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Original article

## Adolescents With Greater Mental Toughness Show Higher Sleep Efficiency, More Deep Sleep and Fewer Awakenings After Sleep Onset

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### A B S T R A C T

**Purpose:** Mental toughness (MT) is understood as the display of confidence, commitment, challenge, and control. Mental toughness is associated with resilience against stress. However, research has not yet focused on the relation between MT and objective sleep. The aim of the present study was therefore to explore the extent to which greater MT is associated with objectively assessed sleep among adolescents.

**Methods:** A total of 92 adolescents (35% females; mean age, 18.92 years) completed the Mental Toughness Questionnaire. Participants were split into groups of high and low mental toughness. Objective sleep was recorded via sleep electroencephalograms and subjective sleep was assessed via a questionnaire.

**Results:** Compared with participants with low MT, participants with high MT had higher sleep efficiency, a lower number of awakenings after sleep onset, less light sleep, and more deep sleep. They also reported lower daytime sleepiness.

**Conclusions:** Adolescents reporting higher MT also had objectively better sleep, as recorded via sleep electroencephalograms. A bidirectional association between MT and sleep seems likely; therefore, among adolescence, improving sleep should increase MT, and improving MT should increase sleep.

### IMPLICATIONS AND CONTRIBUTION

Mentally tough adolescents showed objectively assessed improved sleep. Improving adolescents' mental toughness might also improve adolescents' sleep, and vice versa.

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Adolescence is defined as the period of gradual transition between childhood and adulthood, with conceptually distinct physical changes marking puberty and maturation [1,2]. Along with dramatic changes in physiology and neural networks [3,4], adolescents have to face new challenges and assume responsibility

for issues such as their academic and vocational careers; peer and intimate relationships; increased physical, emotional and financial independence from parents and siblings; use of psychoactive substances; extra-curricular employment; and leisure-time activities such as sports participation and music [1]. Dealing with these issues is potentially stressful; accordingly it is assumed that adolescents with better coping skills will deal more successfully with these challenges [5].

A psychological construct related to favorable stress management is mental toughness (MT). Mental toughness is a relatively new area of academic research [6] and a cognitive

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strength variable known to be associated with good performance both in elite sport [7] and, more recently, in non-elite sport [8–11]. Mental toughness has been conceptualized in various ways in the scientific literature [6]. In the present study, we used the 4C(+2) (Challenges, Commitment, Control [emotional and control over life], Confidence [interpersonal and in ability]) model of MT, defined as performing well in challenging situations (“Challenges usually bring out the best in me”), commitment (“I don’t usually give up under pressure”), control (emotional control: “Even when under considerable pressure I usually remain calm”; and life control: “I generally feel in control”), and confidence (interpersonal confidence: “I usually take charge of a situation when I feel it is appropriate”; and confidence in ability: “I am generally confident in my own abilities”) [12]. In previous studies [9–11], the authors were able to validate a German version of Mental Toughness Questionnaire–48 (MTQ48) [12] and to show, in a large sample of adolescents and young adults, (1) that the construct of MT is not limited to high-performing elite sportsmen and women [9–11]; (2) that MT is associated with increased stress resilience [9,10]; and (3) that MT remains stable over time [11], which suggests that MT is related to successful stress management and to psychological well-being.

With regard to this last construct, numerous studies have indicated that independent of age, there is a bidirectional relation between psychological well-being and sleep [13]. For adolescents, sleep and sleep regulation play a crucial role in both well-being and development [14–17]. Lemola et al. [18,19] showed that dispositional optimism was associated with better sleep quality and longer sleep duration among children and adults. In contrast, sleep disturbances have been reported in more than 25% of adolescents worldwide; poor sleep in adolescence has become a significant public mental and physical health problem [14,20]. Cross-sectional [21,22] and longitudinal studies [23,24] have shown that acute and chronic sleep loss during development persists over time, with negative effects on adolescents’ physical and mental health. At the same time, poor psychological well-being may itself negatively affect adolescents’ sleep [14,25].

To explain the association between poor sleep and psychological processes, it has been proposed that increased arousal and dysfunctional thoughts are directly involved in psychologically caused sleep disturbances [26–29], whereas, the absence of stress and worries, for instance, are associated with favorable sleep. This research points to interrelations among low stress, favorable personality traits, and restorative sleep. Consequently, it seems possible that high MT and good quality sleep are closely linked.

The main goal of the research reported here was to explore the association between MT and objective sleep within a sample of adolescents. The present study may add to the current literature on MT and sleep in an important way by showing a close association between MT (as a marker of psychological well-being) and sleep among non-elite sport adolescents.

The following hypothesis was formulated. Following previous research [9–11,18,19], higher scores for MT would be expected to be associated with improved sleep, as assessed by sleep electroencephalogram (EEG) recordings. More specifically, the researchers expected to find higher sleep efficiency, shorter sleep onset latency, more deep sleep, and less light sleep in adolescents with high MT, with compared to adolescents with low MT. Lower daytime sleepiness (DS) was also expected. Findings that

higher scores of MT were associated with subjectively increased improved sleep would confirm the hypothesis.

## Methods

### Participants

A total of 285 adolescents participated in the study (mean age, 18.26 years; standard deviation 4.17 years); preliminary data are presented elsewhere [30]. All participants completed the MTQ and a questionnaire related to sleep complaints (SC) and daytime sleepiness (DS). To recruit participants, the study was advertised electronically on the homepages of three high schools in the canton of Basel, a district of the German-speaking Northwestern part of Switzerland. Data were collected during spring and summer 2012. Participants were informed about the purpose of the study and about the voluntary basis of their participation. They were also assured of the confidentiality of their responses, and they gave written informed consent. For participants aged <18 years, written informed consent was secured from their parents. The study was approved by the local ethics committee, and the entire study was performed in accordance with the ethical standards in the Declaration of Helsinki.

### Procedure

After completing the MTQ, a subsample of participants with high MT scores (upper 17% of the total score:  $\geq 141$  points) and participants with low MT scores (lower 15.5% of the total score:  $\leq 77$  points) were asked to undergo a sleep EEG assessment. Participants undergoing sleep EEG recordings received a voucher of 30 Swiss francs (about \$30) for participation.

### Materials

Participants completed the MTQ48 [12] to assess MT, the Insomnia Severity Index [31] to assess SC, and the Epworth Sleepiness Scale [32] to assess DS, and underwent objective sleep EEG monitoring [33].

### Measurement of MT

Participants ( $N = 92$ ) were asked to fill out the MTQ48 ([12]; German version: [9–11]), which measures overall MT and its six subcomponents: challenge (e.g., “Challenges usually bring out the best in me”), commitment (e.g., “I don’t usually give up under pressure”), emotional control (e.g., “Even when under considerable pressure I usually remain calm”), life control (e.g., “I generally feel in control”), interpersonal confidence (e.g., “I usually take charge of a situation when I feel it is appropriate”), and confidence in ability (e.g., “I am generally confident in my own abilities”). Answers on the MTQ48 were given on 5-point Likert-type scales ranging from 1 = “strongly disagree” to 5 = “strongly agree”. Items were summed to obtain overall and subscale scores, with higher scores reflecting greater MT (Cronbach  $\alpha = .89$ ).

### Assessment of sleep: objective sleep assessment

To assess sleep objectively, sleep EEG recordings were performed at home using a three-channel EEG device (Fp2-A1, C3-A2, and C4-A1; electrooculogram; electromyogram; Somnowatch;

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