

Pre-Race Sleep Management Strategy and Chronotype of Offshore Solo Sailors

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Purpose: To evaluate chronotype and the sleep management strategy adopted by sailors before the offshore solo sailing race “Mini Transat La Boulangère”. As secondary aim, we assessed whether adopting pre-race sleep management strategy influences performance at race.

Materials and Methods: Forty-two solo sailors completed questionnaires on sleep quality, sleepiness, chronotype and an ad hoc questionnaire on the pre-race sleep management strategy adopted. Arrival times, separately for each race’s leg, were provided by the race organization team.

Results: Solo sailors present mainly with a morning-type (40%) and intermediate-type (60%) chronotype, while none have an evening-type chronotype. Fifty-five percent of sailors adopted pre-race sleep management strategy. Sailors that adopted strategy have travelled more miles in offshore compared to sailors that did not adopt strategy ($p<0.05$). Significant differences emerged in rMEQ scores, with sailors that adopted strategy presenting lower score compared to sailors that did not adopt sleep strategy ($p<0.05$), as well as in chronotype distribution with morning-type sailors that are less likely to adopt pre-race sleep management strategy compared to intermediate type sailors ($p<0.05$). No differences emerged in final arrival times and in arrival time at leg1 and leg2. The most commonly adopted strategy (52% of sailors) consists of sleep extension, followed by the polyphasic sleep (26%), and sleep deprivation (22%) strategy. Sailors trained in polyphasic sleep have higher ESS than sailors trained in sleep deprivation ($p<0.05$).

Conclusion: Morning-type chronotype is overrepresented in this large cohort of solo sailors compared to the general population; moreover, chronotype seems to influence the adoption of sleep management strategy. A little over half of solo sailors participating in the Mini Transat trained in sleep management strategy before the race; however, neither the general adoption of pre-race sleep management strategy nor the adoption of a specific sleep strategy seems to significantly influence final arrival times.

Keywords: sleep, solo sailing, chronotype, sport medicine, training

Introduction

Over the past decade, ultra-endurance sports competitions have become increasingly popular. Such events comprise races that can last from less than a day up to a month during which athletes, spontaneously or forcibly, abstain from sleeping for one or multiple consecutive nights in order to complete the race with the best performance.¹ However, acute and chronic sleep deprivation can jeopardize performance by increasing the odds of having involuntary sleep/micro-sleep episodes and negatively affecting cognitive functioning, most notably attention.² Sleep deprivation has a negative impact also on athletic performance, reducing the time to

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exhaustion and altering physiological responses to exercise.^{3,4} In recent years both researchers and athletes have shown growing interest in identifying strategies to manage sleep and sleep deprivation during competitions. Most of these strategies revolve around the concept of “banking extra sleep” prior to the competition, by either extending the nocturnal rest period or introducing diurnal naps, an idea supported by a handful of studies on professional athletes.^{5–7}

Solo ocean crossings are extremely demanding sporting competitions, usually lasting for several weeks, during which athletes face a constant physical and cognitive effort, which ultimately leads to physical exhaustion and chronic sleep deprivation.⁸ The management of sleep deprivation during such competitions is of the utmost importance, inasmuch the lowering of the supervisory threshold increases the risk of having accidents/collisions with potentially serious and even fatal consequences. Scientific literature in this field is extremely limited, with the few available studies that have focused on the sleep schedules spontaneously adopted by sailors during the competition and their relationship with functional impairments and performance.^{9–12}

In solo sailors, and more broadly in professional athletes, sleep timing and diurnal activities are often ruled by the training schedule, it is therefore of importance that the training and competition schedule couples with the individual differences in circadian timing (ie, chronotype).¹³

However, to date, no published study has explored chronotype distribution among solo sailors. With the present study, we aim at investigating chronotype and sleep management strategy adopted by participants in the preparatory phase of an offshore solo sailing competition. As secondary aim, we assessed whether the adoption of pre-race sleep management strategy influences performance at the race.

Materials and Methods

The Mini Transat Regatta

The “Mini Transat La Boulangère” is a long-standing solo transatlantic yacht race that takes place every 2 years. The route to cover is 4021 miles split into two legs: from La Rochelle in France to Las Palmas in the Canaries islands (leg1) and from Las Palmas to Martinique in the Antilles islands (leg2). Boats admitted are the Mini 6.50 (20-ft length), divided into Serie and Prototype. Sailors have no external assistance during the race; equipment allowed

onboard are a VHF radio, a GPS and a receiver radio that broadcasts the weather conditions once daily.

Participants

The “Mini Transat La Boulangère 2017” organizing team contacted sailors registered for the race and informed about study’s procedures.

Inclusion criteria to participate in the regatta were: a) being at least 18 years old; b) having sailed a minimum of 1000 miles in Mini races (at least one solo race and at least one with a route of minimum 500 miles); c) having completed at least one solo qualifying route of 1000 miles without any stop. Exclusion criteria for participating in the study were: a) recent or ongoing medical conditions that might hinder the modifications of sleep-habits and b) chronic or ongoing use of medications that influence sleep or cognitive functioning.

Among the 51 athletes interested in participating in the study, nine sailors with intention to participate withdrew before the race start, and therefore were excluded from analyses leaving a final study sample of 42 sailors (58% of the sailors registered for the Mini Transat 2017). The study was approved by the local ethics committee (Comitato Etico Interaziendale Bologna-Imola, Prot. Num. 17043) and all participants gave their written informed consent.

Procedure and Measures

Months before the race start, participants were contacted via e-mail and invited to complete electronic questionnaires on chronotype, sleepiness, sleep quality and an ad hoc questionnaire designed to explore pre-race sleep management strategy adopted prior to the race.

The Epworth Sleepiness Scale (ESS) and the Pittsburgh Sleep Quality Index (PSQI) were used to assess daytime sleepiness and sleep quality, respectively.^{14,15}

The reduced version of the Morningness-Eveningness Questionnaire (*r*MEQ) was used to assess chronotype: scores range from 4 to 25, a score ≤ 10 indicates an evening-type chronotype, scores in the 11–18 range indicate an intermediate-type chronotype, and scores ≥ 19 indicate a morning-type chronotype.¹⁶

The questionnaire on pre-race sleep management strategy was designed, in the absence of available tools in literature, on the basis of a study that assessed sleep management strategy among participants in an ultra-endurance marathon.¹⁷

The questionnaire comprises three sections: (a) socio-demographic information, (b) previous sailing experience

and (c) sleep management strategy. Socio-demographic data requested were: age, nationality, weight and height, education (level of education completed), and presence of relevant medical conditions. Sailing experience data requested were: number of crossings in which he/she participated, number of crossings completed, total miles travelled, number of solo-crossings in which he/she participated, number of solo-crossings completed, total miles travelled in solo, total years of experience in crossing, and estimated budget for the Mini Transat 2017. The adoption of sleep management strategies was assessed by asking: “Do you change your sleeping habits before the race with the aim of gaining an advantage during the competition?” Participants who provided a positive answer were asked to indicate what type of strategy they intend to adopt (between sleep extension, sleep deprivation and polyphasic sleep).¹⁷ Moreover, we asked whether the establishment of a sleep management strategy has been supervised by an expert (neurologist, psychologist, sport physician, others).

Finally, we asked participants to indicate how long they implemented their pre-race sleep strategy. The race’s organization team provided official arrival times, separately for leg1 and leg2.¹⁸ Regatta’s chronicles were analyzed by a professional sailor with extensive experience in transoceanic sailing competitions in order to arbitrarily identify incidents occurred during the race (see [Supplementary Material](#)).

Statistical Analyses

Data for each group were explored using descriptive statistics (mean \pm SD). For statistical purposes, participants were classified either as “Sleep-management” (n=23) or “No Sleep-management” (n=19) on the basis of the responses provided in the questionnaire on sleep management strategies. The Kolmogorov–Smirnov one-sample test was used to assess whether data are normally distributed. As most of the variables deviate from a normal distribution, group differences in demographical variables, sailing experience and race performance were analyzed through chi-squared and Mann–Whitney *U*-test. In order to assess differences in questionnaires’ scores and race times with respect to the type of sleep strategy adopted (ie, sleep extension, sleep deprivation, and polyphasic sleep) we conducted a Kruskal–Wallis one-way analysis of variance, followed by pairwise comparisons controlling for Type I error by using the Dunn–Bonferroni method.

Statistical analyses were performed with IBM SPSS Statistics 19 software (SPSS, Inc., Chicago, IL); *p* values

<0.05 were considered statistically significant. Given the exploratory nature of this study alpha-adjustments were not performed.

Results

Demographic data, sailing experience, questionnaires’ scores and arrival time with respect to the adoption of sleep management strategy are reported in [Table 1](#).

Among solo sailors participating in the Mini Transat, 55% adopted a pre-race sleep management strategy and 22% were supervised by an expert during the establishment of such strategy. No statistically significant difference was observed regarding sex distribution between the “Sleep Strategy” and “No-Sleep Strategy” groups ($\chi^2_{(1)}=0.48$, $p=0.49$). Groups did not differ for age, BMI, ESS and PSQI scores. Moreover, no group differences were observed in the proportion of subjects with ESS score >10 ($\chi^2_{(1)}=0.35$, $p=0.56$) and PSQI > 5 ($\chi^2_{(1)}=0.18$, $p=0.67$).

Regarding chronotype distribution, 40% of solo sailors presented with a morning-type chronotype, 60% with an intermediate-type chronotype and none with an evening-type chronotype.

Statistically significant differences emerged between the “Sleep Strategy” and “No-Sleep Strategy” groups in *r*MEQ score and chronotype distribution, with morning-type chronotype sailors less likely to adopt pre-race sleep management strategies compared to intermediate type chronotype sailors. Significant differences were also observed in total miles travelled, with sailors in the “Sleep Strategy” group who have travelled more miles in offshore compared to sailors that did not adopt any sleep strategy. Concerning the type of pre-race sleep management strategy adopted, the most commonly adopted (52% of sailors) consists of “extending sleep” duration prior to the race, followed by the strategy based on “polyphasic sleep” schedule (adopted by 26% of sailors), and the “sleep deprivation” strategy (22% of sailors). Questionnaires’ scores and race performance data for the three types of sleep management strategy are reported in [Table 2](#). Follow-up analyses conducted to evaluate pairwise differences among the three groups showed that sailors trained in “polyphasic sleep” present with significantly higher ESS scores compared to sailors trained in “sleep deprivation” ($H=10.13$, $p<0.05$). No further statistically significant difference was observed.

Discussion

In this study, we explored chronotype distribution among solo sailors participating in solo offshore sailing

Table 1 Demographic Data, Previous Sailing Experience, Arrival Times and Questionnaires' Scores of Participants with Respect to the Adoption of Pre-Race Sleep Management Strategy

	"Sleep Strategy" (n=23)	"No Sleep Strategy" (n=19)	U	P
	Median and IQR	Median and IQR		
Male/Female (%)	87/13	79/21	0.48 ^a	ns
Age, yr	30 (28–35)	32 (25–37)	207	ns
BMI	23.41 (21.70–25.28)	23.36 (21.60–25.11)	200	ns
rMEQ	15 (13–19)	19 (16–21)	123	<0.05
Chronotype (m/ile) (%)	26/74/0	58/42/0	4.37 ^a	<0.05
ESS	9 (5–13)	7 (6–11)	199.5	ns
PSQI	3 (2–5)	3 (1–5)	191.5	ns
Miles traveled	11,000 (7000–30,000)	6000 (5000–8000)	118	<0.05
Ocean crossings completed	1 (0–2)	0 (0–2)	210.5	ns
Solo miles traveled	4000 (2000–10,000)	4000 (3000–5000)	200	ns
Solo ocean crossings completed	0 (0–1)	0 (0–1)	214.5	ns
Solo crossings experience, yr	2 (1–5)	2 (1–4)	202.5	ns
Budget (€)	42,500 (27,500–70,000)	45,000 (28,750–71,250)	187.5	ns
Arrival time, d	27.07 (25.10–29.36)	28.13 (26.81–29.16)	162	ns
Leg1 arrival time, d	10.11 (10.06–11.15)	10.15 (10.09–11.13)	167.5	ns
Leg2 arrival time, d	16.21 (14.82–18.05)	17.03 (16.13–18.11)	165.5	ns

Note: ^aChi-squared test.

Abbreviations: BMI, body mass index; ESS, Epworth Sleepiness Scale; rMEQ, reduced Morningness–Eveningness questionnaire; Chronotype (m, morning type; i, intermediate type; e, evening type); PSQI, Pittsburgh Sleep Quality Index.

Table 2 Demographic Data, Questionnaires' Scores, and Arrival Times with Respect to the Type of Sleep Pre-Race Management Strategy Adopted

	Sleep Extension (n=12) Median and IQR	Sleep Deprivation (n=5) Median and IQR	Polyphasic Sleep (n=6) Median and IQR	H ₍₂₎	P
Age, y	30 (28.3–33.3)	31 (24.5–35)	31.50 (27–35.8)	0.18	ns
ESS	8 (4–13)	6 (3–9)	13 (9–20)	6.89	<0.05
rMEQ	16 (13–18)	16 (13–21)	15 (13–20)	0.58	ns
PSQI	4 (2–5)	3 (2–5)	3 (2–5)	0.04	ns
Time for implementation of sleep strategy, d	14 (3–180)	180 (105–283)	283 (7–365)	4.32	ns
Sleep management rating	8 (4–9)	8 (7–10)	5 (2–10)	1.69	ns
Arrival time, d	25.2 (24.4–29.1)	26.2 (25.1–29.5)	28.7 (26.1–35.1)	1.96	ns
Leg1 arrival time, d	10.1 (10.1–11)	10.1 (10.1–11.2)	10.7 (9.9–11.2)	0.92	ns
Leg2 arrival time, d	15.1 (14.4–18.1)	16.1 (14.4–17.8)	17.1 (15.4–22.1)	1.23	ns

Abbreviations: ESS, Epworth Sleepiness Scale; rMEQ, reduced Morningness–Eveningness questionnaire; PSQI, Pittsburgh Sleep Quality Index.

competitions and how they modified their sleep habits before the race. The choice to study the Mini Transat regatta, the most participated offshore solo sailing race, offered us the opportunity to study a large cohort of sailors participating simultaneously in the same competition, compared to the few available studies that examined relatively small samples or single cases.^{10,11,19}

In our sample, 55% of sailors adopted the strategy to manage sleep before the race, among which 22% were supervised by an expert during the training while the rest

relied on their sailing experience. Although no differences were observed in solo sailing experience with respect to the adoption of sleep management strategy, sailors who adopt sleep strategy have travelled more miles than those who do not adopt sleep strategy, which is indicative of greater sailing experience in the former.

The most commonly adopted strategy consists of extending sleep duration prior to the race (52% of sailors), followed by the strategy based on polyphasic sleep schedule (adopted by 26% of sailors), finally, 22% of

participants adopted a strategy based on sleep deprivation. Stampi, by analyzing post-race interviews and sleep logs of 99 sailors competing in solo- and double-handed ocean sailing races showed that most sailors spontaneously adopt a sleep-wake schedule based on multiple ultra-short naps during the competition, therefore we expected to find a much higher percentage of sailors who trained in polyphasic sleep.⁹ However, it is important to consider that in the preparatory phase to a long-lasting solo regatta, together with sleep management, sailors have to complete an accurate series of checks on equipment and food supplies: accordingly, one conceivable explanation is that most sailors have chosen to adopt the pre-race sleep management strategy which requires the shortest implementation times (as shown in Table 2).

This claim is supported by the differences observed in ESS, as sailors that trained in polyphasic sleep present with significantly higher ESS scores than sailors that trained in sleep deprivation, suggesting that the polyphasic sleep schedule based on short sleep episodes scattered throughout the nycthemeral cycle is more likely to produce residual sleepiness.

Similar results have been reported by Poussel et al that, analyzing the sleep management strategy adopted by participants in an ultra-endurance marathon, showed that increasing the amount of sleep in the days preceding the race (either by increasing the duration of nocturnal sleep or having daytime naps) was the most commonly adopted strategy, although the percentage of athletes that adopted sleep management strategy was considerably higher (ie, 88%) than in our study.¹⁷ When interpreting the results it is important to consider the intrinsic differences between these two competitions: the ultra-endurance marathon studied by Poussel et al is completed in about 40 hr and 72% of runners do not sleep at all during the race, while this approach would not be feasible for a long-lasting competition such as the Mini-Transat. Moreover, contrary to the results of Poussel et al, which showed that athletes who adopt sleep management strategy complete the race faster, we cannot conclude that the adoption of sleep management strategy significantly influences race performance as analyzing the relationship between the adoption of pre-race sleep management strategy and race performance, we failed to detect statistically significant differences in arrival times.

Intriguingly, results emerged regarding the distribution of circadian typology in our sample: indeed, we observed a peculiar chronotype distribution, with 40% presenting with a morning-type chronotype, 60% with an intermediate-

type chronotype and none with an evening-type chronotype. This distribution is in contrast with studies that explored chronotype distribution in the general population, in the same age range of our sample, which showed that the majority (48.9%) of individuals present with an intermediate-type chronotype while 24.7% and 26.4% a morning-type and evening-type chronotype, respectively.²⁰

To our knowledge, this is the first study that evaluated the chronotype among solo sailors; however, the results are in line with those observed in other professional athletes.²¹

Samuels analyzed chronotype distribution among athletes enrolled in a national sports school showing that most athletes (87% of the sample) have an intermediate or morning-type chronotype (51% and 36%, respectively) and only a small portion (13%) has an evening-type chronotype.²²

Similarly, Silva et al explored chronotype distribution among Brazilian athletes participating in the 2008 Paralympic games and showed that 74% have a morning-type chronotype (19% intermediate-type and 7% evening-type).²³

In two separate studies, Kunorozva et al by assessing the chronotype of athletes participating in individual (ie, cyclists, runners and ironman triathletes)¹³ and team (rugby)²⁴ sports showed that both athlete groups display increased frequency of morning-type chronotype compared to a control group of active individuals. Finally, Henst et al assessed the chronotype of Dutch and South African marathon runners and showed that both groups display an overrepresentation of morning-type chronotype compared to a sample of active individuals.²⁵

Noteworthy, we also observed differences in chronotype distribution with respect to the adoption of sleep management strategy, with most sailors that adopt sleep strategy having an intermediate-type chronotype (74%) compared to sailors that do not adopt sleep strategy in which the majority (58%) present a morning-type chronotype. Broadly speaking, morning-type subjects go to bed and wake up earlier and display more rigid sleeping habits compared to evening-type subjects, who go to bed and wake up later and display more flexible sleeping habits.²⁶ Bearing in mind these findings, one conceivable explanation for the differences observed in chronotype is that the more rigid sleep habits associated with morning-type chronotype prevents those subjects from establishing any sleep management strategy involving major changes in sleep and wake timing.

Several limitations should be acknowledged: the main one is that objective assessment of sleep duration and timing during the race was not conducted. Consequently, we cannot assure that the athletes have actually used during the race the sleep management strategy they were training in. Second, the ad hoc questionnaire on sleep management strategy is not validated; however, we wish to highlight that it is a quite common approach in scientific studies assessing how athletes manage sleep before and during competitions.²⁷ As a striking example in two very recent studies that investigated sleep habits and pre-race sleep management strategy among elite athletes the authors, given the lack of validated tools, had to develop a specific questionnaire and in both cases the questionnaire validation was not considered mandatory.^{17,28}

Further studies that objectively assess, by means of actigraphy or sensorized clothes, differences in pre-race sleep and during-race sleep as well as cognitive performance and injuries/accidents in relationship to the pre-race sleep strategy adopted are required to extend our findings and identify the optimal sleep management strategy for solo sailing competitions.

Conclusion

In this study we investigated, to the best of our knowledge for the first time, chronotype distribution among solo sailors and how sailors modify their sleep habit before an offshore solo regatta.

Our data support the growing evidences that the morning chronotype is overrepresented among athletes and extends, for the first time, this finding to solo sailors with 40% having a morning-type chronotype, 60% an intermediate-type chronotype and none an evening-type chronotype. Furthermore, our study shows that only half of solo sailors adopt sleep management strategy: extending sleep duration before the race is the most commonly adopted strategy followed by training in polyphasic sleep. Albeit we acknowledge that several factors not evaluated in this study may affect race performance, based on our data, we cannot conclude that the adoption of the pre-race sleep management strategy significantly affects race performance, while on the contrary, the chronotype appears to influence the adoption of sleep management strategy.

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