The Fatigued Brain: Fatigue and Cognitive Functions in Young Adults

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CHAPTER THREE

Prevalence of Fatigue in Medical Students: Associations with Lifestyle Factors and Executive Functions

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(submitted)

ABSTRACT

This study evaluated the prevalence of fatigue in medical students and explored the potential role of lifestyle correlates and everyday executive abilities. Students in the first three years of medical school at the VU University Medical Center Amsterdam took part in a survey study (*N* = 701; response rate = 67%). Fatigue symptoms were measured using the Checklist Individual Strength. The prevalence of high fatigue within the current sample was 31%. This is relatively high compared to that of peers in the general working population. Moreover, the level of fatigue was related to fatigue duration, with higher levels of fatigue associated with longer duration. Surprisingly, lifestyle factors played a minimal role in fatigue. Of all examined factors, only sports, sleep quality, study satisfaction, medical conditions and living situation were significant correlates of fatigue. That is, students who reported higher sleeping problems or suffered from a disease reported higher levels of fatigue, whereas students who spent more time on sports, who had higher study satisfaction, or who lived away from their parents reported lower fatigue. In a subgroup, we observed that students who reported high planning or self-control ability were less fatigued. Thus, whereas lifestyle factors played a minimal role, our expectation of an important connection between fatigue and executive functions was confirmed.

INTRODUCTION

Fatigue is a common complaint in young adults (Bültmann, Kant, Kasl, Beurskens, & van den Brandt, 2002) and in adolescents (Fowler, Duthie, Thapar, & Farmer, 2005; ter Wolbeek, van Doornen, Kavelaars, & Heijnen, 2006). It refers to a perceived lack of physical or mental energy that interferes with desired activities (Multiple Sclerosis Council 1998). University students are potentially vulnerable to fatigue given their typical lifestyle (e.g., various social activities, drinking behavior and lack of sleep) in combination with academic requirements. Correspondingly, research suggests that medical students are particularly susceptible to fatigue (Tanaka, Fukuda, Mizuno, Kuratsune, & Watanabe, 2009) and to fatigue-related mental health conditions such as burnout (Galán, Sanmartín, Polo, & Giner, 2011; Mosley et al., 1994). Research also suggests that fatigue can be an early stage of more severe health problems such as chronic fatigue syndrome (CFS; Huibers et al., 2004). The current study therefore aimed to contribute to the understanding of fatigue and potential risk factors by exploring the prevalence and lifestyle correlates of fatigue in students in the first stage of medical school.

In general, fatigue is known to arise from a variety of causes. These range from medical conditions and physiological states, to an unhealthy lifestyle and psychosocial stress (see DeLuca, 2005 for an overview). Fatigue can have a serious impact on the quality of life and well-being (DeLuca, 2005), but also on school performance (Nagane, 2004) and school attendance (Fowler et al., 2005). In medical students, higher levels of fatigue have been related to higher levels of perceived stress (Tanaka et al., 2009). This may result from their highly demanding school program (Hafferty, 1998). However, the environment of medical students comprises much more than the demanding medical curriculum. Most students have an extensive social life in which they develop new friendships and are engaged in student societies. Also family (academic) background, engagement in sports, and additional jobs could strongly influence the amount of support they receive, how much time and effort they invest in their studies, and their physical or mental state. We therefore expect that these factors and activities may contribute to fatigue in medical students.

In view of extensive neuropsychological research into the role of cognitive control with respect to behavioral planning, learning and personal growth, the present study also focused on these abilities in medical students. The majority of medical students are in the transitional phase from late adolescence to young adulthood (Arnett, 2000). Both structural (Casey et al., 1997) and functional brain imaging research (Veroude, Jolles, Croiset, & Krabbendam, 2013) show that areas in the prefrontal cortex are still maturing during this period. Accordingly, the executive functions (i.e., a set of goal-oriented functions, such as planning and self-control) ascribed to this part of the brain are still in development. We argue that success in medical school requires adequate control and planning abilities to balance social and academic demands. Insufficient planning and control abilities, together with the highly demanding environment, could partly explain high fatigue in medical students. Therefore, we hypothesized that in addition to lifestyle and environmental correlates, these functions are also related to fatigue in medical students. Based our reasoning above, we expect a negative relation between executive abilities and levels of fatigue.

Current study

In the current study, we investigated the prevalence of fatigue in a sample of medical students and evaluated its lifestyle and environmental correlates. We also examined associations between fatigue and executive functions. For this purpose, a subgroup completed an additional questionnaire on planning and self-control.

METHOD

Participants

The surveys were distributed to all students in the first three years of medical school at the VU University Medical Center Amsterdam, following a written obligatory exam in 2012. Of 1050 eligible students, 701 students returned the completed questionnaire (response rate was 67%). Fatigue prevalence and associated lifestyle and environmental factors were evaluated in this sample. Of the 701 participants, 368 students (52%) also completed a supplementary questionnaire on executive functions to evaluate the possible relation of these to fatigue.

Both samples were considered representative, as the distributions across sex, study year, and decentralized selection (i.e., a qualitative selection procedure based on the motivation and ambition of the students), were similar to those in the eligible population (see Table 1). The NVMO Ethical Review Board approved this study and respondents gave written informed consent for their voluntary participation.

Measures

Fatigue. Fatigue was assessed with the Checklist Individual Strength (CIS; Vercoulen et al., 1994). The CIS was originally developed for patients with unexplained fatigue (i.e., Chronic Fatigue Syndrome: CFS; Vercoulen et al., 1994), but has also been validated in the general Dutch population in adults (Bültmann et al., 2002; Bultmann et al., 2000) and adolescents (Stulemeijer, De Jong, Fiselier, Hoogveld, & Bleijenberg, 2005; ter Wolbeek et al., 2006). The questionnaire consists of 20 statements that measure different aspects of fatigue: fatigue severity (8 items, e.g., "I feel tired"); concentration (5 items, e.g., "my thoughts easily wander off"); motivation (4 items, e.g., "I'm looking forward to many fun things to do"); and physical activity (3 items, e.g., "I don't do much during the day"). Respondents were instructed to rate how they felt during the previous two weeks. Responses were scored on a 7-point Likert scale, ranging from 1 "Yes, that is true", to 7 "No, that is not true". The sum of all scales yielded a fatigue score ranging from 20 to 140.

In line with Bültmann and colleagues (Bultmann et al., 2000), a cutoff score of >76 was used to classify students as "fatigue cases". In this study, Cronbach's Alpha for the CIS was .93. For the fatigue severity, concentration, motivation, and physical activity subscales, Cronbach's Alphas were .90, .88, .77 and .90, respectively.

We also measured the duration of fatigue complaints by asking participants whether they had complaints of fatigue for longer than two weeks. If so, they were asked to indicate whether they felt this level of fatigue for either one of the following options: 2 weeks-1 month; 1-2 months; 2-3 months; 3-4 months; longer than 4 months.

Sleep. Respondents were asked to indicate the average number of hours per night they slept on workdays and in weekends. The difference between sleeping hours on work days and sleeping hours on weekend days was used as an index of "catch-up sleep"(Kim et al., 2011) (i.e., higher catch-up sleep means more sleeping hours in the weekend compared to workdays). To get an indication of sleeping problems, respondents reported on a 5-point Likert scale how much they agreed with the following statements: "I regularly have trouble falling asleep at night"; "I often wake up in the middle of the night and have trouble falling asleep again"; "I often wake up early in the morning and have trouble falling asleep again". Using the sum score of these statements, a higher score indicated more sleeping problems. Cronbach's Alpha for the sleeping problems scale in this study was .68.

Studying. Respondents were asked to indicate their current year of medical training (i.e., Program year: first, second, or third), by which method they had been admitted to medical school (i.e., pre-university GPA weighted lottery, decentralized selection procedure, other), and whether they were falling behind their study schedule (i.e., study delay: yes/no). Furthermore, study satisfaction was assessed by asking respondents to rate on a scale ranging from 1 to 10 how satisfied they were about their choice of study, the quality of the study, and their own study performance.

Lifestyle. Questions about alcohol consumption (number of glasses per week), caffeine intake (units per day), and smoking (daily: yes/no), were included in the questionnaire. Also, the hours weekly spent on sports, leisure time activities, additional jobs and studying, were assessed and respondents were asked to report whether they were member of a students' association.

Other measures. Respondents were asked to report male/female sex, age, medication use, physical or psychological disease, whether they were living away from home or still at their parents', the levels of parental education, and whether they had siblings with a degree in higher education/university. Based on parents' and siblings' educational level, respondents were regarded as either 'a first generation student' (when they had neither a parent nor a sibling with a university degree), or 'not a first generation student' (when they had either a parent or a sibling with a university degree).

Executive Functions. An adapted version of the Amsterdam Executive Function Inventory (AEFI; Van der Elst et al., 2012) was administered to measure self-perceived aspects of executive functions. Two scales of the AEFI were used: "Self-Control and Self-Monitoring" and "Planning and Initiative" (referred to as "Self-control" and "Planning" respectively). The Self-control scale consisted of 7 statements such as "I often lose things". The Planning scale consisted of 6 items such as "I am well organized. For example, I am good at planning my tasks during a day". Respondents reported on a 5-point Likert scale how much they agreed with these statements, ranging from 1 "Completely disagree", to 5 "Completely agree". Using the mean of these items, higher scores on these scales represented higher executive ability. In this study, Cronbach's Alphas for the self-control and the planning scale were .69 and .65 respectively.

Data analyses

All statistical analyses were carried out in PASW Statistics 18.0 (Chicago: SPSS Inc., IL). First, we analyzed the survey completed by 701 students (i.e., main sample). Second, we also included the supplementary questionnaire about executive functions (AEFI) that was completed by 368 of the 701 students (i.e., subsample).

Main sample. Univariate analyses were used to evaluate sex differences in fatigue prevalence (χ^2-test), associations between fatigue duration and fatigue score (one-way Analysis of Variance (ANOVA)), and associations between each factor and fatigue (*t*-tests for dichotomous variables, ANOVA for program year and Pearson's *r* for continuous variables).

All significant correlates of fatigue resulting from the univariate analyses were entered in a series of multiple linear regressions. First, we investigated the associations between several clusters of factors and the fatigue score. In block 1, we studied associations between the demographic factors, as well as disease/medication use and fatigue. In block 2, we evaluated each cluster separately and investigated associations between the factors within each cluster (i.e., sleep, studying and lifestyle factors) and fatigue. The associations within each cluster of factors and fatigue were adjusted for demographic factors and disease/medication use (block 1). Second, in the final model, all factors were entered simultaneously to determine the most important factors related to fatigue.

The consecutive analyses in the first step yielded similar results to those in the final model. Therefore, only the results of the second step are presented.

Subsample. We investigated the additional contribution of executive functions in the subsample of respondents who completed the AEFI. The AEFI scales were added to the final regression model in which all factors were added to the model simultaneously.

RESULTS

Main Sample

Sample Characteristics. Of the main sample (*N* = 701), 69% were female and the average age was 21.20 years old (*SD* = 2.15). Furthermore: 31% of the students suffered from a disease or used medication; 64% was living away from their parents' home; 12% did not have highly educated parents; and 6% of the students were classified as first generation students.

Prevalence and Duration of Fatigue. The mean fatigue score was 65.67 (*SD* = 20.60; see Table 1). Of the total sample of students, 31% were fatigue cases. We found no significant difference in the prevalence of fatigue between males (28%) and females (33%; $\chi^2(1, n = 701) = 1.19$; $p = .276$, *phi* = .04). Of all participants, 62% reported no fatigue complaints for longer than two weeks, 8% reported having fatigue complaints for 2 weeks-1 month, 8% for 1-2 months, 6% for 2-3 months, 2% for 3-4 months, and 15% for longer than 4 months. For the participants who reported fatigue complaints for longer than two weeks, fatigue scores increased as a function of duration: The mean (*SD*) fatigue scores from lowest to highest duration were 73.64 (16.38), 81.19(16.15), 80.13(15.98), 76.31(18.02) and 83.80 (17.86), $F(4,264) = 3.43$, $p < .01$, partial $\eta^2 = .05$. Post hoc *t*-tests indicated that the levels of fatigue between 2 weeks-1 month and more than 4 months differed significantly from each other ($p < .01$, Bonferroni corrected). There were no significant differences between all other pairs ($p > .229$ for all comparisons).

Table 1

Distributions of sex, decentralized selection, study year and fatigue scores in the medical bachelor students of the VU Medical Center Amsterdam, The Netherlands

		Total eligible sample (*N* = 1050)	Main Sample (*N* = 701)	Subsample (*N* = 368)	*p***
Females		64%	69%	70%	.683
Decentralized Selection		37%	41%	39%	.275
Study Year	1	34%	34%	33%	.443
	2	36%	35%	35%	
	3	31%	30%	32%	
CIS fatigue score			*M* (*SD*)	*M* (*SD*)	
	Total		65.1 (21.0)	66.6 (21.4)	.234
	Fatigue severity		27.9 (10.4)	28.4 (9.5)	.240
	Concentration		17.5 (6.6)	18.0 (6.7)	.143
	Motivation		10.3 (4.4)	10.4 (4.5)	.326
	Physical activity		9.4 (4.6)	9.7 (4.6)	.810

Note. ** The *p*-value resulted from the comparison between the main sample and the subsample. For this comparison the subsample was subtracted from the main sample. Thus, *N* = 333 for the main sample in the comparison.

Correlates of Fatigue. Univariate analyses are depicted in Table 2. The factors that were significantly associated with fatigue were: sex, living away from home (demographic cluster); disease/medication use (medical cluster); sleeping problems, sleeping hours on work days, catch-up sleep (sleep cluster); study delay, study satisfaction (studying cluster); hours spent on studying, hours spent on sports (lifestyle cluster). These factors were entered in the multiple regression analyses. Given the known effects of familial education and income inequality on health (Muller, 2002), we included parental educational level and first generation students in the demographic cluster. Age was also included, because we expected to find that that cognitive development in late adolescence might be related to fatigue.

In the final model (Table 3, left side), all factors were entered simultaneously. The level of fatigue was positively related to sleeping problems, disease/medication use, and hours per week spent on studying (from largest to smallest association). Fatigue was negatively related to sports, study satisfaction, living away from home (also from largest to smallest association). The final model accounted for 31% of the variance.

Subsample: Associations with Executive Functioning

Sample Characteristics. Of the subsample (N = 368) 258 were females and the mean age was 21 years (SD = 2). Furthermore: 32% reported the presence of a disease and/or medication use; 66% was living on their own; 13% did not have highly educated parents; and 5% was classified as first generation students. These results were comparable to those in the main sample.

Correlates of Fatigue. Results of the regression analysis on the subsample (thus including the AEFI scales) are depicted in Table 3, right side. This model explained 45% of the variance and yielded similar significant associations, except for "hours spent on studying", which was not significant in this subsample, and "sleeping hours on work days", which was significant in this subsample and not in the main sample. Furthermore, both AEFI scales were associated with fatigue, i.e., lower planning and self-control were both associated with higher fatigue.

Table 2
Main Sample Characteristics and Univariate Tests

Cluster:	Variable	Distribution N^{o} / *M* (*SD*)	Fatigue score *M* (*SD*)	Test statistic^{oo}
Demographic	Sex	215 male / 486 female	63 (20) / 67 (21)	2.38*
	Age	21.2 (2.1)		-.05
	Living away from home	447 yes / 254 no	64 (20) / 68 (21)	2.14*
	Education parents	620 higher / 81 lower	65 (20) / 69 (21)	1.36
	1st generation students	39 yes / 662 no	67 (21) / 65 (21)	-0.30
Medical	Disease/medication use	217 yes / 484 no	74 (20) / 62 (20)	-7.48***
Sleep	Sleeping problems	6.4 (2.6)		.34***
	Sleeping hours work days	7.1 (1.1)		-.12**
	Sleeping hours weekend	8.5 (1.3)		-.01
	Catch-up sleep	1.4 (1.3)		.08*
Studying	Decentralized selection	284 yes / 417 no	66 (21) / 66 (21)	-0.27
	Falling behind	124 yes / 577 no	70 (23) / 65 (20)	-2.38*
	Program year	241 year 1	67 (21)	0.83[a]
		248 year 2	66 (19)	
		212 year 3	64 (22)	
	Study satisfaction	7.8 (0.9)		-.28***
Lifestyle	Alcohol consumption (gl p wk)	8.5 (7.7)		-.02
	Caffeine consumption (daily)	2.0 (1.5)		-.05
	Smoking	40 yes / 661 no	69 (19) / 65 (21)	-1.16
	Additional job	466 yes / 235 no	65 (21) / 67 (20)	0.76
	Member of students' association	206 yes / 495 no	64 (21) / 67 (21)	0.92
Hours spent on	Studying	29.4 (10.5)		.08*
	Sports	3.9 (4.3)		-.30***
	Leisure time activities	10.0 (7.8)		-.06
	Additional job	5.7 (5.8)		-.01
AEFI	Self-control	2.7 (0.7)		-.34***
	Planning	3.6 (0.5)		-.32***

Note. *p<.05; ** p<.01; ***p<.001; [a] f-test; ^{o}*The N varies due to incidental misses*
^{oo}*t*-test for dichotomous and Pearson's *r* for continuous variables

Table 3
Correlates of Fatigue

		b^a	95% CI[a]	β^a	Adjusted R^{2a}	b^b	95% CI[b]	β^b	Adjusted R^{2b}
Demographic factors					.31				.45
	Age	0.14	-0.51 – 0.78	.01		0.29	-0.57 – 1.14	.03	
	Sex	0.43	-2.46 – 3.32	.01		1.36	-2.44 – 5.15	.03	
	Living away from home	-4.15	-6.99 – -1.31	-.10**		-4.82	-8.56– -1.07	-.11*	
	Education parents	0.41	-5.86 – 5.04	-.01		-1.48	-7.99 – 5.02	-.02	
	1st generation	-1.36	-8.89 – 6.17	-.02		1.81	-7.64 – 11.26	.02	
Disease/medication use		9.08	6.21 – 11.94	.20***		8.49	4.81 – 12.16	.19***	
Sleep									
	Sleeping problems	2.14	1.68 –2.68	.28***		2.23	1.60 – 2.85	.28***	
	Sleeping hours (work days)	0.18	-1.11 – 1.56	.01		0.96	-0.73 – 2.64	.05	
	Catch-up sleep	0.9	-0.18 – 1.89	.06		2.38	1.074 – 3.72	.15***	
Studying									
	Study delay	-0.36	-3.90 – 3.17	-.01		-1.88	-6.30 – 2.54	-.03	
	Study satisfaction	-5.58	-7.15 – -4.00	-.23***		-4.57	-6.66 – -2.48	-.19***	
Hours spent on									
	Studying	0.15	0.02 – 0.27	.08*		0.1	-0.06 – 0.27	.05	
	Sports	-1.42	-1.73 – -1.11	-.29***		-1.06	-1.48 – -0.65	-.21***	
AEFI									
	Self-control					-7.94	-10.62 – -5.26	-.24***	
	Planning					-8.08	-11. 51 – -4.66	-.20***	

Note. [a] Main Sample (*N*=701); [b] Subsample (*N*=368) **p*<.05; ** *p*<.01; ****p*<.001

DISCUSSION

In the present study, we investigated the prevalence of fatigue as well as the factors associated with fatigue in a sample of medical students. The prevalence of fatigue was high: one out of every three students regarded himself or herself as fatigued. We found no difference between male and female students. More hours spent on sports, living away from parents, and higher study satisfaction, were related to lower fatigue scores; whereas sleeping problems, disease/medication use, and hours per week spent on studying, were related to higher fatigue scores. Furthermore, we observed that executive functions play an important role in the experience of fatigue, since better planning and self-control abilities were strongly associated with lower fatigue and considerably increased the model fit.

As expected, the prevalence of fatigue in this sample of medical students (males 26% and females 31%) proved to be substantially higher than the prevalence of fatigue in a peer sample from the working population (males and females together 20%; Bültmann et al., 2002). Both samples were taken from Dutch populations and fatigue cases were classified using the same instrument and cutoff score. Our findings also showed an association between fatigue level and duration, with significantly lower levels of fatigue in students who reported fatigue complaints that lasted less than one month compared to that of students who reported complaints for longer than 4 months. We therefore expect that when fatigue persists, students run the risk of developing more severe levels of fatigue. A future longitudinal study could test this hypothesis.

Surprisingly, the level of fatigue was minimally explained by lifestyle characteristics. In contrast to what would seem the most obvious explanation of fatigue in students, substance use or extracurricular activities, e.g., additional jobs, students associations and nightlife activities, were no significant correlates. The only significant correlates of our cluster of lifestyle factors were hours spent on studying and hours spent on sports. More hours spent on studying was related to higher fatigue, but this association was very weak and did not hold in a smaller sample (i.e., our subsample). By contrast, sport was the strongest predictor of fatigue in our full model. Students who spent more time on sports reported lower fatigue. A similar relation was found in scholars (ter Wolbeek et al., 2006) and adults (Cardol, Bensing, Verhaak, & Bakker, 2005). As suggested by Ter Wolbeek and colleagues (2006), it is plausible that engagement in sports reduces the risk of developing fatigue. For example, Viner and Hotopf showed that higher levels of childhood exercise were related to lower risk of developing CFS in adulthood (Viner & Hotopf, 2004). In light of this, our findings emphasize the importance of engagement in sports.

The relation between sleep and fatigue has been well established. Numerous studies related decreased sleep duration to fatigue during the day (Åkerstedt et al., 2004; Leonard, Fanning, Attwood, & Buckley, 1998). Yet, the current study showed that, in the full model, perceived sleeping problems were related to fatigue, whereas the number of sleeping hours and catch-up sleep were not. It must be noted however that in the subsample, catch-up sleep did reach significance. Sleep quality has in fact previously been related to fatigue (Brown & Schutte, 2006). The underlying cause of sleeping problems is often attributed to stress and rumination (Querstret & Cropley, 2012; Zawadzki, Graham, & Gerin, 2013). Thus, possibly, our observed relation between fatigue and sleep quality in medical students may be explained by amount of stress.

Study satisfaction was another strong correlate. Students who were less satisfied with their choice of study, study performance, or quality of the study, were more fatigued. This could indicate that students who are not satisfied with what they are doing may have to push themselves more to accomplish their tasks, which increases fatigue. Conversely however, since fatigue and school performance are related (Bull, Espy, & Wiebe, 2008; St Clair-Thompson & Gathercole, 2006), fatigued individuals may become less satisfied with their study performance. Also, fatigue is associated with a lower level of well-being (DeLuca, 2005), which may lower satisfaction in general.

Other significant factors included disease/medication use and living away from home. Since fatigue is a symptom of disease in general (Wessely et al., 1995), and a side effect of all kinds of medicinal products (Zlott & Byrne, 2010), the association between disease/medication use and fatigue is unsurprising. Of our demographic factors, whether or not the students still lived with their parents was significantly predictive of the level of fatigue. Students who lived away from home had lower fatigue scores compared to students still living with their parents. This seems counterintuitive, as students who live away from home have more responsibilities and social influences. Perhaps this effect relates to traveling time: students who live with their parents possibly spend more time commuting, which may in itself be fatiguing and it reduces the time available for other activities or relaxation.

As expected, we observed a strong relation between self-perceived executive functions and level of fatigue; students who reported better planning and self-control skills also reported lower fatigue scores. This confirms the close connection between executive functions and fatigue that has been suggested by various studies (Boksem, Meijman, & Lorist, 2005; Bryant, Chiaravalloti, & DeLuca, 2004; Krupp & Elkins, 2000; Schwid et al., 2003; van der Linden & Eling, 2006; van der Linden, Frese, & Sonnentag, 2003). Even though the causal direction is unclear, it is conceivable that fatigue results from insufficient planning and self-control ability in combination with a demanding environment. In order to avoid stressful situations such as ending up with too much work at the last minute, students are required to organize their tasks well in advance (an example of planning) and keep to their schedules (an example of self-control). Insufficient planning or self-control may thus lead to stressful situations. The relation between stress and fatigue has been well established by previous research (Maslach & Leiter, 1997). Conversely, induced fatigue could be detrimental to executive functions (Boksem, Meijman, & Lorist, 2005; van der Linden & Eling, 2006; van der Linden, Frese, & Sonnentag, 2003), so another possibility is that fatigued individuals develop problems with planning and self-control.

Limitations

This study used a cross-sectional design, which allowed us to collect data from a large number of participants within a short period of time. However, this design limits inferences about directionality. Another point of caution relates to the use of a questionnaire to assess executive functions. More research is necessary to investigate whether fatigue is related to actual executive abilities, or merely to the students' perception of their own skills. Furthermore, the executive functions questionnaire was optional, which increased the risk of a selection bias. However, as the distributions of sex, study year, and admittance procedure in the subsample were similar to those of the main sample and the total eligible sample, and the regression models in both samples yielded similar findings, it is likely that a possible bias is negligible.

Conclusions and Implications

The current results confirmed that fatigue in medical students is common: one out of every three students was characterized by fatigue. Important correlates of fatigue were sleep quality, engagement in sports, but also executive abilities. Surprisingly, lifestyle factors such as substance use and extracurricular activities other than sports were not related to the level of fatigue. Further research is necessary to clarify whether these findings apply specifically to medical students or to students in general.

To improve our understanding of the directionality of the associations found in this study, future research should study these factors using a longitudinal design, or by means of interventions. Such studies could elucidate which factors are predictive of fatigue in medical students. Given the well-known association of fatigue with disease, well-being, and academic achievement, it is in the interest of the students' health and academic career to gain more insight into the development and prevention of fatigue in this population.