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Original article

Daily Morning Running for 3 Weeks Improved Sleep and Psychological Functioning in Healthy Adolescents Compared With Controls

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A B S T R A C T

Purpose: To compare sleep electroencephalographic patterns and psychological functioning of healthy adolescents running regularly in the mornings with those of control subjects. Although several studies have shown that regular moderate-to-vigorous exercise is related to favorable sleep and psychological functioning in adolescents, research on the effectiveness of short interventions is more limited.
Methods: Fifty-one adolescents (mean age = 18.30 years; 27 female [53%]) took part in the study; they were randomly assigned either to a running or to a control group. The running group went running every morning for 30 minutes at moderate intensity during weekdays for 3 consecutive weeks. Sleep electroencephalographic patterns and psychological functioning were assessed in both groups before and after the 3-week period. All participants also kept a sleep log for 3 weeks.
Results: Objective sleep improved (slow-wave sleep increased; sleep onset latency decreased) in the running group compared with the control group. Subjective sleep quality, mood, and concentration during the day improved, whereas sleepiness during the day decreased.
Conclusions: Thirty minutes of running in the morning during weekdays for 3 consecutive weeks impacted positively on sleep and psychological functioning in healthy adolescents compared with control subjects. Running is inexpensive and easy to implement during school schedules, and as both objective and subjective improvements were observed within 3 weeks, regular physical exercise should be promoted.

IMPLICATIONS AND CONTRIBUTION

Moderate running in the morning for 3 consecutive weeks impacted positively on objective and subjective sleep and psychological functioning among healthy adolescents. Regular exercise, such as running should be promoted as both remedy and preventative measure for poor sleep and poor psychological functioning.

Adolescence is a critical period for both neural and psychological [1] development, in which sleep plays an important functional role [2,3]. Owing to a variety of different factors, such as physical maturation (e.g., dramatic increase in secretion of growth hormones), psychological factors (e.g., identity formation), social factors (relative dependence from parents and peers), and extracurricular factors (e.g., sports and leisure activities, academic achievements), total sleep time (TST) decreases [2–5], although adolescents seem to still require 9 or more hours of sleep per night [4,5]. Daytime sleepiness is common among adolescents, and acute [6] and chronic [7] sleep disturbances have been related to poor physical and psychological functioning. In a cross-sectional survey [8], >60% of respondents were categorized as poor-quality sleepers, and shorter sleep duration, poor sleep quality, and sleepiness were independently associated with poor school achievement in children and adolescents [9].

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Exercise appears to be a simple and inexpensive method for addressing sleep loss and daytime sleepiness. Although there is empirical evidence for young and elderly adults [10], relevant research on adolescents is scarce, and studies have predominantly involved cross-sectional designs [11,12]. In previous studies, we have been able to show a relation between exercising and improved subjective and objective sleep in adolescent elite athletes [13,14] and in moderately exercising adolescents [15], compared with control subjects. A limitation was that findings were derived from cross-sectional group-comparison designs, whereas intervention studies do allow stronger conclusions regarding the direct effects of exercising. In this respect, Dworak et al [16] were able to show that acute bouts of exercise increased objectively recorded sleep.

Additionally, there is evidence that regular exercise is associated with improved psychological functioning in adolescents [14,15,17,18]; exercising buffered the effects of family conflict on depressed mood [19], and sports participation has been shown to be a protective factor against depression and suicidal ideation, mediated by its impact on increased self-esteem and social support [20]. Additionally, there is also evidence that the implementation of regular exercise as a therapeutic intervention leads to positive psychological outcomes: regular exercising improved self-esteem in children and adolescents [21], and walking regularly for 30–45 minutes during weekdays for 12 consecutive weeks led to complete psychiatric remission in half of patients suffering from therapy-resistant major depressive disorders, as compared with control subjects [22].

Thus, there is reason to anticipate that exercise interventions can improve sleep and psychological functioning. Therefore, the following two hypotheses were formulated. First, we expected a positive impact of a moderate-to-vigorous exercise (here, moderate-to-vigorous exercise was defined as planned and continuous running without interruption at a speed such that conversation is not possible) training program on sleep [13,16] as compared with a control condition. Second, following previous research [13–18], we anticipated an improvement in psychological functioning (such as stress perception, curiosity, somatosensory amplification, mood, concentration, and sleepiness) in exercising adolescents as compared with control subjects.

Methods

Sample

Participants were recruited from a high school in the canton of Basel-Landschaft, a district of the German-speaking northwestern part of Switzerland. Figure 1 shows the study flowchart and dropout rates. Of the 60 adolescents originally approached, 51 (85%) completed the study (see Figure 1; age: mean [M] = 18.30 years; standard deviation [SD] = .89; range: 17.5–19.5 years): 27 were female (age: M = 18.11 years, SD = .80) and 24 were male (age: M = 18.13 years, SD = 1.00). Participants were randomly assigned to either the running or the control group (see later in the text). Neither gender distribution ($\chi^2(1) = .30$, $p = .87$) nor age (analysis of variance [ANOVA]: group: $F(1, 47) = .01$, $p = .97$; gender: $F(1, 47) = .02$, $p = .97$) differed significantly between the two groups. Body mass index differed significantly between male and female participants (male: M = 23.29, SD = 2.27; female: M = 20.74, SD = 1.54; gender: $F(1, 47) = 18.62$, $p = .000$) but not between the two groups (group: $F(1, 47) = .44$, $p = .51$). As in previous studies [14,15], mean weekly vigorous exercise was assessed through the following question: "For how many hours do you do vigorous exercise? Vigorous exercise means: You are playing sports at such a level as to have a markedly increased heart rate and to sweat." Answers indicated the number of hours over which intense exercise was undertaken for each of the 7 consecutive days. These values were then summarized to generate a total weekly exercise index (hrs/wk). At the beginning of the study, mean vigorous exercise did not statistically differ between the two groups (running group [RG]: M = 2.19 hours (SD = 1.56); control group [CG]: M = 2.24 hours (SD = 1.78); $t(49) = .53$, $p = .60$, $d = .15$).

All students were informed about the purpose of the study and about the voluntary basis of participation. Participants were assured of the confidentiality of their responses and gave written informed consent. Of the 51 participants, 10 were younger than 18 years. For these participants, parents' written informed consent was requested. For participation, they received a voucher of 30.00 Swiss francs for a sports shop. The study was approved by the local ethics committee of Basel (Switzerland; trial number: 72/10).

Procedure

Figure 1 depicts the study structure, assessments, randomization, and total sample sizes. First, a psychiatric interview [23] ensured that only participants without psychiatric disorders (e.g., affective disorders, eating disorders, substance abuse disorders, sleep disorders, or others) were enrolled in the study. Additionally, brief questions related to physical health state ensured that only participants without medical illnesses, allergies, and cardiovascular, pulmonary, or orthopedic diseases took part in the study. Thereafter, participants were asked to refrain from any intake of psychoactive or sleep-altering substances (alcohol, cannabis, nicotine, mood- or energy-enhancing drinks) for 2 weeks before commencement of and during the study itself.

Participants kept a sleep log (see later in the text) for 3 weeks (21 consecutive days), covering 3 × 5 weekdays and 3× 2 weekend days. To compare possible effects of regular running, at the beginning and at the end of the study, participants completed a series of questionnaires related to psychological functioning and sleep (see later in the text). Additionally, at the beginning and at the end of the study, objective sleep assessment was executed (which will be described further).

The study was conducted during a school term from mid-August to the end of September 2010, that is, during the summer season with high light exposure from early morning.

Participants were randomly assigned to one of the two study conditions, namely, the RG or the CG. For 3 consecutive weeks, during the 5 school days per week, participants assigned to the RG or the CG met every morning at 7 AM at school. Afterward, the RG went running for between 30 and 37 minutes. All participants in the RG had 3 × 5 running sessions. Running was cross-country; after two laps on the school's running track, running continued in the forest close to school. Participants were allowed to maintain their own pace though while running without interruption in groups of at least four people. Running differed from jogging in that running speed was such that talking was more difficult. All participants had to pass a checkpoint and a turning point, and the track did not allow shortcuts. After participants completed the session, they got ready for school, and a breakfast was provided before school commenced.

In contrast to the RG participants, those in the CG remained on the school's running track, remained seated, followed