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Objective assessment of nap as a method to improve cognitive performance using a bio-mathematical model

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ABSTRACT

Introduction: Strategic naps are considered as efficacious means of maintaining performance and reducing the individual's sleep debt. It can reduce subjective feelings of fatigue and improve performance and alertness. However, literature is scant on assessment of naps and associated cognitive performance in the Indian military aviation scenario. This study is an attempt to assess the nap duration and its objective assessment on gain in performance, if any.

Material and Methods: In this cross-sectional observational study, sleep data were collected from 23 aviation personnel in a military flying base using actigraphy device. The actigraphic data were then fed into a software called fatigue avoidance scheduling tool. The nap duration and its effect on cognitive parameters were analyzed.

Results: About 65.2% of the participant were found to be Day-Time Habitual Nappers. Of the 50 Naps logged by these participants, 11 (22%) naps were less than 30 min, 14 (28%) were between 30 and 60 min, 15 (30%) were between 60 and 120 min, and only 10 (20%) were above 120 min. Post-nap gain in the effectiveness and other cognitive parameters was found to be different in different cognitive domains.

Conclusion: Naps more than 30 min had the optimal efficiency. The nap-induced gain in the task effectiveness and cognitive performance was confirmed. While the performance enhancement was significant for the naps more than 30 min, naps more than 60 min did not have any added advantages.

Keywords: Fatigue, Napping, Actigraphy, Bio-mathematical model, Cognitive performance

INTRODUCTION

Fatigue in aviation has been an threat to aviation safety because of the resultant impairment in alertness and crew performance.[1] Fatigue is known to affect many cognitive functions such as impairment of short-term memory, increased reaction time, and errors of omission.[2] Significant decrement in cognitive performance invariably results in errors, some of which may prove fatal. It also endures a variety of physical, psychological, and physiological stressors that affects the operational effectiveness of the crew. Fatigue is a major contributor for aircrew errors[3] and hence of aircraft accidents.[4] As per Shappell and Weigman, 70% of aircraft accidents can be attributed to human error.[5]

Aviation organizations have adopted multi-pronged approach to counter this challenge. Strategic napping is one such measure. Caldwell *et al*. have described that a well-planned nap is the best countermeasure for fatigue as this serves as a recuperative function to attenuate the effects of fatigue on performance.[6] It was recommended that naps should be considered as a first-line approach toward preserving alertness on the job whenever 8 h of consolidated sleep would not be possible. In a survey conducted by Taneja, it was documented that a large number of IAF aircrew follow the practice of crew-room napping of variable duration and they felt that it improved the drowsiness and tiredness and also crew performance in the flight.[7] While such survey report was based on the subjective assessment of the crew, it is imperative to study the beneficial effect of napping objectively. With limited studies on the subject available in the Indian military aviation, this study was envisaged with an aim to study the effectiveness of naps toward improving the crew effectiveness and cognitive performance using a validated biomathematical model.

MATERIAL AND METHODS

Study design

In this cross-sectional design study, convenience sampling was adopted to study the relationship between the nap and the nap induced change in the cognitive performance.

Participants

A total of 23 service personnel from a military flying base volunteered to participate. Fifteen responses, who could meet the criteria of Habitual Day-time Nappers, were finally registered for the study. All the participants were male and were in the active duties related to flying. The inclusion criteria considered were full flying-medical classification, age group of 20-45 years, not committed for any outstation duties during the study period. The exclusion criteria included the sleep disorder of any kind, BMI >30, known history of daytime sleepiness, and history of neurological disorder or traumatic brain injury in the past 1 year.

The study was approved by Institute Ethics Committee at Institute of Aerospace Medicine, Indian Air Force, Bengaluru. All participants were given the written informed consent to participate in the study.

Materials

Actigraphy device

Actiwatch Spectrum from Philips (Respironics), USA was used to collect actigraph data. This is a wrist worn device capable of providing sleep quantity, and sleep quality by computing the activity/sleep data based on of recording the gross motor activity. Various sleep variables such as total sleep time, sleep efficiency (SE), sleep onset latency (SOL), wake after sleep onset, and number of awakenings/arousals in numerical data were retrieved.

Actigraphy is validated as a tool for aiding in the diagnosis of several sleep disorders and particularly in the evaluation of sleep disturbances in shift workers due to certain advantages.[8,9] Although actigraphy is not as accurate as PSG for sleep evaluation, studies have shown that actigraphy, with its ability to record continuously for long time periods, is more reliable for evaluating the sleep during extended period. Actigraphy in this study was considered suitable to record the 24-h sleep/activity data continuously for a period of 5 working days.

Bio-mathematical fatigue model

Fatigue avoidance scheduling tool (FAST) software was used for generating sleep weighted performance predicted data. The actigraphic data were fed into a standalone PC running the FAST software. After identifying the nap period, the associated performance and cognitive indicators, namely, effectiveness, cognitive reserve, lapse rate, reaction time, and sleep reservoir were determined both before the nap and after the nap by moving the “Reference Line” in the FAST window. The enhancement cognitive performance associated with napping was calculated by subtracting the post-nap values from the pre-nap values. The parameters were effectiveness gain (EfG), cognitive reserve gain (CRG), improvement in lapse rate (ILR), improvement in reaction time (IRT), and sleep reservoir gain (SRG). Running a dimension reduction method in a statistical package (SPSS), these parameters were transformed into a single factor by principal component analysis (PCA). This extracted factor was named as “Combined COG Factor.” Similarly, the fatigue inducing factors, namely, “Total sleep time in the last 24 h,” “Chronic Sleep Debt,” and “Out of Phase Sleep (OOPS)” along with “SE (Nap)” were derived from the biomathematical model software and were also analyzed.

A bio-mathematical fatigue model is basically a set of integrated equations that predict human fatigue based on factors such as recent sleep quantity, sleep quality, and sleep/wake timing; the current time of day (during duty); and workload. Of several model devised so far, two were specifically tailored for the aviation environment, that is, the Sleep, Activity, Fatigue, and Task-Effectiveness (SAFTE) model and the System for Aircrew Fatigue Evaluation (SAFE). FAST was developed based on SAFTE model. SAFTE model was developed by Dr Hursh *et al.*[10] This patented model has received a broad-spectrum scientific review and the US Department of Defense considers it the most complete, accurate, and operationally practical model currently available to aid operator scheduling. The FAST software has been specifically designed for applications in industrial settings and transportation, for example, aviation and rail. FAST is an integral tool used by US Navy and US Air Force to evaluate schedules and plan optimal napping and recovery sleep strategies for the aircrew involved during extended air operations.[11] FAST was selected for this study due its suitability and commercial availability.

Data analysis

Data were analyzed using Microsoft Excel and IBM SPSS version 21.0. The descriptive statistics were computed to ascertain the mean, SD and ranges. PCA with "Direct Oblimin" oblique rotation method was carried out to extract a single factor with adequate loading from the variables related post-nap cognitive gain. One-way ANOVA was carried out to study the relationship between Nap-groups. Thereafter, "backward-stepwise" multiple regressions was carried out to rule out the influence of confounders and covariates.

RESULTS

A total of 23 service personnel involved in various duties related to aviation had voluntarily participated in the study. Of them, only 15 (65.2%), who were found to be the "Day-time Habitual Napper (DTHN)" could be considered for analysis of data. Demographic details of these participants are displayed in Table 1.

Of the 50 Naps logged by the participants, 11 (22%) naps were less than 30 min, 14 (28%) were between 30 and 60 min, 15 (30%) were between 60 and 120 min, and only 10 (20%) were above 120 min. The sleep quality indicators for these nap-groups are displayed in Table 2.

A series of One-Way ANOVA was carried out to examine the differences among the nap-groups for various sleep quality indicators. The results of the same along with *post hoc* analysis for pair-wise comparisons are displayed in the Table 3.

The mean SE for the nap-groups 1, 2, 3 and 4 were 62.3%, 78%, 74.7%, and 76.3%, respectively. The first nap-groups, in which the participants were having naps for the duration of 30 min or less had the lowest SE in comparison to other groups and the differences were statistically significant whereas, those in the nap-groups 2, 3, and 4 were not statistically significant.

Table 1: The demographic details of participants.

	Number	%
n	15	100
Male	15	100
Married	12	80.0
Smoking habit	5	33.3
Alcohol habit	3	20.0
	Mean	**Minimum–Maximum**
Age (year)	34.3	23–52
Weight (kg)	65.6	52–76
BMI (kg/m^2)	24.6	21.3–28.1

The enhancement in cognitive performance associated with napping was calculated by subtracting the post-nap values from the pre-nap values. The means (SD) of these differences are displayed in Table 4. One-Way ANOVA was carried out to examine the differences among the nap-groups for each cognitive performance indicators and the results are displayed in Table 5.

Post-nap gain in the effectiveness and other cognitive parameters was found to be different among the nap-groups in different cognitive domains such as EfG ($F = 10.45$, $P = 0.000$), CRG ($F = 4.29$, $P = 0.009$), ILR ($F = 9.18$, $P = 0.000$), IRT ($F = 4.10$, $P = 0.012$), and SRG ($F = 4.81$, $P = 0.005$). In comparison to the nap-group 1, the post-nap EfG and CRG were statistically significant for nap-groups 2, 3, and 4. No statistically significant differences were observed between the nap-group 2, 3, and 4. The similar group differences was also observed as far as improvement in the cognitive functions such as lapse rate (ILR) was concerned. However, the statistically significant SRG were observed for Group 3 and 4 and IRT was observed for Group 4 only.

To examine the influence of various demographic variables on the nap induced enhancement of cognitive performance, multiple regression analysis was carried out by adjusting the demographic variables, namely, age, seniority, marital status, weight, BMI, alcohol, and smoking habits. The results are displayed in Table 6.

Post-nap gain in the effectiveness and other cognitive parameters was found to be linked with nap duration with no significant influence from any of these demographic variables was confirmed for EfG ($F = 35.35$, $P = 0.000$, $R^2 = 0.424$), CRG ($F = 10.13$, $P = 0.002$, $R^2 = 0.174$), ILR ($F = 27.26$, $P = 0.000$, $R^2 = 0.362$), IRT ($F = 12.68$, $P = 0.000$, $R^2 = 0.209$), and SRG ($F = 8.34$, $P = 0.005$, $R^2 = 0.148$).

A similar regression analysis was also carried out to examine the influence of fatigue inducing factors on the post-nap gain in the effectiveness and the associated cognitive performance. The details of the descriptive data for all fatigue inducing factors namely "Total sleep time in the last 24 h," "Chronic Sleep Debt," "Out of Phase Sleep (OOPS)" along with "SE (Nap)," and "SE (Duration)" are displayed in Table 7 and the results of the regression analysis are displayed in Table 8.

The variables with significant influence on the post-nap cognitive performance gain were "Total sleep time in the last 24 h" for EfG, CRG, ILR, and IRT; "Out of Phase Sleep (OOPS)" for CRG, ILR, and SRG; "SE (Nap)" for EfG, CRG, ILR, IRT, and SRG; and "Nap (Duration)" for EfG, ILR, IRT, and SRG. The only variable which was found to have no such influence was "Chronic Sleep Debt." R^2 indicates the amount of variation in the

Table 2: The details of the sleep quality indicators (SE, SOL, and wake percentage) for various nap groups.

Nap-group			SE		SOL		WAKE %	
	Nap duration (in min)	*n* (%)	Mean SD	Lower Upper	Mean SD	Lower Upper	Mean SD	Lower Upper
Gp-1	≤30	11	62.3	41.6	2.63	0.5	18.24	0
		22	11.9	80.6	1.1	4.5	5.69	41.5
Gp-2	31–60	14	78.0	66	2.60	0	14.8	0
		28	9.6	92.3	2.8	8.5	9.3	32
Gp-3	61–120	15	74.7	54	2.13	0	22.68	0
		30	13.3	100	2.4	7	13.4	45.3
Gp-4	> 120	10	76.3	54.4	2.85	0	21.6	6.1
		20	13.2	91.3	3.2	10	13.7	45

Table 3: The results of one-way ANOVA for the sleep quality indicators (SE, SOL, and wake percentage) among various nap groups.

	F Statistics				Post hoc Analysis
	One-way ANOVA		Levene's test		Pairs showing significant differences
	F	*P*	*P*	#	Tukey's HSD
SOL	0.18	0.90	0.02	#	-
SE	4.22	0.01*	0.56		Gp-1 versus Gp-2 (*P*=0.01) Gp-1 versus Gp-3 (*P*=0.02) Gp-1 versus Gp-4 (*P*=0.04)
Wake%	1.02	0.39	0.12		-

*Statistically significant as $P<0.05$

gain in the cognitive performance that can be explained by the respective fatigue inducing variables. In presence of significant R^2, these fatigue inducing variables could be considered as the covariates for the Nap (Duration), which was the primary predictor for nap-induced cognitive performance gain.

To control such variations in the gains in the different cognitive parameters, these parameters were subjected to a dimension reduction analysis, namely, "Principal Component Analysis" and a single cognitive factor was extracted (named as Combined Cognition Factor). On repetition of regression analysis with Combined COG Factor, only two fatigue inducing factors, namely, SE (Nap) ($P = 0.000$) and Sleep in last 24 h ($P = 0.042$) were found to be significant covariates for nap-induced performance enhancement.

DISCUSSION

The sleep data were collected through a wrist based actigraphy device and fed into SAFTE based software called FAST. The nap episodes were identified and were subjected for analysis. About 65.2% of the studied population were found to be the "Day-time Habitual Napper (DTHN)" with a history minimum of 3 or more day-time naps in the week. Earlier studies had documented the DTHN among 35–42% of Indian military aircrew and 68% of general population.[7,12] Considering the napping to be an effective fatigue prevention strategy, this proportion of DTHN in our study could be encouraging.

Of the 50 Naps logged by the participants, 11 (22%) naps were less than 30 min, 14 (28%) were between 30 and 60 min, 15 (30%) were between 60 and 120 min, and only 10 (20%) were above 120 min. In a questionnaire survey in IAF by Taneja, it was reported that 31.3–37.1% of aircrew used to nap for duration of 30–60 min, which was comparable to our results.[7] Although the nap of longer duration is beneficial toward restoration of sleep debt,[13] the sleep opportunity to have such longer naps may not be available to the crew in an active operational set-up. Therefore, it is prudent to find out the optimal duration of nap and the associated benefits toward the crew effectiveness.

Like sleep, the naps are also qualified by the sleep quality indicators such as SE, SOL, number of arousals/awakenings, and percentage of time wasted as arousals. The average SE for the nap-groups 1, 2, 3, and 4 were 62.3%, 78%, 74.7%, and 76.3%, respectively. As per the National Sleep Foundation, sleep is considered optimal if its efficiency is more than 75%. Our results indicated suboptimal SE for the naps less than 30 min. No statistically significant difference was also observed with naps between 30 to 60 min with those more than 60 min. However, any Nap with a duration more than 30 min was associated with a significantly higher SE in comparison to the nap-group having naps of less than 30 min duration. Interestingly, the other sleep quality indicators such as SOL, wake percentage, and bouts of awakenings were not statistically different among the nap-groups and no group in particular had registered a poor-quality nap.

Table 4: The details of the gain in cognitive performance indicators (effectiveness, cognitive reserve, lapse rate, reaction time, and sleep reservoir) among various nap groups.

Nap-group		EfG		CRG		ILR		IRT		SRG	
	Nap duration (in min)	Mean SD	Lower Upper	Mean SD	Lower Upper	Mean SD	Lower Upper	Mean SD	Lower Upper	Mean SD	Lower Upper
Gp-1	≤ 30	0.81	0	0.36	0	−0.08	−0.2	−1.8	−11	0.18	0
		0.1	1	0.2	2	0.06	0	3	0	0.4	1
Gp-2	31–60	3.14	0	1.57	0	−0.42	−1.6	−4.2	−14	0.28	0
		2.5	10	0.3	4	0.4	0	4	0	1	5
Gp-3	61–120	3.5	0	1.8	0	−6.7	−0.8	−4.4	−8	1.2	0
		2.0	7	1.0	4	0.2	0	0.2	0	0.6	2
Gp-4	>120	6.1	1	2	0	−0.73	−1.1	−6.5	−9	1.7	0
		2.7	9	1.4	4	0.29	−0.2	2.5	−2	1	3

Table 5: The results of one-way ANOVA for the cognitive performance indicators (effectiveness, cognitive reserve, lapse rate, reaction time, and sleep reservoir) among various nap groups.

	F Statistics				*Post hoc* Analysis	
	One-way ANOVA		Levene's test		Pairs showing significant differences	
	F	*P*	*P*	#	Tukey's HSD	Games-Howell
EfG	10.45	0.000	0.007	#	-	Gp-1 versus Gp-2 (*P*=0.024) Gp-1 versus Gp-3 (*P*=0.001) Gp-1 versus Gp-4 (*P*=0.001)
CRG	4.29	0.009	0.025	#	-	Gp-1 versus Gp-2 (*P*=0.047) Gp-1 versus Gp-3 (*P*=0.001) Gp-1 versus Gp-4 (*P*=0.033)
ILR	9.18	0.000	0.02	#	-	Gp-1 versus Gp-2 (*P*=0.034) Gp-1 versus Gp-3 (*P*=0.000) Gp-1 versus Gp-4 (*P*=0.000)
IRT	4.10	0.012	0.425		-	Gp-1 versus Gp-4 (*P*=0.006)
SRG	4.81	0.005	0.016	#	-	Gp-1 versus Gp-3 (*P*=0.000) Gp-1 versus Gp-4 (*P*=0.006)

#: The "Homogeneity assumption" was violated and therefore Games-Howell *post hoc* analysis was carried out

Table 6: The results of multiple regression analysis for the influence of demographic variables on the effect of nap-induced gain in the cognitive performance indicators (effectiveness, cognitive reserve, lapse rate, reaction time, and sleep reservoir).

Dependent variables	B for nap (duration)$	F	*P*-value	R^2
EfG	0.031	35.35	0.000	0.424
CRG	0.009	10.13	0.002	0.174
ILR	−0.003	27.26	0.0000	0.362
IRT	−0.027	12.68	0.0008	0.209
SRG	0.007	8.34	0.005	0.148

F statistic and *P* value: Goodness of fit is satisfied if $P<0.05$. R^2: The percentage of variances of dependent variable is explained by the predictors. $: Model adjusted for age, seniority, marital status, body weight, BMI, alcohol, and smoking habits

All nap-groups had registered the gain/improvements in all the domains of cognitive performance. EfG, CRG, SRG, ILR, and IRT were observed by all nap-groups but in a different quantum. When analyzed by One-Way ANOVA, nap-groups 2, 3, and 4 were not different statistically. However, all had statistically significant gain in comparison to the nap-group 1. This finding provided an indication that a significant difference in the improvement in cognitive performance was linked to the nap duration of 30 min. Any nap more than 30 min was associated with optimal gain in cognitive performance in comparison to the nap less than 30 min. Second, naps more than 60 min did not show any added advantages in the form of cognitive gain in comparison with the naps between 30 and 60 min.

In a NASA publication, Dr Rosekind and his associates had confirmed that 30–40 min of cockpit naps could prevent many instances of attention lapses and microsleeps encountered by the crew during the long-haul flights.[14] In another study, Angus *et al.* had documented an increase in the correct responses in a cognitive test performed after a 2-h nap among subjects who had exhibited drop in correct responses while following a continuous work period.[15] In a similar study, Caldwell *et al.* had documented that the

Table 7: The descriptive statistics for various fatigue inducing factors (nap duration, sleep efficiency for nap, sleep in last 24 h, sleep debt, and out of phase sleep) among various nap groups.

Nap-group		Nap Dur		SE (Nap)		24 h sleep		Sleep Debt		Out of Phase Sleep	
	Nap duration (in min)	Mean SD	Lower Upper	Mean SD	Lower Upper	Mean SD	Lower Upper	Mean SD	Lower Upper	Mean SD	Lower Upper
Gp-1	≤30	15.5	8	62.32	41.67	8.01	6	3.95	2.67	1.81	0
		7.17	28	11.9	80.6	1.17	11	0.88	5.51	1.18	4.32
Gp-2	31–60	47.4	36	78	66	7.34	4.75	4.12	1.95	2.11	0
		8.23	58	9.6	92.3	1.24	9.25	1.08	6.12	1.91	4.91
Gp-3	61–120	97.5	68	74.73	54	7.6	5	4.08	2.58	2.28	0.18
		18.58	120	13.3	100	1.25	9.75	0.88	5.57	1.44	4.03
Gp-4	>120	168.4	129	76.3	54.4	8.67	7.5	3.56	0.77	3.21	0.25
		22.7	195	13.23	91.3	0.90	10	3.6	2.42	1.28	5.1

Table 8: The results of multiple regression analysis for the influence of fatigue inducing factors on the effect of nap induced gain in the cognitive performance indicators (effectiveness, cognitive reserve, lapse rate, reaction time, sleep reservoir, and combined cognition factor).

Dependent variables	*P*-values of independent variables (predictors)					F	*P*-value	R^2	Coeff
	Nap duration	SE (Nap)	Sleep in past 24 h	Out of phase sleep	Chronic sleep debt				
EfG	0.000	0.000	0.042	0.06	0.97	34.78	0.000	0.694	0.833
CRG	0.002	0.71	0.0006	0.002	0.32	14.11	0.000	0.479	0.692
ILR	0.000	0.003	0.002	0.014	0.12	25.90	0.000	0.697	0.834
IRT	0.003	0.003	0.014	0.70	0.48	15.99	0.000	0.510	0.714
SRG	0.049	0.000	0.98	0.004	0.87	30.36	0.000	0.563	0.750
Combined Cognition Factor (@)	0.000	0.000	0.042	0.367	0.572	28.82	0.000	0.630	0.878

F statistic & *P* value: Goodness of Fit is satisfied if $P<0.05$. R^2: The percentage of variances of dependent variable is explained by the predictors. Coeff: The strength of relationship between the observed data (Y) and predicted data (Ŷ). @: Combined Cognition Factor was extracted through principal component analysis

group having a 2 h nap before a long overnight work period exhibited lesser decrease in alertness in comparison to the group who had not taken any nap.[16] Caldwell Jr. in his book named "Fatigue in aviation" had mentioned that "although 2–4-h naps are considered optimal for arresting performance declines associated with continuous work without sleep, even the short naps (20–30 min in length) have been found to enhance the productivity and safety of sleep-deprived personnel."[17]

In a survey among the IAF aircrew, Taneja observed that large number of fixed wing aircrew (Fighter – 65% and Transport – 72.9%) reported napping to enhance crew performance in a flight by reducing drowsiness, or feelings of tiredness.[7] Although there are evidence, which suggests that strategic naps can reduce subjective feelings of fatigue and improve performance and alertness,[13] our study has provided the same objectively.

To examine the influence of various demographic variables on the nap induced enhancement of cognitive performance, multiple regression analysis was carried out by adjusting the demographic variables, namely, age, seniority, marital status, weight, BMI, alcohol, and smoking habits. Post-nap gain in the effectiveness and other cognitive parameters was found to be linked with nap duration with no significant influence from any of these demographic variables.

The quantity and the quality of the sleep and the naps could vary depending on the age, gender, physical constituency such as body weight and BMI. Alcohol and many drugs can also influence the sleep. Therefore, the influence of such parameters required to be adjusted before confirming the main effects of naps on enhancement of cognitive performance. However, such confounding effects were not observed in our study.

Similarly, the fatigue inducing factors could independently influence the study outcome as the covariates. "Total sleep time in the last 24 h," "Chronic Sleep Debt," and "Out of Phase Sleep (OOPS)" along with "SE (Nap)" were derived from the biomathematical model software and were also examined for their influence as covariates. Since the influences were different for different domains of the cognitive function, a single cognitive factor was computed by a dimension reduction analysis using PCA and this extracted factor which was called “Combined Cognition Factor” was regressed with these factors. Only two fatigue inducing factors namely SE (Nap) (P = 0.000) and “Sleep in last 24 hours” (P = 0.042) were found to be the significant covariates for nap-induced performance enhancement.

In the past, investigators had brought out that the nap duration alone might not be a good indicator to explain the variable responses in performance enhancement following a nap.[18] The results of our study, could confirm at least two additional factors such as SE (Nap) and “sleep in past 24 h” could vary the nap induced gain in cognitive performance. The influence of Out of Phase Sleep (OOPS) during the post-nap restoration of cognitive reserve was also a take home message from this study.

Limitation of the study

An important limitation of our study was the limited sample size. Although appropriate statistical steps to improve the outcome were carried out, a larger sample size could have brought more confidence while drawing the conclusions from the results of the study. Second limitation was about the outcome variables. The cognitive parameters used in the analysis were based on predictive data based on bio-mathematical model and not the actual ones. Similar research in the future can be undertaken by considering the appropriate cognitive tests. The study could have been better by conducting a comparative analysis with questionnaire based subjective analysis of nap. The other limitation was the variation in the nap environment. Since this was an observational study in a flying base, factors like place, environmental and climatic conditions were left to the participant’s choice. Investigators were aware of these confounders.

CONCLUSION

Sleep deprivation is a fact of life for all aviation personnel especially those who are involved in military flying. Apart from the high tempo operational flying, the flying efforts involved during training, VIP missions, and carrier borne flying operations will possess a situation of restricted sleep opportunities. Under such circumstances, napping could be handy as a short-term fatigue prevention strategy. Our study, which was undertaken with an aim to carry out an objective assessment of naps taken by the aviation crew, could reiterate some of the established facts and register few new findings. A good proportion of crew is aware of this fact and follows judiciously. Our study has indicated existence of such practice among the aviation crew though the duration of naps varies from person to person, time of napping, and the circumstances for the naps. Like sleep, naps are also qualified based on SE and most of these naps are optimum if the duration is more than 30 min. Depending on the duration and the efficiency, naps help in enhancing the task effectiveness and cognitive performance of the subject. While the performance enhancement is significant for the naps more than 30 min, naps more than 60 min may not have the added advantages of yielding more gain in the cognitive performance apart from the risk of getting sleep inertia. Unlike sleep, the nap induced cognitive gain had little influence by the demographic variables. However, the factors such as “sleep in past 24 h,” “out of phase sleep” could affect the post-nap gain in cognitive functions.

Declaration of patient consent

The authors certify that they have taken consents from the participants and Institute Ethics Committee clearance.

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Conflicts of interest

There are no conflicts of interest.

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