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Music Interventions and Sleep Quality among College Students

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Abstract. Sleep problems among college students are an increasingly prominent topic in current health research. Existing studies have shown that music can have a certain positive effect on improving sleep, but there may be differences in intervention outcomes among individuals. Therefore, this article adopts the method of literature review to sort out and analyze the research on music intervention, the sleep quality of college students, and related individual differences; explore the impact of music on the sleep quality of college students; and further examine the role of neuroticism and psychological state in sleep treatment. Existing studies have found that music can improve subjective sleep quality and sleep performance to a certain extent, but the results of objective sleep indicators are not exactly the same, and their effects on different degrees of neuroticism and psychological state are also different. This study shows that music has the potential to help improve the sleep of college students. Future research should further integrate objective sleep measurement methods and focus on more personalized musical interventions.

Keywords: Sleep problems, college students, health

1. Introduction

Sleep is an essential part of daily life, and good sleep supports physical health, psychological well-being, and normal academic and daily functioning [1]. However, in modern society, problems such as insufficient sleep, difficulty falling asleep, sleep disturbances, and poor sleep quality are common. Therefore, sleep-related problems have become one of the main topics in public health and mental health research [1]. For college students, the pressure of studies, changes in daily schedules, and inconsistent sleep habits are worthy of greater attention, and sleep deprivation may further affect their mental health, academic performance, and quality of life [2, 3]. Therefore, exploring a convenient, low-risk, and easily integrated approach to improving sleep in daily life has certain practical significance. Music, as a non-pharmacological intervention, has increasingly been used to improve sleep and may help reduce anxiety and shorten sleep-onset latency among college students [4]. Based on this background, this article will adopt a literature review approach to analyze the impact of music on the sleep quality of college students, and further discuss the possible effects of music intervention and the differences in efficiency that different individual characteristics may

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bring, in order to provide a reference for improving sleep and more personalized music intervention for college students.

2. Core concepts

2.1. Sleep quality

Sleep quality is a comprehensive concept that reflects the overall sleep status of the individual, including not only the subjective evaluation of sleep experience, but also the objective performance of sleep duration, continuity, and regularity [1]. Therefore, the quality of sleep cannot be judged by the duration of sleep alone [1]. It also includes appropriate sleep time, regularity, no sleep disorders, and good sleep quality [1]. In addition, sleep quality can be evaluated both through self-scoring and objective sleep continuity indicators [1].

2.2. Music intervention

In this article, music intervention mainly refers to the use of music as a non-drug method to promote relaxation and sleep before going to bed [4]. Against this background, sleep environment music can be used as interventional music, which is defined as a type of music that uses specific musical elements to create a specific environmental atmosphere [4]. This kind of music can evoke the audience's association with nature or a specific environment and promote relaxation. It is usually characterized by low volume, weak energy, slow rhythm, and gentle melody. It can contain not only natural sounds such as instrumental music, rain, waves, etc., but also environmental sound elements such as cafes or city streets [4].

2.3. Sleep problems

Sleep problems cover all kinds of sleep difficulties, and the common symptoms in existing studies mainly include the following categories. Specifically, sleep problems usually include difficulty falling asleep [4, 5], difficulty maintaining sleep [5], poor sleep quality [2, 4, 5], sleep pattern disorder [4], insufficient sleep time [1], irregular sleep time [1], insomnia [1], sleep delay [2], and short sleep time [2].

2.4. Neuroticism

Neuroticism is one of the personality dimensions in the five-factor model, which mainly reflects the sensitivity of individuals to stress and negative emotions [6]. A higher level of neuroticism usually indicates that individuals are more susceptible to stress, have stronger self-awareness, and have a stronger emotional response [6]. In addition, neuroticism can be regarded as a stable personality characteristic associated with emotional distress [6, 7]. Therefore, neuroticism can be used to describe an individual's relatively stable tendency to respond to stress and negative emotions [6, 7].

3. The positive effects of music therapy on sleep quality

3.1. Findings from studies on how music improves sleep quality

Existing studies generally show that music intervention is associated with the improvement of sleep quality [4, 8, 9]. However, due to differences in music genres, intervention duration, and

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measurement methods, there are large differences in the reported improvement [4, 8, 9]. The following will compare the relevant research in terms of research objects, intervention methods, measurement indicators, and research results.

First of all, Jespersen and others made a large-scale review of the overall impact of music on sleep [8]. This Cochrane systematic review includes 13 randomized controlled trials involving 1007 adults with insomnia or sleep difficulties, so that the overall impact of music intervention on sleep can be evaluated based on a large sample size [8]. The music used in the study includes classical music, jazz, ambient music, neo-classical music, and Buddhist songs. Each listening session is about 25–60 minutes, and the total duration of the intervention is between 3 and 90 days [8]. Although there are significant differences in the intervention methods, 10 studies using the Pittsburgh Sleep Quality Index (PSQI) scale found that the average PSQI score of the music group was 2.79 points lower than that of the control group, indicating that the subjective sleep quality had improved overall. This conclusion was rated as medium-certain evidence [8]. In addition, the subgroup analysis found no significant differences in the effect based on the duration of the intervention, or whether the music was selected by the researchers or selected by the participants from the preset tracks [8]. Therefore, it is impossible to conclude that any particular type of music is the most effective, or that the longer the listening time is, the stronger the effect is [8].

The review also shows that subjective improvement is not exactly the same as objective sleep changes [8]. The survey results showed that the participants subjectively reported faster sleep, longer sleep time, and improved sleep efficiency, but the improvement of repeated awakening at night was not obvious [8]. In contrast, three studies using polysomnography did not find a significant improvement in these objective sleep indicators, indicating that the impact of music intervention on sleep may be more reflected in the subjective sleep experience of individuals [8].

Based on the above general evidence, Hu and others further focused on the group of college students. By collecting subjective records and objective activity monitoring data at the same time, they compared the different effects of music intervention on the two types of indicators [4]. The study recruited 138 college students with poor sleep quality and asked them to undergo a four-week sleep environment music intervention (SEMI), listen to 30 minutes of music before going to bed every day, and be monitored through subjective recording and an actigraphy [4]. The results showed that the participants' subjective feedback said that they fell asleep faster, slept longer, woke up at night less often, and the overall sleep quality improved [4]. However, the changes shown by the activity recorder are generally limited. The most obvious improvement is the shortening of the sleep onset latency (SOL), which means that participants fall asleep faster after trying to fall asleep [4].

Sleep efficiency only improved significantly in the third week, while the total sleep time and the number of nightly awakenings did not change significantly [4]. This is consistent with the overall research results of Jespersen and others, which show that subjective improvement is more comprehensive than objective change [4, 8]. The study also found that participants subjectively reported a shorter sleep time from the second day, and the activity recorder did not record this change until the third day, indicating that the subjective improvement occurred slightly earlier than the objectively recorded improvement [4].

On this basis, Yan and others used a randomized controlled trial design to further verify the effect of music intervention on improving sleep among college students [9]. The study randomly assigned 75 students with sleep problems to the classical music group, jazz group, and control group [9]. For five weeks, the music group listened to at least 30 minutes of music before going to bed on two working days a week, while doing deep breathing and relaxation exercises [9]. The control group did the same relaxation exercises, but did not listen to music. Five weeks later, the Insomnia

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Severity Index (ISI) of the music group fell by an average of 7.48 points, while the control group fell by 3.96 points. The PSQI scores decreased by 4.59 points and 2.16 points, respectively, indicating that the addition of music to the same relaxation program can make the participants report greater improvements in the severity of insomnia and sleep quality [9].

Yan and others used classical and jazz instruments, while Hu and others used ambient music. However, Yan et al. found that there was no significant difference between the effects of the two instruments [9]. This is consistent with the research results of Jespersen and others, which show that there is no sufficient evidence that a particular musical style is most effective, and whether music can create a state of relaxation may be more important than the style itself [8, 9]. However, the experiments of Yan et al. only used subjective questionnaires such as ISI and PSQI, and did not use activity recorders or polysomnography (PSG), which shows that although the study cannot determine whether the objective sleep indicators have changed to the same degree, adding music may lead to an even greater degree of improvement in students' self-reported sleep quality [9].

All in all, these three studies show clear progress from general evidence, college student samples to randomized controlled trials. Based on multiple randomized controlled trials (RCTs), Jespersen and others found that the improvement effect of music on subjective sleep quality was generally stable, but there was no obvious difference between different types of music and intervention duration [8]. Hu et al. further found that subjective improvement is not exactly equivalent to objective sleep changes, among which the shortening of the SOL is a relatively stable objective result [4]. Yan et al. found through a randomized design that college students reported more significant sleep improvements even when listening to classical music and jazz than to ambient music [9]. Therefore, the existing evidence generally supports that music can improve the subjective sleep experience, but its specific impact on objective sleep status needs to be further studied [4, 8, 9].

3.2. Possible mechanisms through which music affects sleep quality

The effect of music in improving sleep may not occur directly in the sleep process itself, but rather by regulating an individual's psychological and physiological states, reducing pre-sleep tension, and making it easier for the body and brain to enter a state suitable for sleep [10, 11]. Among these, stress reduction, anxiety relief, and reduced arousal may be important mechanisms by which music affects sleep [10, 11]. The following will combine relevant research to analyze how music intervention may affect sleep quality through psychological regulation and physiological relaxation.

First of all, to understand the mechanism by which music affects sleep, people must consider the relationship between psychological state and sleep quality. The study by Henrich et al. on the sleep quality of college students found that the higher the degree of depressive symptoms, the worse the subjective sleep quality; while more positive emotional regulation is associated with better sleep performance [5]. Although the study did not directly examine music intervention, the results show that sleep quality is not only affected by sleep behavior, but also by individual emotional state and stress management style [5]. This provides a basis for subsequent discussions on how music can improve sleep through emotional regulation.

On this basis, de Witte and others have demonstrated the decompression effect of music from a broader perspective [10]. Their meta-analysis of 104 randomized controlled trials found that music intervention can improve psychological stress indicators and certain physiological stress indicators at the same time, indicating that the role of music may involve both subjective emotional experience and physiological arousal [10]. This result provides a theoretical basis for the effect of music on

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sleep, because greater stress is often accompanied by increased psychological and physiological arousal, which increases the difficulty of falling asleep [9, 10].

However, unlike de Witte and others who mainly focus on the overall pressure changes in the experimental environment, Linnemann and others further explore how college students can use music in daily life [11]. The study found that music does not have the effect of relieving stress in all situations; the purpose of using music may be an important factor affecting its effect [11]. Only when participants actively listen to music for the purpose of relaxation will the decompression effect be more significant, accompanied by changes in cortisol levels [11]. This finding complements the research results of de Witte and others [11], indicating that the decompression effect of music may depend not only on the music itself, but also on the purpose of the individual's use of music, the situation, and the level of arousal induced by music [10, 11]. In other words, the reason why music can improve sleep is not that all auditory stimuli are effective, but because some music experiences for bedtime relaxation can relieve tension and promote a more stable psychological state [10, 11].

In addition, sleep intervention research has begun to directly explore whether this psychological regulation process occurs with the improvement of sleep quality. Hu et al. found that sleep ambient music can not only improve the sleep quality of college students, but also reduce anxiety and depression levels [4]. The author puts forward an important point: ambient music may reduce mental activity before falling asleep by diverting the individual's attention from the source of stress and interrupting continuous thinking about stressful events, thus helping the individual enter a more relaxed state [4]. This explanation echoes the aforementioned stress study, which shows that music may first reduce the psychological burden, and then further affect the sleep experience [4, 10, 11].

However, Yan et al. made an important supplementary explanation [9]. The study found that the sleep quality and psychological state of the music group improved, but the control group that received deep breathing and relaxation training also showed a certain degree of improvement [9]. Therefore, the improvement of sleep quality cannot be attributed only to music itself, because deep breathing and relaxation training may also affect sleep by reducing the level of wakefulness [9]. This shows that music itself may not directly improve sleep, but may help people relax before falling asleep [9].

In general, many studies have supported the possible mechanism of music affecting sleep from different angles. Henrich et al. proved that psychological state is an important factor affecting the sleep of college students [5]; and the research results of de Witte et al. and Linnemann et al. further show that music has the effect of reducing stress and promoting relaxation, but this effect will be affected by the use situation [10, 11]. Hu and Yan et al. linked this mechanism with actual sleep improvement [4, 9]. Overall, these evidences show that music may create more favorable conditions for sleep by reducing stress, relieving anxiety, and reducing excessive levels of psychological and physiological arousal before bedtime [4, 10, 11]. However, most of the current studies only prove the association between music, stress changes, and sleep improvement, but have not fully clarified the causal path. Therefore, music may improve sleep in multiple ways, such as psychological adjustment, physical relaxation, and changes in sleep experience, not just through a single mechanism.

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4. The moderating role of personality and individual differences on the effectiveness of music in improving sleep

4.1. Neuroticism, sleep quality, and music responses

Neuroticism reflects an individual's sensitivity to threats and negative emotions and may therefore moderate the sleep-related benefits of music interventions by influencing stress responses and emotional recovery processes [6]. This dimension mainly reflects an individual's emotional stability, stress sensitivity, and tendency to generate sustained negative emotions [6, 7]. Individuals with high neuroticism are usually more prone to experiencing anxiety and producing persistent negative emotions, so their sleep may be more easily affected [6, 7]. Wang et al., in a meta-analysis of 60 studies involving 73,540 participants, found that among the Big Five personality dimensions, neuroticism showed the strongest association with poor sleep quality [6]. Higher neuroticism was also associated with shorter sleep duration, and these associations were relatively consistent across regions, sample sizes, and sleep measurement methods [6]. This shows that neuroticism is not the only determinant of sleep problems, but it has a stable relationship with the individual's tendency to experience sleep problems.

However, this relationship is not completely fixed. After tracking 302 college freshmen, Catherman et al. found that students with higher levels of neuroticism were more likely to report poor sleep quality [7]. At the same time, the study found that depressive symptoms may explain part of the association between neuroticism and poor sleep quality, and may also change the intensity of this association. In other words, high neuroticism is not the only factor affecting sleep. Therefore, high neuroticism may make a person more prone to sleep problems, but the actual sleep state will also be affected by factors such as emotional state at that time [7].

Zamani et al. further examined this relationship in greater detail. Research has found that neuroticism is not only directly associated with poor reported sleep quality, but also with sleep-related metacognitions, looming cognitive style, and cognitive reappraisal [12]. For example, individuals with high neuroticism are more likely to exhibit a looming cognitive style, which tends to perceive potential threats as continuously escalating and difficult to control [12]. This kind of premature anxiety is more difficult to bring emotional relief to oneself by reinterpreting negative events from other perspectives [12]. These characteristics may make it harder for people to truly relax before going to bed [12].

More direct evidence comes from Lo et al. The study divided 79 college students into high- and low-neuroticism groups and asked all participants to listen to soothing music for approximately 8 minutes after the stress task [13]. Both groups showed significant decreases in negative affect and heart rate decreased significantly after listening to music, but the decrease in negative affect was reported significantly more by the high-neuroticism group, and there was no significant difference in the decline in heart rate between the two groups [13]. This indicates that there may be a certain degree of inconsistency between their self-reported emotional changes and physiological reactions [13]. Zamani et al. further pointed out that cognitive and emotional regulation processes such as sleep-related metacognition, looming cognitive style, and cognitive re-evaluation may help explain why people with high neuroticism levels are more prone to sleep problems [12]. Lo et al. found that there were differences in negative emotional changes after listening to music in people with different levels of neuroticism, and there was no significant difference in heart rate between groups [13]. Therefore, existing studies support the association between neuroticism and short-term musical response, and show that people with higher neuroticism levels may still receive emotional or

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physiological benefits [13]. However, there is still a lack of direct comparative evidence to determine whether neuroticism will steadily change the effect of music on improving sleep.

In general, existing studies have clarified the relationship between neuroticism and sleep and music response from different angles. Catherman et al. showed that there is a relatively stable relationship between high neuroticism and poor sleep quality [6, 7]. However, this relationship is not immutable, because emotional state and other factors may also play a role [7]. Zamani et al. linked neuroticism-related sleep problems to cognitive and emotional regulation processes [12]. Lo et al. found that neuroticism influenced emotional responses to music but not heart rate changes, suggesting potential benefits across neuroticism levels [13]. However, there is still a lack of direct comparative evidence as to whether neuroticism will consistently change the effect of music on improving sleep.

4.2. The impact of psychological state on the effectiveness of music in improving sleep

Although neuroticism is a relatively stable personality trait, its relationship with sleep is not completely fixed [6]. Wang et al. found that the severity of depressive symptoms affects the intensity of the relationship between neuroticism and sleep quality [6]. This shows that an individual's sleep status cannot be determined only by his or her neurotic level; his or her current psychological state must also be taken into account.

This difference is also obvious in actual sleep interventions. The meta-analysis found that in a study involving students with insomnia symptoms, the improvement of sleep and depressive symptoms was more significant, while anxiety symptoms did not show the same difference [2]. Although these studies are not music intervention studies, the results show that the pre-intervention state of the participants may be related to the benefits obtained in the end [2]. The authors also point out that there is still a lack of direct comparisons of intervention effects among students with different mental health statuses [2].

This state difference may also appear in the music response. Linnemann et al. found that listening to music was associated with lower subjective stress in ordinary study weeks, while the same relationship was not observed in more stressful examination weeks [11]. However, because the interaction effect did not reach statistical significance, the observed difference between ordinary study weeks and examination weeks should be interpreted only as a preliminary trend [11]. Therefore, this result suggests only that the relationship between music and changes in stress may vary across situations and does not demonstrate that high stress necessarily weakens the effects of music [11].

Hu et al. further suggest that psychological state may first change individuals' perception of sleep onset time, sleep efficiency, and total sleep duration, while objective sleep changes may not occur simultaneously [4]. The study found that PSQI and subjective SOL, sleep efficiency (SE), and total sleep time (TST) were significantly correlated with anxiety and depression, whereas objective SOL and SE did not show the same relationship. This shows that anxiety and depression may affect subjective sleep evaluation, and continuous negative sleep experiences may in turn aggravate anxiety and depression [4]. Combined with the previous research on neuroticism, highly neurotic people are more likely to have strong negative emotions and stress reactions [6], so these changing psychological states may further cause individual differences in music intervention experience.

Overall, neuroticism may constitute relatively stable individual differences, while current psychological states such as depression and stress may further affect actual intervention responses. Existing research has shown that psychological state can affect the relationship between neuroticism and sleep [6], the benefits of general sleep interventions [2], and individual music response [11].

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However, comparative studies simultaneously examining neuroticism, psychological state, and music-based sleep interventions are currently lacking. Therefore, instead of assuming that all highly neurotic individuals will have the same response to music, it is more reasonable to consider both their personality traits and their psychological state at the time.

5. Discussion and suggestion

Existing evidence consistently supports the role of music in improving subjective sleep quality and sleep experience, but its effect on objective sleep indicators remains less consistent [4, 8]. Previous studies show that music improves subjective sleep quality and sleep onset more consistently, while changes in objective sleep indicators are not equally significant [4, 8]. At present, no clear optimal choice has been found among different music types [8, 9]. In Yan et al.'s study, both classical and jazz music can improve sleep, but there is no clear advantage or disadvantage between them [9]. Therefore, a more reasonable conclusion is that music may be a helpful sleep intervention [8, 9], but its effects may also be influenced by music type and preference, subjective and objective measurement methods, neuroticism level, and current depression and stress states [6, 11].

There are also some shortcomings in existing research. Although Hu et al. used both PSQI and Actigraphy, they employed a self-control design and did not have an independent randomized control group [4]. Although Yan et al.'s study adopted a randomized controlled design, it was still limited by its small sample size, reliance on self-report measures, and relatively concentrated participant sources [9]. Objective sleep data were not included, and the sources of participants were relatively concentrated [9]. Saruhanjan et al. further pointed out that the current number of studies on sleep intervention for college students is still limited, and some studies have a high risk of bias, with insufficient long-term follow-up data [3]. The lack of randomized controlled trials limits causal explanations, limited validity of single self-assessment indicators [9], limited generalizability of results in centralized samples [9], and insufficient follow-up to limit long-term effect judgments [3].

Based on these findings, music may be more appropriately used as an adjunctive sleep aid tailored to individual circumstances rather than as a uniform intervention [6, 8, 9]. In practical application, students' original sleep problems, psychological state, and music preference can be considered [6, 8]. Future research can further expand the sample, increase the number of participants from different schools and backgrounds [6, 9], and combine subjective and objective measurement methods such as PSQI, actigraphy, or PSG [6, 8, 9]. Future studies could stratify participants according to neuroticism level and baseline psychological state and test interactions among personality, psychological state, and music interventions [6]. Wang et al. also pointed out that more long-term research and objective sleep measures are needed in the future to further understand the relationship between personality and sleep [6]. In the end, the focus of future research should gradually shift from "whether music is effective" to "what kind of music is more suitable for what kind of people", to develop more personalized music sleep interventions [6, 8].

6. Conclusion

This article discusses the influence of music on the sleep quality of college students, and further analyzes the possible role of individual differences such as emotional state and neuroticism. Existing studies show that as a simple, low-cost, and easy-to-implement non-drug intervention, music has potential value in improving the sleep experience and subjective sleep quality of college students. However, the size and stability of these effects may vary by research and individual. Its positive effects are mainly reflected in helping individuals relax, relieve stress, and improve subjective sleep

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experience. However, the results of different studies are not exactly the same, and the degree of improvement of different individuals may be different. Therefore, in practical applications, music is more suitable as a sleep aid, which can be adjusted according to personal needs, such as personal music preferences, listening time, and bedtime, rather than adopting a completely unified fixed plan. For scientific research, future research needs to adopt a more rigorous research design, combine subjective and objective sleep measurements, and pay more attention to factors such as personality, psychological state, and music preference, so as to explore more personalized music intervention methods. The importance of this article lies in linking the problem of music-enhanced sleep with the individual differences of college students. It not only summarizes the existing research on the value of music intervention, but also clarifies the view that different individuals may need different sleep intervention methods. This perspective can provide a reference for the daily sleep management of college students and provide a new direction for the research of personalized music intervention in the future.

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