Section: Physiology

Original Research Article

IS SOCIAL JET LAG AFTER SLEEP DEBT CORRECTION, ASSOCIATED WITH OBESITY AND PREFERENCE FOR JUNK FOOD CONSUMPTION IN YOUNG ADULTS? - A CROSS SECTIONAL ANALYTICAL STUDY

Sowmya Rajaram[1], Suraj Rangam Sathyanarayana[2]

[1]Assistant Professor, Department of Physiology, Bangalore Medical College and Research Institute, Bengaluru, India
[2]Post-graduate student, Department of Physiology, Bangalore Medical College and Research Institute, Bengaluru, India

Received : 03/01/2024
Received in revised form : 22/02/2024
Accepted : 07/03/2024

Keywords:
Circadian misalignment, Social jet lag, obesity, junk food.

Corresponding Author:
Dr. Sowmya Rajaram
Email: rajaram.sowmya@gmail.com

DOI: 10.47009/jamp.2024.6.2.80

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (2); 379-383

Abstract

Background: Circadian misalignment, the discrepancy between social and biological clocks can be quantified and is given by the absolute difference between mid-point of sleep time of the night before workdays and that of the night before weekend. Research studies have shown that Social Jet Lag (SJL) is associated with obesity. However, SJL is confounded by sleep debt or sleep loss which gives a higher value of social jet lag, than the true value which is obtained after sleep debt correction. **Objectives:** Our primary objective was to determine whether SJLSDC (social jet lag after sleep debt correction) is associated with body mass index, waist circumference and body composition parameters. A second objective was to determine whether SJLSDC was associated with junk food preference score. **Materials and Methods:** 103 subjects completed the google form which enquired about the sleep onset and offset during the workdays and free days during last 1month, International Physical Activity Questionnaire (IPAQ) Short form, and Junk food preference. Measurements of height, weight, waist circumference were taken by a trained observer and body composition was estimated by a bioelectrical impedance analyser. **Results:** Predictor equations were obtained when dependent variable was subcutaneous fat %, visceral fat % or fat free mass. However, BMI and Waist circumference were not associated with SJLSDC. Statistically significant correlation coefficient of 0.231 showed that as the log transformed (LT) SJLSDC increased, the junk food preference score also increased. **Conclusion:** We need to educate our young population right from school to have regular sleep timings, and to inculcate healthy food habits and shun junk food, to be physically active and avoid sedentary behaviour so that they don't suffer from SJL and obesity.

INTRODUCTION

The social clock determines our time of going to sleep at night and the time of waking up in the morning in order to attend to work or school. During weekends, we are free to choose the time of going to sleep and the time of waking up as we don't have any social obligations. The absolute difference between mid-point of the sleep time during nights before workdays, and nights before weekend, is termed as social jetlag. That is, if one were to go to sleep at 11pm and wake up at 6am on workdays and, were to sleep at 1am on the night before weekends and wake up at 11 am on weekends, then, midsleep time on the night before workdays would be 2.30am and during weekend night would be 6am and Social jet lag (SJL) would be 3.5 hours. The term SJL was coined by Roenneberg in 2006.[1]

In the run against the biological clock, in order to keep up with the social clock, in some people, a sleep deprivation also referred to as sleep debt is incurred and confounds the value of SJL (Social Jet Lag). For those subjects whose sleep duration was higher during workdays nights and who went to sleep later on free days than workdays, SJLSDC (Social Jet Lag after Sleep Debt Correction) was given by the difference between sleep offset on free days and workdays. For those subjects whose sleep duration was higher during free days and who woke up from sleep later on free days than workdays, SJLSDC was given by the difference between sleep onset on free days and workdays.[2] The SJLSDC in above example is 2hours.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

The circadian clock regulates energy homeostasis and the disruption of energy homeostasis may result in obesity.[3] Research studies have shown that social jet lag is associated with obesity.[3,4] Literature shows that sleep debt per se is also associated with obesity, type 2 diabetes mellitus and other metabolic diseases.[5] Hence the need for removing the effect of the sleep debt (confounding factor) and estimating the value of social jet lag after sleep debt correction (SJLSDC). This was proposed by Jankowski.[2]

In 2019, Rugerio et al published a paper on the research conducted on social jet lag in the Spanish general population and the findings were that individuals with greater social jet lag showed lower adherence to Mediterranean diet, that is lesser intake of vegetables and fruits, and skipping breakfast and had a higher body mass index (BMI).[6]

Research conducted by Kim et al on Korean adults as part of Korean National health and nutrition examination survey and published in 2020, showed that social jet lag was associated with obesogenic tendency only in men. This study showed that as the SJL increased, so did the body mass index.[7]

In a cross-sectional study published by Suikki et al in 2021, Social jet lag greater than or equal to 2 hours was seen in evening chronotypes, and an increase in social jet lag was associated with high body mass index. Those with high social jet lag also showed lesser adherence to Baltic diet. Also, here the authors calculated social jet lag after sleep debt correction and used that parameter. In other words, they studied the parameter SJLSDC instead of SJL, which was used in the other studies.[8]

A research study conducted on Brazilian general population by Mota et al, 2019 showed that those with social jet lag preferred eating energy-dense processed food. Those with social jet lag had a higher risk of consumption of total fat, saturated fat and cholesterol when compared to those without social jetlag.[9]

There are no studies done in Indian population regarding SJL and its association with obesity and anthropometric indices. Furthermore, except for one Finnish study published in 2021, there are no studies so far studying the association between social jet lag after sleep debt correction (SJLSDC) (after removing the confounding factor Sleep debt) and its association with obesity in young adults. Hence, we undertook this study.

Our objectives were

1. To determine whether an increase in SJLSDC was associated with an increase in Body mass index, waist circumference, fat mass, fat-free mass, visceral fat percent and subcutaneous fat percent in young adult Indians
2. To determine whether an increase in SJLSDC is associated with preference for low nutritive value but energy dense processed food in young adult Indians.

MATERIALS AND METHODS

Subjects: Ethical approval for this research study was obtained from the Ethical clearance committee of Bangalore Medical College and research institute. We obtained written informed consent from each of the subjects who volunteered. Based on the inclusion and exclusion criteria, they were recruited for the study. Inclusion criteria were age from 19 to 30 years, either genders and young university students and office staff from BMCRI, who were teetotallers. Smokers, and subjects with any acute or chronic illness or taking any regular drugs/medications were excluded. Subjects were administered a google form with 4 sets of questions (1) Biographic information (2) sleep onset and offset timings during work days and free days (3) junk food questionnaire, (4) International physical activity questionnaire (IPAQ). After completing the questionnaires, subjects came to human experiment laboratory for measurements. Data collection were carried out from July 2023 to Aug 2023. Out of 140 subjects who filled the questionnaire, only 131 came for measurements. Finally, after deleting those for missing values, we had complete data for 103 subjects.

Materials

(1) Biographic information was collected from subjects.

(2) Circadian misalignment was assessed from questionnaire enquiring about sleep onset and sleep offset during workdays and weekends. The absolute difference in midsleep time between work days (MSW) and free days (MSF) was calculated as Social Jet Lag. The SJLSDC (after removing the confounder sleep debt) was calculated [2].

(3) Junk food questionnaire: Which was designed by the authors to assess the preference for junk food in the subjects consisted of 7 questions each of which carried a maximum score of 8. The maximum score was 56 while the minimum score was 9.

(4) Short form of International Physical Activity Level Questionnaire: It enquired about the vigorous or highly intensive activity, moderate level of activity and walking activity performed for a minimum of at least 10 minutes at a time by subjects in the last 1 week.

(5) MCP Wall-Mounted growth stature meter with height measuring tape was used to measure height to the nearest 5mm.

(6) Beat XP Smart plus Model no BXPBMI1004, Unit Kg/Lb, Capacity 6-180 kg/13.2-396 Lb/0.93-28st. Following calibration, the subjects were instructed to stand bare feet on it with each of their hindfeet and forefeet in direct contact with the four metal sensors without any intervening clothing or socks.

Statistical analysis: Data were entered in Microsoft Excel and descriptive statistics were performed using JAMOVI, an open source software, and were expressed as median and Interquartile range. Inferential statistics were performed with multiple

ISSN (O): 2687-5365; ISSN (P): 2753-6556

regression analysis. Firstly, it was checked whether the assumptions of multiple regression analysis, which were normality, independence, linearity, homoskedasticity, and no multi collinearity, were met. Then gender, total junk food preference (JFP) score, total physical activity level (TPAL) score and SJLSDC score were independent variables taken simultaneously and each of the dependent variables which were Body Mass Index, Waist circumference, Waist hip ratio, fat mass, fat free mass, subcutaneous fat percent and visceral fat percent were taken one at a time to derive equations. Correlation between junk food score and SJLSDC using Pearson's correlation coefficient was performed. P less than 0.05 was regarded as significant.

RESULTS

Inferential statistics on table 4 shows that when the dependent variable was either fat- free mass, visceral fat% or subcutaneous fat%, each of these variables(y) could be predicted by the four independent variables simultaneously. This is indicated statistically by the significant p value and the high F statistics which indicates that it is not merely by chance.

However, the same set of independent variables could not predict log transformed Body Mass Index (LT BMI), Waist circumference, Waist hip ratio, or Fat mass (LT fat Mass).

The prediction equation when the y is for Fat free mass is given by Y = 4.27 - 0.30 (male=1, females=2) - 0.03 (Junk food preference score) - 0.0016(Total Physical activity level score) - 0.001(SJLSDC score)

The prediction equation when the y is for Subcutaneous Fat is given by Y = 9.57 + 5.519 (male=1, females=2) + 0.02 (Junk food preference score) - 0.4108 (Total Physical activity level score) - 0.2948 (SJLSDC score)

The prediction equation when the y is for visceral Fat is given by Y= 2.9 - 0.48 (male=1, females=2) - 0.306(Junk food preference score) + 0.0024 (Total Physical activity level score) + 0.0409 (SJLSDC score)

Correlation matrix depicting Pearson's correlation coefficient was 0.231 and P value of 0.039 showed that the two log transformed values of SJLSDC and Junk food preference score correlated well with each other.

No significant correlation was found between log transformed values of SJLSDC and Total Physical Activity Level (TPAL) and also between log transformed values of SJLSDC and sedentary time in minutes per day.

Table 1 shows the median and IQR of subjects age, waist circumference, hip, circumference and waist/hip ratio

Parameter	Age completed in years	Waist circumference in cms	Hip Circumference	W/H ratio
N	103	103	103	103
Median	19	77	92	0.821
IQR	0.5	11	11	0.0646
Shapiro-Wilk W	0.358	0.983	0.982	0.977
Shapiro-Wilk p	< .001	0.208	0.187	0.067

Table 2 shows the median, Interquartile Range (IQR) of subject's BMI, Fat Mass, fat free mass, subcutaneous fat in %, visceral fat in % and Muscle Mass in Kgs.

Parameter	BMI	Fat Mass in kgs	Fat free body weight in kgs	Subcutaneous fats in %	Visceral Fat in %	Muscle mass in kgs
N	103	103	103	103	103	103
Median	21.6	13	45.5	14.9	3.6	42.6
IQR	4.35	9.1	13.6	8.2	3.1	12.6
Shapiro-Wilk W	0.95	0.941	0.961	0.989	0.94	0.959
Shapiro-Wilk p	< .001	< .001	0.004	0.525	< .001	0.003

Table 3 shows the median, IQR of subject's Total Diet score, Total METS expended, Sedentary time in Minutes per day, SJL in hours and SJL SDC in hours.

Parameter	Total Diet Score	Total METS	Sedentary time in minutes per day	SJLin hrs	SJL SDC
N	103	103	103	103	103
Median	24	1480	480	1.25	1
IQR	8	2520	255	1.12	1
Shapiro-Wilk W	0.964	0.72	0.944	0.944	0.832
Shapiro-Wilk p	0.006	< .001	< .001	< .001	< .001

Table 4 shows the beta coefficient of the 4 independent variables -gender, junk diet score, total physical activity level and social jet lag after sleep debt correction when the dependent variable is LTBMI, Waist circumference, Waist/hip ratio, LT fat mass, LT fat free mass, subcutaneous fat and LT visceral fat.

Y=dependent variable	Intercept or Constant	Beta one Gender	Beta 2 junk food score	Beta 3 Total physical activity level	Beta 4 social jet lag after sleep Debt correction	Adjusted r square	F	Value P
Log transformed body mass index	3.246	- 0.034	-0.005	- 0.015	0.00402	- 0.0307	0.349	0.0844

ISSN (O): 2687-5365; ISSN (P): 2753-6556

waist circumference	103.58	- 5.59	- 3.57	-0.915	- 1.26	0.0492	1.96	0.110
waist to hip ratio	1.065	-0.022	-0.061	- 0.001	- 0.00958	0.0462	1.9	0.121
Logarithm transformed fat mass	2.2109	0.2655	0.0838	-0.0537	- 0.0413	0.0426	1.82	0.134
Logarithm transformed fat free mass	4.27218	-0.303	0.03243	-0.0157	-0.00106	0.729	50.8	Less than 0.001
Subcutaneous fat	9.5774	5.5192	0.0176	-0.4108	-0.2948 0	0.290	8.55	Less than 0.01
Logarithm transformed visceral mass	2.934	- 0.480	-0.306	0. 0024	0.04094	0.131	3.79	Less than 0.001

*Variables that were not normally distributed were Log Transformed before inferential statistics.

DISCUSSION

Our findings reveal that visceral fat%, subcutaneous fat% and fat free mass in kgs could be predicted from the model equations, with the same four independent variables (gender, LT Junk food score, LTSJLSDC and LTTPAL score) acting simultaneously. Also, the P value when BMI was dependent variable was 0.08. This shows a trend towards significance even though it is statistically insignificant. We also found that there is a significant correlation between LT junk food score and LTSJLSDC showing a correlation co-efficient value of 0.231 and P value of 0.039.

Research studies have shown that an increase in SJL is associated with an increase in Body Mass Index[6-9]. In one study from Netherlands, the authors found that there was no association between SJL and BMI.[10] They have explained that a low sample size and a smaller number of overweight and obese were responsible for the negative result. In our study, a P value of 0.08 has shown a trend towards significance. A larger sample and a greater number of overweighing or obese adults in our study, and a higher representation of adults in their late 20s would have yielded significant value. Furthermore, the parameter SJLSDC which we studied was derived from SJL after removing the confounder sleep debt.

Research conducted by Taheri et al[11] has shown that those who sleep less than 8 hours per night have an increase in BMI which is proportional to the decreased sleep hours. There was a 14.9% increase in Ghrelin (the hunger hormone), and a decrease in Leptin (the satiety hormone) in those who slept for less than 5hrs (recorded by polysomnography) in contrast to those who slept for more than 8hours. These changes increase appetite and increase food ingestion leading to an increase in weight gain. SJL is associated with a decrease in sleep duration during some nights of the week. Such shortened sleep durations increase hunger and food ingestion and hence an increase in weight.

The result that there is a positive correlation between log transformed SJLSDC and log transformed junk food preference score means that as the SJLSDC increased so did the junk food preference. This indicates that this is one of the mechanisms through which overweight or obesity occurs in nature. There are studies that showed that SJL per se was associated with skipping morning breakfast and preference for calorie-rich, but non-nutritive energy drinks, caffeinated drinks and preference for fat-rich diet.[6-9]

Strengths and Limitations: Objective methods of body composition measurement using the Bio-Electrical Impedance Analyzer was one of the strengths of this study. The observer taking measurements was blinded to the hypothesis. And also, the social jet lag after sleep correction status of the subjects, which were calculated from the values in google form, was not disclosed to the observer. Our study was a cross-sectional analytical study and hence the causative nature of SJLSDC, leading to obesity could not be ascertained. A longitudinal study design is required to prove causation. There are not many studies using a longitudinal study design and there is a definite knowledge gap in this area.

CONCLUSION

We need to inform and educate not only the young adults, but also adolescents and children, as SJL develops during puberty and peaks in late adolescence, regarding the need to go to bed at the same time every day. Furthermore, adolescents and young adults should be appraised of what constitutes a healthy diet and the hazards and pitfalls of preferring bakery foods, sweets, fried foods and caffeinated soft drinks or energy drinks and also, the need to be physically active and to shun sedentary behaviour, should be inculcated right from schools so that our young population does not fall prey to social jet lag, and/or obesity and other cardiovascular or metabolic diseases.

REFERENCES

1. Wittmann M, Dinich J, Merrow M, Roenneberg T. Social jetlag: misalignment of biological and social time. Chronobiol Int. 2006;23(1-2):497-509. doi: 10.1080/07420520500545979. PMID: 16687322.
2. Jankowski KS. Social jet lag: Sleep-corrected formula. Chronobiol Int. 2017;34(4):531-535. doi: 10.1080/07420528.2017.1299162. Epub 2017 Mar 20. PMID: 28318321.
3. Roenneberg T, Allebrandt KV, Merrow M, Vetter C. Social jetlag and obesity. Curr Biol. 2012 May 22;22(10):939-43.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

doi: 10.1016/j.cub.2012.03.038. Epub 2012 May 10. Erratum in: Curr Biol. 2013 Apr 22;23(8):737. PMID: 22578422.
4. Koopman ADM, Rauh SP, van 't Riet E, Groeneveld L, van der Heijden AA, Elders PJ, Dekker JM, Nijpels G, Beulens JW, Rutters F. The Association between Social Jetlag, the Metabolic Syndrome, and Type 2 Diabetes Mellitus in the General Population: The New Hoorn Study. J Biol Rhythms. 2017 Aug;32(4):359-368. doi: 10.1177/0748730417713572. Epub 2017 Jun 20. PMID: 28631524; PMCID: PMC5564947.
5. Cooper CB, Neufeld EV, Dolezal BA, Martin JL. Sleep deprivation and obesity in adults: a brief narrative review. BMJ Open Sport Exerc Med. 2018 Oct 4;4(1):e000392. doi: 10.1136/bmjsem-2018-000392. PMID: 30364557; PMCID: PMC6196958.
6. Zerón-Rugerio MF, Cambras T, Izquierdo-Pulido M. Social Jet Lag Associates Negatively with the Adherence to the Mediterranean Diet and Body Mass Index among Young Adults. Nutrients. 2019 Jul 30;11(8):1756. doi: 10.3390/nu11081756. PMID: 31366143; PMCID: PMC6723476.
7. Kim JH, Lyu YS, Kim Y. Impact of Social Jetlag on Weight Change in Adults: Korean National Health and Nutrition Examination Survey 2016-2017. Int J Environ Res Public Health. 2020 Jun 18;17(12):4383. doi: 10.3390/ijerph17124383. PMID: 32570840; PMCID: PMC7344837.
8. Suikki T, Maukonen M, Partonen T, Jousilahti P, Kanerva N, Männistö S. Association between social jet lag, quality of diet and obesity by diurnal preference in Finnish adult population. Chronobiol Int. 2021 May;38(5):720-731. doi: 10.1080/07420528.2021.1876721. Epub 2021 Feb 8. PMID: 33557623.
9. Mota MC, Silva CM, Balieiro LCT, Gonçalves BF, Fahmy WM, Crispim CA. Association between social jetlag food consumption and meal times in patients with obesity-related chronic diseases. PLoS One. 2019 Feb 12;14(2):e0212126. doi: 10.1371/journal.pone.0212126. PMID: 30753224; PMCID: PMC6372231.
10. de Zwart BJ, Beulens JWJ, Elders P, Rutters F. Pilot data on the association between social jetlag and obesity-related characteristics in Dutch adolescents over one year. Sleep Med. 2018 Jul;47:32-35. doi: 10.1016/j.sleep.2018.03.024. Epub 2018 Apr 12. PMID: 29880145..
11. Taheri S, Lin L, Austin D, Young T, Mignot E. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. PLoS Med. 2004 Dec;1(3):e62. doi: 10.1371/journal.pmed.0010062. Epub 2004 Dec 7. PMID: 15602591; PMCID: PMC535701.

ISSN (O): 2687-5365; ISSN (P): 2753-6556