient Sleep. Front Neurol. 2015;6:112.
15. Grandner MA, Williams NJ, Knutson KL, Roberts D, Jean-Louis G. Sleep disparity, race/ethnicity, and socioeconomic position. Sleep Med. 2016 Feb;18:7-18.
16. Perales F, Plage S. Losing ground, losing sleep: Local economic conditions, economic vulnerability, and sleep. Soc Sci Res. 2017 Feb;62:189-203.
17. Piccolo RS, Yang M, Bliwise DL, Yaggi HK, Araujo AB. Racial and socioeconomic disparities in sleep and chronic disease: results of a longitudinal investigation. Ethn Dis. 2013 Autumn;23(4):499-507.
18. Chen KM, Lin MH, Wang YC, Li CH, Huang HT. Psychological and socioeconomic health of community-dwelling older adults. Int J Psychol. 2013;48(6):1038-49.
19. Etindele Sosso F Proceedings of 5th international conference on Alzheimer's disease and dementia: conference series p. https://d2cax41o7ahm5l.cloudfront.net/cs
20. Etindele Sosso F. Sleep Disorders and Insomnia: Effects on a Young Population. Psychology and Psychiatry. 2017;2:26-32.
21. Etindele Sosso F. Allostastic Load and Allostatic Weight: A Literature Review of a Confusing Concept. J Neurol Neurosci. 2018;09:242-247.
22. Etindele Sosso FA, Nakamura O, Mitsu N. Evaluation of Combined Effects of Insomnia and Stress on Sleep Quality and Sleep Duration. Journal of Neurology and Neuroscience. 2017;8(3).
23. Sosso FAE RS. An Overview of Positive Interaction between Exercise and Mental Health. J Neurol Neurosci. . 2017 August 31st, 2017;8(4):215-219.
24. Sekine M, Chandola T, Martikainen P, Marmot M, Kagamimori S. Work and family characteristics as determinants of socioeconomic and sex inequalities in sleep: The Japanese Civil Servants Study. Sleep. 2006 Feb;29(2):206-16.

25. Seo WH, Kwon JH, Eun SH, Kim G, Han K, Choi BM. Effect of socio-economic status on sleep. J Paediatr Child Health. 2017 Jun;53(6):592-597.
26. Stamatakis KA, Kaplan GA, Roberts RE. Short sleep duration across income, education, and race/ethnic groups: population prevalence and growing disparities during 34 years of follow-up. Ann Epidemiol. 2007 Dec;17(12):948-55.
27. Van Cauter E, Spiegel K. Sleep as a mediator of the relationship between socioeconomic status and health: a hypothesis. Ann N Y Acad Sci. 1999;896:254-61.
28. Hall M, Bromberger J, Matthews K. Socioeconomic status as a correlate of sleep in African-American and Caucasian women. Ann N Y Acad Sci. 1999;896:427-30.
29. Ryu SY, Kim KS, Han MA. Factors associated with sleep duration in Korean adults: results of a 2008 community health survey in Gwangju metropolitan city, Korea. J Korean Med Sci. 2011 Sep;26(9):1124-31.
30. Sivertsen B, Boe T, Skogen JC, Petrie KJ, Hysing M. Moving into poverty during childhood is associated with later sleep problems. Sleep Med. 2017 Sep;37:54-59.
31. Adler NE, Epel ES, Castellazzo G, Ickovics JR. Relationship of subjective and objective social status with psychological and physiological functioning: preliminary data in healthy white women. Health Psychol. 2000 Nov;19(6):586-92.
32. Anders MP, Breckenkamp J, Blettner M, Schlehofer B, Berg-Beckhoff G. Association between socioeconomic factors and sleep quality in an urban population-based sample in Germany. Eur J Public Health. 2014 Dec;24(6):968-73.
33. Arman AR, Ay P, Fis NP, Ersu R, Topuzoglu A, Isik U, et al. Association of sleep duration with socio-economic status and behavioural problems among schoolchildren. Acta Paediatr. 2011 Mar;100(3):420-4.
34. Bagley EJ, Kelly RJ, Buckhalt JA, El-Sheikh M. What keeps low-SES children from sleeping well: the role of presleep worries and sleep environment. Sleep Med. 2015 Apr;16(4):496-502.
35. Bapat R, van Geel M, Vedder P. Socio-Economic Status, Time Spending, and Sleep Duration in Indian Children and Adolescents. J Child Fam Stud. 2017;26(1):80-87.
36. Biggs SN, Lushington K, James Martin A, van den Heuvel C, Declan Kennedy J. Gender, socioeconomic, and ethnic differences in sleep patterns in school-aged children. Sleep Med. 2013 Dec;14(12):1304-9.
37. Counts CJ, Grubin FC, John-Henderson NA. Childhood socioeconomic status and risk in early family environments: predictors of global sleep quality in college students. Sleep Health. 2018 Jun;4(3):301-306.
38. Friedman EM, Love GD, Rosenkranz MA, Urry HL, Davidson RJ, Singer BH, et al. Socioeconomic status predicts objective and subjective sleep quality in aging women. Psychosom Med. 2007 Sep-Oct;69(7):682-91.
39. Grandner MA, Petrov ME, Rattanaumpawan P, Jackson N, Platt A, Patel NP. Sleep symptoms, race/ethnicity, and socioeconomic position. J Clin Sleep Med. 2013 Sep 15;9(9):897-905; 905a-905d.
40. Jarrin DC, McGrath JJ, Silverstein JE, Drake C. Objective and subjective socioeconomic gradients exist for sleep quality, sleep latency, sleep duration, weekend oversleep, and daytime sleepiness in adults. Behav Sleep Med. 2013 Apr;11(2):144-58.
41. Moore PJ, Adler NE, Williams DR, Jackson JS. Socioeconomic status and health: the role of sleep. Psychosom Med. 2002 Mar-Apr;64(2):337-44.
42. Nomura K, Yamaoka K, Nakao M, Yano E. Social determinants of self-reported sleep problems in South Korea and Taiwan. J Psychosom Res. 2010 Nov;69(5):435-40.
43. Soltani M, Haytabakhsh MR, Najman JM, Williams GM, O'Callaghan MJ, Bor W, et al. Sleepless nights: the effect of socioeconomic status, physical activity, and lifestyle factors on sleep quality in a large cohort of Australian women. Arch Womens Ment Health. 2012 Aug;15(4):237-47.
44. Goodin BR, McGuire L, Smith MT. Ethnicity moderates the influence of perceived social status on subjective sleep quality. Behav Sleep Med. 2010;8(4):194-206.
45. Green MJ, Espie CA, Hunt K, Benzeval M. The longitudinal course of insomnia symptoms: inequalities by sex and occupational class among two different age cohorts followed for 20 years in the west of Scotland. Sleep. 2012 Jun 1;35(6):815-23.
46. Okun ML, Tolge M, Hall M. Low socioeconomic status negatively affects sleep in pregnant women. J Obstet Gynecol Neonatal Nurs. 2014 Mar-Apr;43(2):160-7.
47. Chiang JJ, Tsai KM, Park H, Bower JE, Almeida DM, Dahl RE, et al. Daily family stress and HPA axis functioning during adolescence: The moderating role of sleep. Psychoneuroendocrinology. 2016 Sep;71:43-53.

48. Carroll JE, Irwin MR, Merkin SS, Seeman TE. Sleep and Multisystem Biological Risk: A Population-Based Study. PLOS ONE. 2015;10(2):e0118467.
49. Vgontzas AN, Zoumakis E, Bixler EO, Lin HM, Follett H, Kales A, et al. Adverse effects of modest sleep restriction on sleepiness, performance, and inflammatory cytokines. J Clin Endocrinol Metab. 2004 May;89(5):2119-26.
50. Ekstedt M, Nyberg G, Ingre M, Ekblom O, Marcus C. Sleep, physical activity and BMI in six to ten-year-old children measured by accelerometry: a cross-sectional study. Int J Behav Nutr Phys Act. 2013 Jun 22;10:82.
51. Ekstedt M, Darkeh MH, Xiu L, Forssen M, Johansson E, Ek A, et al. Sleep differences in one-year-old children were related to obesity risks based on their parents' weight according to baseline longitudinal study data. Acta Paediatr. 2017 Feb;106(2):304-311.
52. Roman V, Hagewoud R, Luiten PG, Meerlo P. Differential effects of chronic partial sleep deprivation and stress on serotonin-1A and muscarinic acetylcholine receptor sensitivity. J Sleep Res. 2006 Dec;15(4):386-94.
53. Novati A, Roman V, Cetin T, Hagewoud R, den Boer JA, Luiten PG, et al. Chronically restricted sleep leads to depression-like changes in neurotransmitter receptor sensitivity and neuroendocrine stress reactivity in rats. Sleep. 2008 Nov;31(11):1579-85.
54. Chervin RD, Clarke DF, Huffman JL, Szymanski E, Ruzicka DL, Miller V, et al. School performance, race, and other correlates of sleep-disordered breathing in children. Sleep Med. 2003 Jan;4(1):21-7.
55. Lauderdale DS, Knutson KL, Yan LL, Rathouz PJ, Hulley SB, Sidney S, et al. Objectively measured sleep characteristics among early-middle-aged adults: the CARDIA study. Am J Epidemiol. 2006 Jul 1;164(1):5-16.
56. Lima MG, Bergamo Francisco PM, de Azevedo Barros MB. Sleep duration pattern and chronic diseases in Brazilian adults (ISACAMP, 2008/09). Sleep Med. 2012 Feb;13(2):139-44.
57. Reddy EV, Kadhiravan T, Mishra HK, Sreenivas V, Handa KK, Sinha S, et al. Prevalence and risk factors of obstructive sleep apnea among middle-aged urban Indians: a community-based study. Sleep Med. 2009 Sep;10(8):913-8.
58. Wong JC, Li J, Pavlova M, Chen S, Wu A, Wu S, et al. Risk factors for probable REM sleep behavior disorder: A community-based study. Neurology. 2016 Apr 5;86(14):1306-12.
59. Wang Y, Mei H, Jiang YR, Sun WQ, Song YJ, Liu SJ, et al. Relationship between Duration of Sleep and Hypertension in Adults: A Meta-Analysis. J Clin Sleep Med. 2015 Sep 15;11(9):1047-56.
60. Itani O, Jike M, Watanabe N, Kaneita Y. Short sleep duration and health outcomes: a systematic review, meta-analysis, and meta-regression. Sleep Med. 2017 Apr;32:246-256.
61. Yin J, Jin X, Shan Z, Li S, Huang H, Li P, et al. Relationship of Sleep Duration With All-Cause Mortality and Cardiovascular Events: A Systematic Review and Dose-Response Meta-Analysis of Prospective Cohort Studies. J Am Heart Assoc. 2017 Sep 9;6(9).
62. Li L, Zhang S, Huang Y, Chen K. Sleep duration and obesity in children: A systematic review and meta-analysis of prospective cohort studies. J Paediatr Child Health. 2017 Apr;53(4):378-385.
63. Lee SWH, Ng KY, Chin WK. The impact of sleep amount and sleep quality on glycemic control in type 2 diabetes: A systematic review and meta-analysis. Sleep Med Rev. 2017 Feb;31:91-101.
64. Sauvet F, Florence G, Van Beers P, Drogou C, Lagrume C, Chaumes C, et al. Total sleep deprivation alters endothelial function in rats: a nonsympathetic mechanism. Sleep. 2014 Mar 1;37(3):465-73.
65. Calvin AD, Covassin N, Kremers WK, Adachi T, Macedo P, Albuquerque FN, et al. Experimental sleep restriction causes endothelial dysfunction in healthy humans. J Am Heart Assoc. 2014 Nov 25;3(6):e001143.
66. Jagannath A, Peirson SN, Foster RG. Sleep and circadian rhythm disruption in neuropsychiatric illness. Curr Opin Neurobiol. 2013 Oct;23(5):888-94.
67. Lallukka T, Sares-Jaske L, Kronholm E, Saaksjarvi K, Lundqvist A, Partonen T, et al. Sociodemographic and socioeconomic differences in sleep duration and insomnia-related symptoms in Finnish adults. BMC Public Health. 2012 Jul 28;12:565.
68. Li X, Sundquist K, Sundquist J. Socioeconomic status and occupation as risk factors for obstructive sleep apnea in Sweden: a population-based study. Sleep Med. 2008 Jan;9(2):129-36.
69. Mezick EJ, Matthews KA, Hall M, Strollo PJ, Jr., Buysse DJ, Kamarck TW, et al. Influence of race and socioeconomic status on sleep: Pittsburgh SleepSCORE project. Psychosom Med. 2008 May;70(4):410-6.
70. Paine SJ, Gander PH. Explaining ethnic inequities in sleep duration: a cross-sectional survey of Maori and non-

Maori adults in New Zealand. Sleep Health. 2016 Jun;2(2):109-115.
71. Paine SJ, Harris R, Cormack D, Stanley J. Racial Discrimination and Ethnic Disparities in Sleep Disturbance: the 2002/03 New Zealand Health Survey. Sleep. 2016 Feb 1;39(2):477-85.
72. McLaughlin Crabtree V, Beal Korhonen J, Montgomery-Downs HE, Faye Jones V, O'Brien LM, Gozal D. Cultural influences on the bedtime behaviors of young children. Sleep Med. 2005 Jul;6(4):319-24.
73. Patel SR, Sotres-Alvarez D, Castaneda SF, Dudley KA, Gallo LC, Hernandez R, et al. Social and Health Correlates of Sleep Duration in a US Hispanic Population: Results from the Hispanic Community Health Study/Study of Latinos. Sleep. 2015 Oct 1;38(10):1515-22.
74. Pena MM, Rifas-Shiman SL, Gillman MW, Redline S, Taveras EM. Racial/Ethnic and Socio-Contextual Correlates of Chronic Sleep Curtailment in Childhood. Sleep. 2016 Sep 1;39(9):1653-61.
75. Etindele Sosso FA. Negative Involvement of the Working Environment in the Occurrence of Cognitive Disorders. Transl Biomed. 2017;8:2.
76. Tomfohr LM, Ancoli-Israel S, Dimsdale JE. Childhood socioeconomic status and race are associated with adult sleep. Behav Sleep Med. 2010;8(4):219-30.
77. Mulatu MS, Schooler C. Causal connections between socio-economic status and health: reciprocal effects and mediating mechanisms. J Health Soc Behav. 2002 Mar;43(1):22-41.
78. MULATU MS, SCHOOLER C. Longitudinal Effects of Occupational, Psychological, and Social Background Characteristics on Health of Older Workers. Annals of the New York Academy of Sciences. 1999;896(1):406-408.
79. Moore M, Kirchner HL, Drotar D, Johnson N, Rosen C, Redline S. Correlates of adolescent sleep time and variability in sleep time: the role of individual and health related characteristics. Sleep Med. 2011 Mar;12(3):239-45.
80. Contoyannis P, Jones AM. Socio-economic status, health and lifestyle. J Health Econ. 2004 Sep;23(5):965-95.
81. Boe T, Hysing M, Stormark KM, Lundervold AJ, Sivertsen B. Sleep problems as a mediator of the association between parental education levels, perceived family economy and poor mental health in children. J Psychosom Res. 2012 Dec;73(6):430-6.
82. Prather AA, Janicki-Deverts D, Hall MH, Cohen S. Behaviorally Assessed Sleep and Susceptibility to the Common Cold. Sleep. 2015 Sep 1;38(9):1353-9.
83. Kumari M, Badrick E, Chandola T, Adler NE, Epel E, Seeman T, et al. Measures of social position and cortisol secretion in an aging population: findings from the Whitehall II study. Psychosom Med. 2010 Jan;72(1):27-34.
84. Hawkley LC, Lavelle LA, Berntson GG, Cacioppo JT. Mediators of the relationship between socioeconomic status and allostatic load in the Chicago Health, Aging, and Social Relations Study (CHASRS). Psychophysiology. 2011 Aug;48(8):1134-45.
85. Gu D, Sautter J, Pipkin R, Zeng Y. Sociodemographic and health correlates of sleep quality and duration among very old Chinese. Sleep. 2010 May;33(5):601-10.
86. Gureje O, Oladeji BD, Abiona T, Makanjuola V, Esan O. The natural history of insomnia in the Ibadan study of ageing. Sleep. 2011 Jul 1;34(7):965-73.
87. Hsu YW, Ho CH, Wang JJ, Hsieh KY, Weng SF, Wu MP. Longitudinal trends of the healthcare-seeking prevalence and incidence of insomnia in Taiwan: an 8-year nationally representative study. Sleep Med. 2013 Sep;14(9):843-9.
88. Lo CM, Lee PH. Prevalence and impacts of poor sleep on quality of life and associated factors of good sleepers in a sample of older Chinese adults. Health Qual Life Outcomes. 2012 Jun 18;10:72.