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Effects of aromatherapy and music therapy interventions on blood pressure, pulse, and levels of stress and fatigue in nursing staff: meta-analysis of randomized controlled trials

Zhan Ye

Nursing College, Hebei Medical University, Shijiazhuang, China

3303065125@qq.com

Abstract. Background & Objective: Current research on aromatherapy and music therapy mainly focuses on patients, lacking demographic diversity. This study evaluates the physiological and psychological effects of these therapies on nursing staff. Methods: PubMed, Web of Science, and CNKI were searched for eligible RCTs published before September 2025. Outcomes included stress, fatigue, blood pressure, and heart rate. Results: Eight RCTs involving 1,382 nursing staff were included. Aromatherapy and/or music therapy did not significantly reduce stress and fatigue levels (MD: 0.51; 95% CI: 0.47–0.56; p = 0.6855). However, they effectively reduced systolic blood pressure (MD: -3.04 mmHg; 95% CI: -4.87 to -1.22; p = 0.0494), diastolic blood pressure (MD: -2.67 mmHg; 95% CI: -3.91 to -1.43; p = 0.0147), and pulse rate (MD: -2.34; 95% CI: -4.02 to -0.67; p = 0.0021). Conclusion: Compared to control conditions, aromatherapy and/or music therapy can effectively alleviate autonomic nervous system tension in nursing staff, but their subjective stress and fatigue did not show significant improvement.

Keywords: aromatherapy, music therapy, nursing staff, blood pressure, pulse

1. Introduction

Aromatherapy, also known as essential oil therapy, is a natural therapy that uses plant essential oils to regulate physical and mental health through sensory pathways such as olfaction and touch. Its main raw materials are essential oils, and its core principle involves the penetration of essential oil molecules into the human body, acting on various physiological systems including the nervous systen and blood circulation, to alleviate emotional stress and promote bodily balance. Music Therapy is an emerging interdisciplinary field. It is based on the theories and methods of psychological treatment, using the unique physiological and psychological effects of music. With the participation of a music therapist, the client goes through specially designed musical activities and experiences to eliminate psychological obstacles and restore or improve physical and mental health.

In previous meta-analyses, aromatherapy and music therapy have been shown to be effective and are widely used as non-pharmacological treatments in clinical settings. A 2007 randomized controlled trial on the effects of music and aromatherapy on anxiety and stress levels in emergency nurses found that

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music-aromatherapy helped reduce their depression, anxiety, and stress [1]; music-aromatherapy massage significantly alleviated anxiety in emergency nurses. In another randomized controlled trial, researchers found that during the COVID-19 pandemic, geranium aromatherapy reduced fatigue levels and improved sleep quality in intensive care unit nurses [2]: the mean fatigue scores in the aromatherapy group were lower than those in the control group immediately after the intervention and 60 minutes later ($p < 0.05$). Meanwhile, some studies have shown that rose and lavender scents can reduce nurses' over-reliance on medication to cope with work-related stress [3]: there was no statistically significant difference in work stress between the two groups at baseline or at the end of the second week. At the end of the fourth week, a statistically significant difference emerged between the groups ($p < 0.003$). Compared with placebo, rose-scented aromatherapy had a positive effect on nurses' work stress at the end of the fourth week ($p = 0.002$).

The populations in the above studies were all nurses, but their working environments and conditions varied. Taken together, the results suggest that music therapy and/or aromatherapy can generally reduce anxiety levels among nursing staff. On the other hand, these studies have limitations: most of them did not simultaneously examine the psychological and physiological changes in nurses, focusing only on one aspect, and there is a lack of meta-analyses or systematic summaries. Therefore, investigating the effects of aromatherapy and music therapy on anxiety levels, heart rate, and pulse in nursing personnel (including nursing students and practicing nurses) becomes a critical and non-negligible issue.

2. Materials and methods

Based on the theories and methods of psychotherapy, studies were included if they met the following criteria: (1) The study design was a Randomized Controlled Trial (RCT); (2) The study population consisted of nursing staff, including nursing students and practicing nurses; (3) The intervention was aromatherapy or music therapy or a combination of both; (4) The study had a complete design, process, and outcomes; (5) Outcomes included at least one of the following: (i) complete data on blood pressure and pulse, including Systolic Blood Pressure, Diastolic Blood Pressure, and Pulse Rate; (ii) assessment scales measuring anxiety, such as the Beck Anxiety Inventory, State Anxiety, Test Anxiety, etc.

Exclusion criteria: (1) Incomplete or unavailable data, such as missing outcomes; (2) Articles not in English; (3) Non-randomized controlled trials, such as case studies or studies without a control group; (4) Studies that did not involve aromatherapy and music therapy. (As shown in Figure 1, the PRISMA statement outlines the selection of studies.)

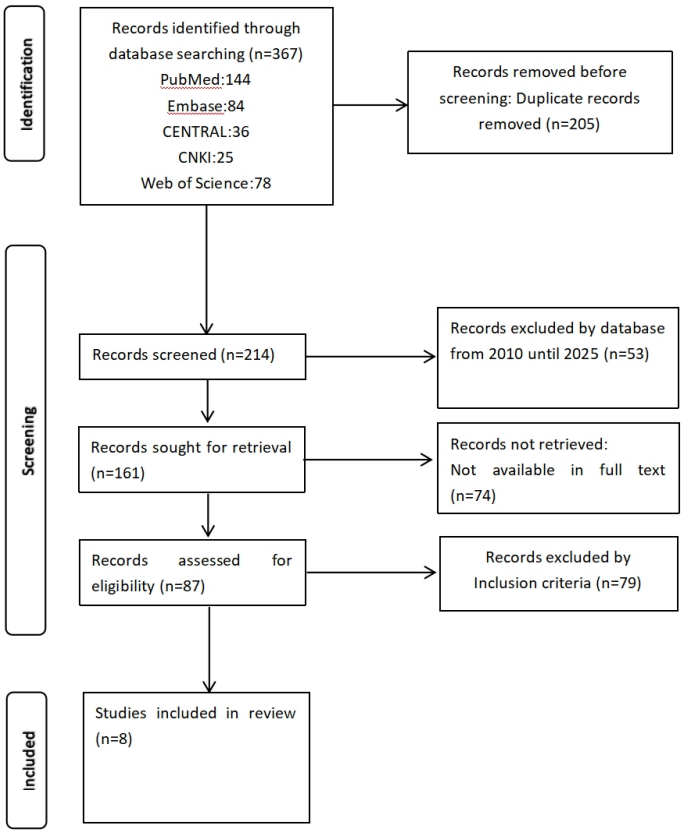

Figure 1. PRISMA statement (selection of studies)

3. Data extraction and outcome assessment

We independently extracted data from qualified studies using a data extraction form which has been designed before. The form include: author, publication year, RCT name, data source (from litreature or clinical trial registry), study design, follow-up duration, participants (sample size, diagnosis, background therapy), intervention group (age, gender, sample size), control group (age, gender, sample size), outcomes (primary outcomes, secondary outcomes). The primary outcome of our study was stress and fatigue levels, and the secondary outcomes were blood pressure (Systolic and Diastolic) and Pulse Rate.

The primary outcome was whether aromatherapy and music therapy could reduce stress and fatigue levels in nursing staff; the secondary outcomes were whether aromatherapy and music therapy could reduce Systolic and Diastolic Blood Pressure respectively in nursing staff, and whether the effect on Pulse Rate, while not significant, still showed some reduction.

3.1. Primary outcome

Stress and fatigue scores were the primary outcomes in this study. Among the 8 RCTs, five reported stress and fatigue scores. Due to the variety of scales used to assess these outcomes (including Beck Anxiety Inventory, Test Anxiety, State Anxiety, etc.), standardization (SMD conversion) was necessary. The five RCTs included a total of 373 nursing staff. Heterogeneity was low, and subgroup analysis was not required. This meta-analysis showed that aromatherapy and/or music therapy had no statistically remarkable effect on reducing stress and fatigue levels in nursing staff.

3.2. Secondary outcomes

Blood Pressure and Pulse Rate were the secondary outcomes in this study. Among the 8 RCTs, five were included, all of which contained data on Systolic Blood Pressure, Diastolic Blood Pressure, and Pulse Rate. These five RCTs involved a total of 1,009 nursing staff, with 511 in the intervention groups and 498 in the control groups. As Blood Pressure and Pulse are continuous variables, SMD conversion was not required. This meta-analysis showed that aromatherapy and/or music therapy effectively reduced Systolic Blood Pressure, Diastolic Blood Pressure, and Pulse Rate in nursing staff. Heterogeneity was assessed using the criteria by Higgins et al. (I^2 = 0-40%: might not be important; 30-60%: moderate heterogeneity; 50-90%: substantial heterogeneity; 75-100%: considerable heterogeneity).

4. Results

4.1. Outcomes

This study included a total of 8 Randomized Controlled Trials (RCTs), involving 1,382 nursing staff, covering two different types of outcomes: psychological indicators (stress and fatigue levels) and physiological indicators (Blood Pressure and Pulse Rate). The results for nursing staff after aromatherapy and/or music therapy intervention were as follows: stress and fatigue levels (MD: 0.51; 95% CI: 0.47 to 0.56; p = 0.6855), Systolic Blood Pressure (MD: -3.04 mmHg; 95% CI: -4.87 to -1.22; p = 0.0494), Diastolic Blood Pressure (MD: -2.67 mmHg; 95% CI: -3.91 to -1.43; p = 0.0147), Pulse Rate (MD: -2.34; 95% CI: -4.02 to -0.67; p = 0.0021). The data for Systolic Blood Pressure, Diastolic Blood Pressure, and Pulse Rate showed substantial heterogeneity: Systolic Blood Pressure (I^2 = 49.4%), Diastolic Blood Pressure (I^2 = 59.3%), Pulse Rate (I^2 = 66.9%). Accordingly, an analysis of heterogeneity was conducted. (Figure 2 presents the outcomes of stress and fatigue levels. The outcomes of systolic blood pressure are shown in Figure 3. Figure 4 displays the outcomes of diastolic blood pressure. As summarized in Figure 5, the outcomes of pulse rate are reported.)

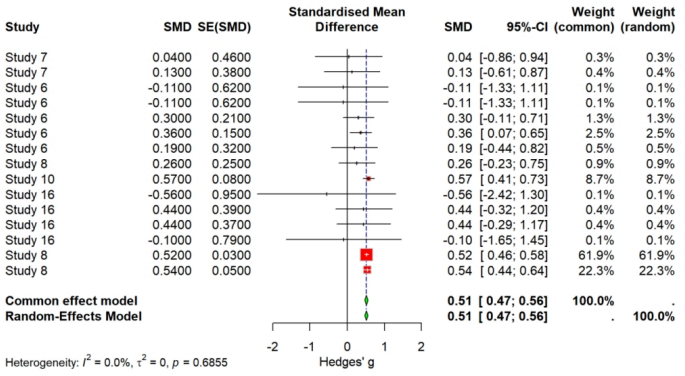

Figure 2. Outcomes of stress and fatigue levels

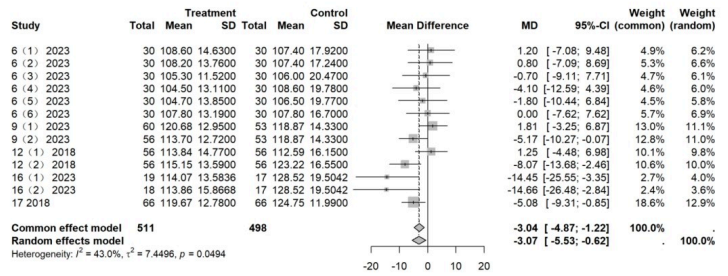

Figure 3. Outcomes of systolic blood pressure

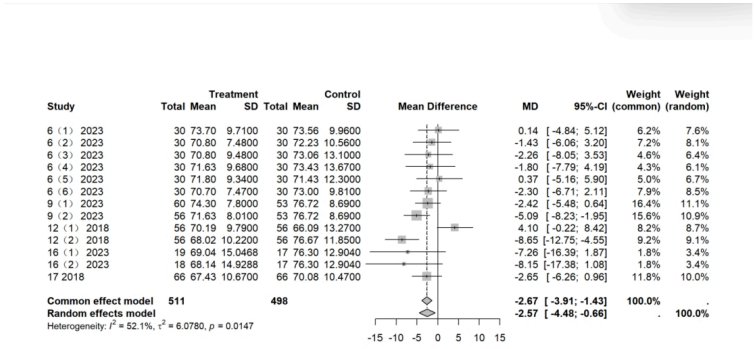

Figure 4. Outcomes of diastolic blood pressure

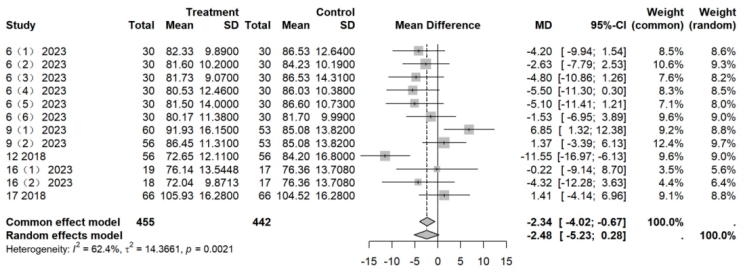

Figure 5. Outcomes of pulse rate

4.2. Heterogeneity analysis

To discover the origin of heterogeneity, subgroup analyses were performed. Factors considered as subgrouping included continent, ethnicity, education level, etc. Due to limitations in standardizing education levels across different countries, factors of continent and ethnicity were analyzed first, with the possibility of analyzing other factors if necessary.

4.2.1. Ethnicity

Regarding ethnicity, since the nursing staff came from Taiwan China, Italy, Spain, Iran, and Turkey, they were divided into two ethnic types: Caucasian (European), including Italy, Spain, Iran, and Turkey; and Mongoloid (Asian), from Taiwan China.

Systolic Blood Pressure of the Caucasian group (MD: -6.08 mmHg; 95% CI: -10.43 to -1.72; p = 0.0195; I^2 = 62.8%); Systolic Blood Pressure of the Mongoloid group (MD: 0.68 mmHg; 95% CI: -2.67 to 4.02; p =

0.9583; I^2 = 0%). Pooled Systolic Blood Pressure (MD: -2.95 mmHg; 95% CI: -5.73 to -0.18; p = 0.0264; I^2 = 49.4%). (Figure 6 provides the heterogeneous results for systolic blood pressure.)

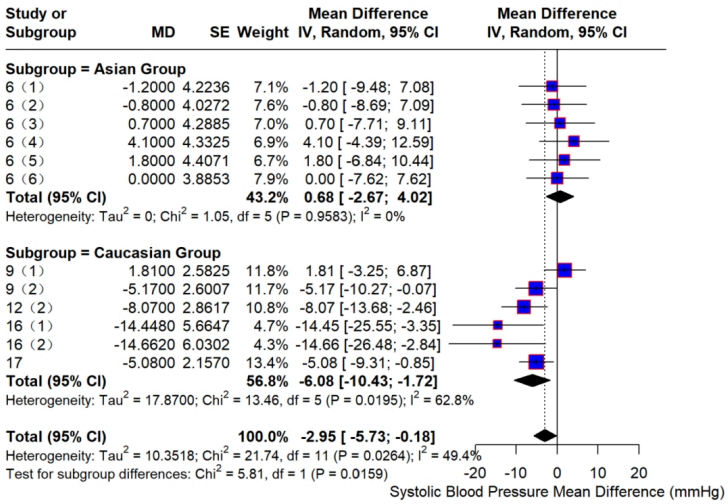

Figure 6. Heterogeneous results of systolic blood pressure

Diastolic Blood Pressure of the Caucasian group (MD: -4.87 mmHg; 95% CI: -7.12 to -2.52; p = 0.1671; I^2 = 36%); Diastolic Blood Pressure of the Mongoloid group (MD: 1.24 mmHg; 95% CI: -0.85 to 3.33; p = 0.9624; I^2 = 0%). Pooled Diastolic Blood Pressure (MD: -2.03 mmHg; 95% CI: -4.20 to 0.15; p = 0.0046; I^2 = 59.3%). (The heterogeneous results of diastolic blood pressure can be seen in Figure 7.)

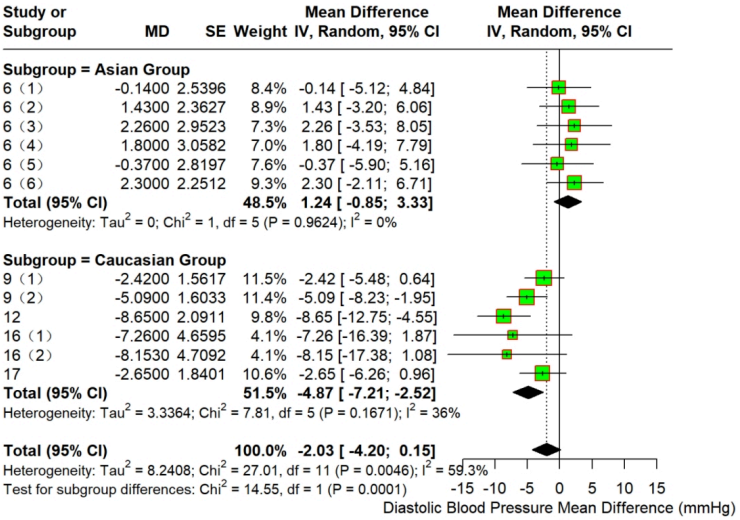

Figure 7. Heterogeneous results of diastolic blood pressure

Pulse rate of the Caucasian group (MD: -1.01; 95% CI: -6.31 to 4.30; p = 0.0002; I^2 = 79.7%); Pulse Rate of the Mongoloid group (MD: 3.81; 95% CI: 1.47 to 6.14; p = 0.9145; I^2 = 0%). Pooled Pulse Rate (MD: 1.55; 95% CI: -1.40 to 4.49; p = 0.0005; I^2 = 66.9%). (Figure 8 illustrates the heterogeneous results of pulse rate.)

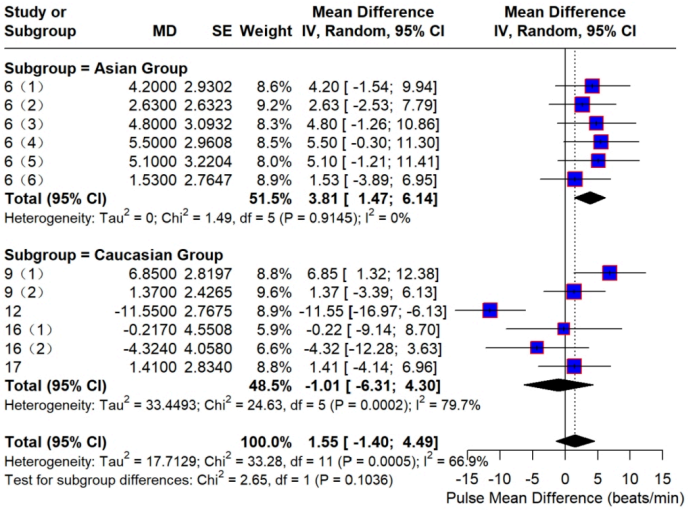

Figure 8. Heterogeneous results of pulse rate

4.2.2. Continent

Regarding continent, since the nursing staff came from Taiwan China, Italy, Spain, Iran, and Turkey, they were divided into two continents: Asia, including Taiwan China, Iran, and Turkey; and Europe, including Italy and Spain.

Systolic Blood Pressure in the Asian group (MD: -1.22 mmHg; 95% CI: -3.78 to 1.34; p = 0.3371; I^2 = 11.7%); Systolic Blood Pressure in the European group (MD: -10.37 mmHg; 95% CI: -15.30 to -5.43; p = 0.4352; I^2 = 0%). Pooled Systolic Blood Pressure (MD: -2.95 mmHg; 95% CI: -5.73 to -0.18; p = 0.0264; I^2 = 49.4%). (Heterogeneous results of systolic blood pressure are outlined in Figure 9.)

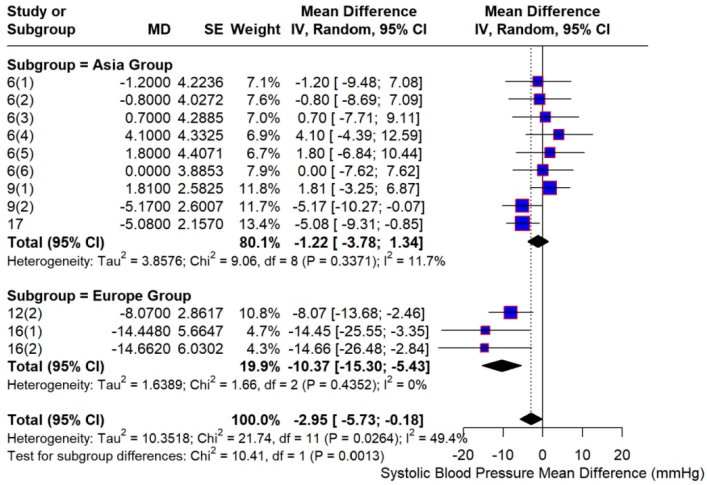

Figure 9. Heterogeneous results of systolic blood pressure

Diastolic Blood Pressure in the Asian group (MD: -0.88 mmHg; 95% CI: -2.79 to 1.04; p = 0.1011; I^2 = 40%); Diastolic Blood Pressure in the European group (MD: -8.38 mmHg; 95% CI: -11.85 to -4.91; p = 0.9623; I^2 = 0%). Pooled Diastolic Blood Pressure (MD: -2.03 mmHg; 95% CI: -4.20 to 0.15; p = 0.0046; I^2 = 59.3%). (Figure 10 gives the heterogeneous results of diastolic blood pressure.)

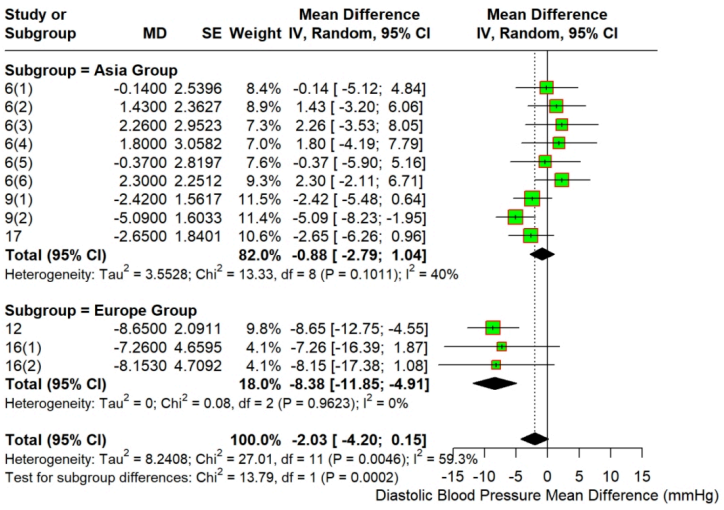

Figure 10. Heterogeneous results of diastolic blood pressure

Pulse Rate in the Asian group (MD: 1.41; 95% CI: -0.63 to 3.45; $p = 0.8311$; $I^2 = 0\%$); Pulse Rate in the European group (MD: -7.12; 95% CI: -14.26 to 0.02; $p = 0.0701$; $I^2 = 62.4\%$). Pooled Pulse Rate (MD: 1.55; 95% CI: -1.40 to 4.49; $p = 0.0005$; $I^2 = 66.9\%$). (As shown in Figure 11, the heterogeneous results of pulse rate are presented.)

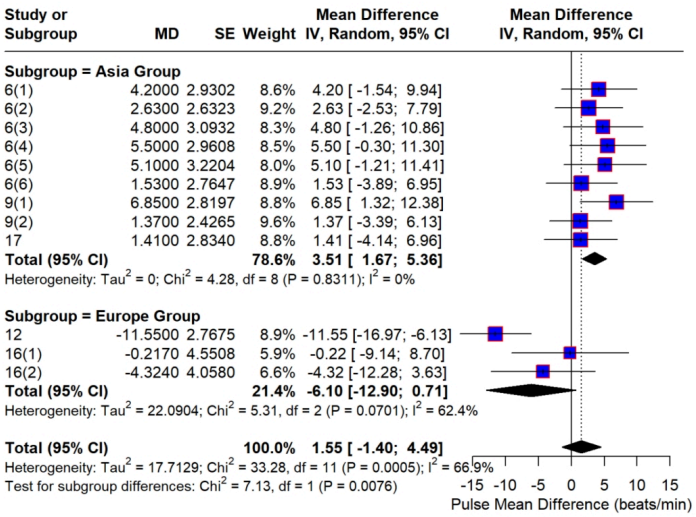

Figure 11. Heterogeneous results of pulse rate

5. Discussion

Research on the effects of aromatherapy and/or music therapy on healthcare workers has often lacked detail and comprehensive synthesis. Therefore, given the frequent psychological and physiological high-load states of nursing staff (e.g., tachycardia, hypertension, anxiety), we conducted this meta-analysis focusing on nursing staff. It incorporated nursing staff from different countries and regions as the study population and included only Randomized Controlled Trials (RCTs) as data sources for the meta-analysis. In this study, we found that nursing staff showed varying degrees of improvement in psychological and physiological indicators (including

Systolic Blood Pressure, Diastolic Blood Pressure, and Pulse Rate) after receiving aromatherapy and/or music therapy.

During the meta-analysis, substantial heterogeneity was observed in the extracted blood pressure and pulse data from different groups. The sources of heterogeneity could be numerous. As the data came from different countries, involving different ethnicities and continents of origin, significant heterogeneity was possible. Therefore, we performed subgroup analyses based on ethnicity and continent. The results indicated that continent inconsistency was the primary source of heterogeneity.

5.1. Discussion on ethnicity subgroups

The within-group heterogeneity for Systolic Blood Pressure, Diastolic Blood Pressure, and Pulse Rate in the Caucasian group were (I^2 = 62.8%, I^2 = 36%, I^2 = 79.7%) respectively. The within-group heterogeneity for these measures in the Mongoloid group were (I^2 = 0, I^2 = 0, I^2 = 0) respectively. The between-group heterogeneity (Caucasian vs. Mongoloid) for these measures were (I^2 = 49.4%, I^2 = 59.3%, I^2 = 66.9%) respectively. From these three sets of data, although the between-group heterogeneity for Diastolic Blood Pressure was higher, the data for the other two measures clearly show that the within-group heterogeneity among Caucasians was much larger than the between-group heterogeneity. This suggests that the heterogeneity primarily originates from within the Caucasian group, rather than between ethnicities. Accordingly, using ethnicity as a basis for data grouping was deemed inappropriate. Therefore, the continent of origin was considered next as the basis for subgrouping.

5.2. Discussion on continent subgroups

The within-group heterogeneity for Systolic Blood Pressure, Diastolic Blood Pressure, and Pulse Rate in the Asian group were (I^2 = 11.7%, I^2 = 40%, I^2 = 0) respectively. The within-group heterogeneity for these measures in the European group were (I^2 = 0, I^2 = 0, I^2 = 62.4%) respectively. The between-group heterogeneity (Asia vs. Europe) for these measures were (I^2 = 49.4%, I^2 = 59.3%, I^2 = 66.9%) respectively. These three sets of data show that after grouping by continent, the within-group heterogeneities were generally lower. Although the heterogeneity for Diastolic Blood Pressure in the Asian group remained at 40%, it was reduced compared to the between-group Diastolic Blood Pressure heterogeneity (I^2 = 59.3%), suggesting that the main source of heterogeneity for Diastolic Blood Pressure lies in the populations from different continents.

Conclusion after including all 8 RCTs: Compared to control conditions, aromatherapy and/or music therapy can effectively reduce Blood Pressure and Pulse Rate in nursing staff, but showed no significant effect on improving stress and fatigue levels. This suggests that introducing aromas and playing soothing music in healthcare public spaces could reduce the circulatory system load on nursing staff, which is beneficial for their physical health.

This study observed that while aromatherapy and music therapy significantly improved some physiological indicators (e.g., blood pressure) in nursing staff, their self-reported stress and fatigue did not decrease correspondingly. This paradoxical phenomenon reveals a dissociation between physiological responses and subjective feelings. That is, objective improvements in autonomic nervous system activity (such as decreased blood pressure, increased heart rate variability) may not directly translate into conscious experiences of relaxation.

This finding is consistent with previous studies. For example, Grewe et al. [4] also reported inconsistencies between changes in physiological indicators and subjective reports after music intervention. The underlying mechanism may lie in the fact that the relationship between emotional experience and physiological response is not a simple linear correspondence. Observations of nurses during the COVID-19 pandemic [5] also

indicated discrepancies between physiological and psychological responses. This linear correspondence might be related to the anxiety regulation system proposed [6]. On the other hand, results from exposure therapy also confirm that changes in subjective emotion and physiological response are not synchronous [7]. Despite physiological changes, subjective experience showed no significant difference [8]. For recent research [9], challenges the traditional mind-body monism, suggesting that similar subjective feelings may be driven by diverse patterns of physiological responses, and vice versa. For instance, Sumińska et al. [10] suggest that similar emotional experiences can evoke different physiological reactions [11]. indicates that mindfulness-based therapy did not reduce anxiety levels in patients, while Ding et al.'s [12] systematic review suggests that personal music preference influences the fatigue-alleviating effect of music. The conclusion of Merrill et al. [13] further indicate that disliked music can cause significant physiological and psychological reactions. Therefore, the phenomenon of "physiological improvement without change in subjective feeling" observed in this study likely stems from this complex, non-one-to-one correspondence between mind and body. Factors such as individual interpretation of "relaxation", expectations regarding the interventions, and emotional numbness caused by long-term occupational burnout may all play roles.

On the other hand, the results of this study suggest that the effects of aromatherapy and music therapy may be moderated by cultural background. The relatively weaker psychological benefits observed in the Asian population might be related to cultural differences in the perception and interpretation of sensory stimuli. Specifically, culture shapes our aesthetic preferences for sensory experiences, the meaning we assign to them, and our modes of expression. Research [14] shows differences in odor perception among people from different cultural backgrounds, while Sorokowski et al. [15] indicate that even within the same culture, individual cognition of odors varies. Cross-cultural study [16] demonstrated that the same piece of music can elicit different physiological and psychological reactions in individuals from different cultural backgrounds [17]. suggests that musical preferences affect patients' mental health levels [18]. points out that the importance placed on olfactory information and its cultural connotations differ significantly across societies, which may affect the efficacy of scents in aromatherapy to trigger positive emotional connections. As stated by Liao et al. [19], music from different cultural backgrounds affects the psychological and physiological responses of pain patients differently. Furthermore, as discussed by Liu et al. [20], cultural background profoundly influences individual preferences for music genres, and music that aligns with cultural aesthetics is more likely to resonate and induce relaxation, a view confirmed by research in Australia [21]. Odors might influence patient compliance with treatment [22], and racial differences in musical interest can also affect therapeutic outcomes [23]. Therefore, if the scents or music types used in the interventions are not well-suited to the cultural background of the study participants, it may weaken their psychological acceptance and experiential depth, leading to less pronounced improvement in subjective stress and fatigue compared to physiological indicators. This reminds us that cultural compatibility must be fully considered when developing non-pharmacological intervention programs in the future.

Recent research shows that odors can improve anxiety levels, but physiological results characterized by EEG and ECG may dissociate from subjective experience [24]. This conclusion strongly supports the previous phenomenon of dissociation between physiological changes and subjective experience and also indicates that many issues regarding this phenomenon remain to be discovered and resolved.

Previous research mostly focused on physiological changes and psychological feelings in patients. This meta-analysis compensates for the lack of research on the effects of aromatherapy and music therapy on physiological responses and psychological feelings in nursing staff. It also holds significant clinical implications, potentially aiding in the maintenance and improvement of autonomic nervous system health for nursing staff and reminding healthcare workers to pay attention to their own often high-stress physiological

and psychological states, necessitating attention and the adoption of more methods to alleviate this tension. It also enlightens clinical workers to apply some auxiliary therapies previously used for patients to themselves when conditions permit.

Prior to this, the effects of music therapy and aromatherapy on nursing staff have been studied by other scholars, but this study differs significantly from theirs. For example, another systematic review indicated that music therapy and aromatherapy can mitigate the effects of shift work on nurses, particularly gastrointestinal symptoms [25]. However, that systematic review only investigated organic pathologies (e.g., gastrointestinal diseases) in nursing staff and failed to address their subjective experiences. Meanwhile, this article focuses on the broader group of nursing staff, including practicing nursing students, covering a larger population than the nurse groups in previous papers, thus offering greater comprehensiveness and uniqueness.

This article synthesizes 8 RCTs on changes in psychological and physiological indicators in nursing staff after receiving aromatherapy and/or music therapy. The evidence quality from Randomized Controlled Trials (RCTs) is higher than other study types, making the data more representative. After receiving aromatherapy and/or music therapy, nursing staff showed reductions in blood pressure and pulse rate to varying degrees, but no significant changes were observed in psychological levels of fatigue and stress. This indicates that these two therapies have a positive effect on relaxing the sympathetic nervous system of nursing staff, but the self-experienced effect of psychological relaxation is not obvious. In future medical settings such as hospitals, CDC centres, and community health centres, playing soothing music and placing aromatherapy diffusers could better promote relaxation among healthcare staff.

6. Conclusion

This study conducted a meta-analysis of Randomized Controlled Trials (RCTs) investigating changes in psychological and physiological indicators in nursing staff after implementing aromatherapy and/or music therapy. A total of 8 RCTs were included. The results showed that physiological indicators such as systolic blood pressure, diastolic blood pressure, and pulse rate decreased to varying degrees after the intervention. However, no significant improvement was found in subjective psychological feelings regarding fatigue and stress. This result suggests that after receiving non-pharmacological adjuvant interventions, there may be a certain degree of dissociation between the physiological responses and subjective psychological feelings of nursing staff. Therefore, while focusing on the improvement of physiological indicators, greater attention should be paid to the subjective psychological state of nursing staff, and the exploration of other intervention strategies should be combined to more effectively alleviate their anxiety and tension. Furthermore, this study found that aromatherapy and music therapy demonstrate various positive effects among healthcare worker populations, indicating the application potential of such adjuvant therapies in this group, worthy of promotion and verification in broader contexts.

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