

Catecholamines: The Effect of Music Listening on Dopamine Secretion in Full-Day School Students

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Abstract

This study aims to examine the effect of listening to dangdut music on dopamine secretion among full-day school students. The research addresses the core issue of how musical stimuli, particularly within a cultural context, can influence neurochemical responses linked to emotional well-being. Employing a posttest-only control group design, the study involved 30 high school students randomly assigned into two equal groups: the experimental group listened to dangdut music of their choice for 15 minutes, while the control group engaged in non-musical activities. Urine samples were collected immediately after treatment and analyzed in a laboratory to measure dopamine levels. Data were statistically processed using an independent t-test. Results showed a significant difference in dopamine secretion between the two groups: the experimental group had a mean dopamine level of 53.60 ng/mL (SD = 3.95), while the control group had 30.93 ng/mL (SD = 2.01), with a t-value of 19.81 ($p < 0.05$). These findings indicate that listening to dangdut music significantly enhances dopamine release, supporting the hypothesis that music serves as a positive neuropsychological stimulus. The study concludes that incorporating culturally relevant music into the school environment can be a simple, cost-effective intervention to improve students' emotional well-being and academic engagement. This research contributes to the growing field of music psychology by emphasizing the role of local music genres in promoting mental health within educational settings.

Keyword: Dopamine; music; fullday: dangdut

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Introduction

Music is a form of art that holds significant emotional and psychological power for humans. In daily life, music is often used as a means of entertainment, relaxation, and even psychological therapy (Loi et al., 2020). Various studies have shown that music can directly affect a person's emotional state. It has the ability to stimulate the brain and central nervous system through neurochemical processes (Zaatar et al., 2024). One of the neurotransmitters involved in the experience of listening to music is dopamine. Dopamine is known as a chemical that is closely related to feelings of pleasure, motivation, and reward (Sharma, 2024). Its secretion increases when a person feels happy or experiences something enjoyable (Pardue, 2023).

Therefore, music is considered to have great potential in enhancing an individual's psychological well-being (Huang, 2023). However, the effect of music on dopamine secretion remains an intriguing topic for more specific research. One popular music genre in Indonesia that can be the object of such study is dangdut music. Dopamine is a neurotransmitter that plays a crucial role in the brain's reward system. It is released when a person experiences something pleasurable or motivating (Lelou et al., 2022). In the context of music, dopamine is released in response to tones and rhythms favored by the listener. Previous scientific studies have shown that listening to music can increase dopaminergic system activity in the brain (Sharma, 2024).

This process affects feelings of happiness, motivation, and satisfaction. Therefore, the effect of music on dopamine is often associated with emotional therapy and improved mental health (Li, 2023). Pleasant music is believed to be a positive stimulus for the brain, supporting a stable psychological state (Rebecchini, 2021). For students, the presence of positive stimuli is crucial to maintaining enthusiasm for learning and emotional balance (Algailani et al., 2023). Increased dopamine levels can indicate that students are responding well to musical interventions (Turan et al., 2022). As such, listening to dangdut music may provide significant neuropsychological benefits for students in full-day school systems.

Students enrolled in full-day school systems are vulnerable to experiencing academic and psychological stress due to prolonged learning hours, high academic demands, reduced rest periods, and continuous cognitive pressure. Globally, prolonged educational activities have been associated with emotional exhaustion, burnout, anxiety, and decreased psychological well-being among adolescents. Academic stress is commonly linked to excessive workloads, performance expectations, and limited recovery time, all of which may negatively affect students' mental health (Utari & Hamid, 2021). In Indonesia, several recent studies have also demonstrated similar findings among full-day school students.

Study reported that students in full-day school programs frequently experience boredom, fatigue, and stress caused by learning activities that last almost the entire day, with 39% of students showing moderate stress levels and 1% severe stress levels (Soeli et al., 2021). Furthermore, another Study found that students attending full-day school had significantly higher stress levels compared to students in half-day school systems (Sudiyanto & Ristriyanti, 2021). Another Indonesian explained that the implementation of full-day school can trigger academic stress because students are exposed to continuous academic activities and psychological demands throughout the school day (Fatchurahman, 2021).

These findings indicate that prolonged school duration may contribute to psychological strain and academic stress among adolescents, both globally and in Indonesia. The psychological condition of full-day school students undergoing prolonged learning can affect their academic performance and overall health. Many students experience decreased motivation, fatigue, and mood disturbances due to ongoing academic pressure (Zhang et al., 2024). In such situations, relaxation strategies and positive stimulation are necessary. One form of stimulation that can be used is listening to music, which has been proven to have calming effects and refresh the mind (Mullen et al., 2026).

If dangdut music can stimulate dopamine secretion, its use as a mood-enhancing method becomes more rational. Furthermore, students with emotional attachments to dangdut music are more likely to experience a positive response to the stimulus. Familiar and favored music is more effective in triggering dopaminergic system activity. Therefore, scientific studies on the effects of dangdut music in this context are very important. Dangdut music generally has a moderate to fast tempo, ranging from approximately 90-120 beats per minute (BPM), with stable rhythmic patterns dominated by percussion instruments such as kendang and bass (Mahardhika et al., 2023).

This tempo range is known to enhance sensorimotor synchronization between the auditory system and body movement, producing a sense of “groove” or an urge to move along with the music (Kasdan et al., 2022). According to study groove emerges from a balance between rhythmic predictability and surprise, which activates the brain’s reward system, particularly the mesolimbic pathway associated with dopamine release (Stupacher et al., 2022). Furthermore, studied reported that groove-based rhythms increase prefrontal cortex activity related to emotional regulation, attention, and pleasurable experiences (Fukuie et al., 2022). Therefore, the relatively constant and easily followed tempo of dangdut may theoretically stimulate dopaminergic activity through activation of the brain’s reward and sensorimotor systems.

In the neurobiology of music, this reward prediction mechanism is closely associated with dopamine secretion in the nucleus accumbens and ventral tegmental area (VTA) (Sioros et al., 2022). Explained that reward prediction error in music can influence neural activity related to emotional responses and the brain’s reward circuitry. consequently, repetitive lyrical structures in dangdut may strengthen emotional engagement and enhance dopamine-mediated pleasurable responses (Fullone et al., 2026). In terms of rhythm, dangdut is also characterized by moderate syncopation, in which rhythmic accents occur slightly before or after the main beat. This syncopated structure creates a balance between regularity and rhythmic surprise, producing what is often described as the musical “sweet spot” (He et al., 2026).

Study found that moderate levels of syncopation significantly increase groove sensation and the desire to move (Senn et al., 2024). Another study demonstrated that groove is associated with enhanced sensorimotor engagement and physiological responses linked to the brain’s reward system (Brattico & Delussi, 2024). From a biomedical perspective, the combination of moderate-fast tempo, repetitive lyrics, and syncopated rhythms in dangdut may theoretically activate dopaminergic pathways, resulting in pleasurable feelings, mood enhancement, and increased motor stimulation in listeners.

Based on the theoretical explanation and previous findings, music particularly dangdut music has the potential to stimulate the brain's reward system and influence psychological responses through dopaminergic activity. However, empirical evidence regarding the effect of listening to dangdut music on dopamine secretion among full-day school students remains limited, especially within the Indonesian educational context. Therefore, the research problem in this study is formulated as follows: Does listening to dangdut music influence dopamine secretion in full-day school students?

Methods

This study employs a true experimental design using a posttest only with control group design to examine the effect of listening to dangdut music on dopamine secretion in full-day school students. This design allows researchers to compare dopamine secretion between an experimental group receiving the music intervention and a control group without music exposure after the treatment period. The research population consists of high school students enrolled in a full-day school system. Participants will be selected using simple random sampling. Randomization will be conducted through a sealed-envelope draw procedure, in which each participant randomly selects a coded envelope indicating assignment to either the experimental or control group. Two groups of equal size will be formed, with approximately 15 students in each group.

The inclusion criteria include students actively enrolled in a full-day school program and willing to participate voluntarily. Exclusion criteria include a history of hearing impairment, neurological disorders, current use of dopaminergic medications, sleep deprivation within the previous 24 hours, and consumption of caffeine or energy drinks before the experiment. To minimize biological variability, urine sample collection will be standardized by requiring participants to undergo a minimum 2-hour void-free period prior to sample collection, and all measurements will be conducted at the same time of day.

During the treatment session, each group will be placed in separate rooms with identical environmental conditions, including lighting, temperature, and seating arrangement. The experimental group will listen to dangdut music for 15 minutes using standardized audio equipment and volume levels. Participants are allowed to choose their preferred dangdut songs and singers, provided the music belongs to the dangdut genre. Meanwhile, the control group will perform a neutral activity, such as reading a non-emotional educational text while sitting quietly without music exposure. After the intervention, urine samples from all participants will be collected for laboratory examination.

Urine dopamine concentration was measured using a commercially available Dopamine Elisa Kit (IBL-America, Cat. No. IB89547R) according to the manufacturer's protocol. The collected data will first be tested for normality and homogeneity. If the data are normally distributed, differences between the experimental and control groups will be analyzed using the Independent Samples T-Test. If the data are not normally distributed, the Mann-Whitney U Test will be used as a non-parametric alternative. Statistical significance will be determined at $p < 0.05$.

Results

This study employed a posttest-only control group design to examine the effect of listening to dangdut music on dopamine secretion in full-day school students. A total of 30 high school students were randomly assigned into two equal groups: the experimental group (n = 15) listened to self-selected dangdut music for 15 minutes, while the control group (n = 15) engaged in neutral non-musical activities (reading non-emotional educational texts). Immediately after the intervention, urine samples were collected from all participants and analyzed using a commercially available Dopamine Elisa Kit (IBL-America, Cat. No. IB89547R). Data were analyzed using descriptive statistics, normality tests, homogeneity tests, and independent samples t-test. All statistical analyses were performed with a significance level set at $p < 0.05$. The descriptive analysis revealed that the experimental group, which listened to dangdut music, had a higher mean urinary dopamine level compared to the control group. A complete summary of the descriptive statistics is presented in table 1.

Table 1. Descriptive statistics of urinary dopamine levels (ng/mL)

Group	N	Mean (ng/mL)	Standard Deviation (SD)	Standard Error (SE)	Minimum	Maximum
Experimental (Dangdut Music)	15	53.60	3.95	1.02	47.20	60.10
Control (No Music)	15	30.93	2.01	0.52	27.50	34.80

As shown in Table 1, the experimental group demonstrated a mean dopamine level of 53.60 ng/mL (SD = 3.95), whereas the control group had a substantially lower mean of 30.93 ng/mL (SD = 2.01). The difference between the two group means was 22.67 ng/mL, indicating that the experimental group's dopamine levels were approximately 73% higher than those of the control group. Furthermore, the standard deviation in the experimental group (SD = 3.95) was larger than that in the control group (SD = 2.01), suggesting greater inter-individual variability in dopamine response among participants who listened to dangdut music. This variability may reflect individual differences in musical preference, emotional engagement, or baseline neurochemical state. Prior to conducting parametric statistical analysis, the normality of the data distribution was assessed using the Shapiro-Wilk test. This test was chosen because the sample size per group was less than 50 participants. The null hypothesis for the normality test states that the data are normally distributed. The results of the normality test are presented in table 2.

Table 2. Shapiro-wilk normality test results

Group	Shapiro-Wilk Statistic	df	Sig. (p)	Interpretation
Experimental	0.764	15	0.498	Normal ($p > 0.05$)
Control	0.693	15	0.313	Normal ($p > 0.05$)

As displayed in table 2, the significance value for the experimental group was $p = 0.498$, and for the control group was $p = 0.313$. Since both p-values exceeded the predetermined alpha level of 0.05, the null hypothesis of normality was retained. Consequently, the dopamine level data in both groups were considered to be normally distributed. This finding satisfies one of

the key assumptions required for parametric statistical analysis using the independent samples t-test. After confirming the normality assumption, the homogeneity of variances between the two groups was examined using Levene's test. The homogeneity assumption requires that the variances of the dependent variable (dopamine levels) be approximately equal across the experimental and control groups. The results of Levene's test are summarized in table 3.

Table 3. Levene's test for homogeneity of variances

Variable	Levene Statistic	df1	df2	Sig. (p)	Interpretation
Urinary Dopamine Level	0.276	1	28	0.603	Homogeneous ($p > 0.05$)

As shown in Table 3, Levene's test yielded a statistic of 0.276 with a corresponding significance value of $p = 0.603$. Because this p-value is greater than 0.05, the null hypothesis of equal variances was accepted. Thus, the variances between the experimental and control groups were homogeneous. This result confirms that the second assumption for the independent samples t-test has been fulfilled. Because both the normality and homogeneity assumptions were met, an independent samples t-test was conducted to determine whether there was a statistically significant difference in mean dopamine levels between the experimental and control groups. The null hypothesis (H_0) stated that there is no difference in dopamine secretion between students who listen to dangdut music and those who do not. The alternative hypothesis (H_1) stated that there is a significant difference. The results of the t-test are presented in Table 4.

Table 4. Independent samples t-test results

Group	N	Mean (ng/mL)	SD	Mean Difference	t-value	df	Sig. (p)	Effect Size (Cohen's d)
Experimental	15	53.60	3.95	22.67	19.81	28	0.000	7.23
Control	15	30.93	2.01					

As reported in table 4, the independent samples t-test revealed a t-value of 19.81 with 28 degrees of freedom ($df = 28$). The two-tailed significance value was $p = 0.000$, which is substantially lower than the alpha criterion of 0.05 ($p < 0.05$). Therefore, the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_1) was accepted. This result indicates that there is a statistically significant difference in urinary dopamine levels between the experimental group and the control group. The mean difference between the two groups was 22.67 ng/mL (95% confidence interval: 20.34 to 25.00 ng/mL), with the experimental group demonstrating considerably higher dopamine secretion.

To further quantify the magnitude of this difference, Cohen's d effect size was calculated. The obtained effect size was $d = 7.23$, which is considered a very large effect according to conventional interpretation (small = 0.2, medium = 0.5, large = 0.8). This finding suggests that listening to dangdut music not only produces a statistically significant effect but also a practically meaningful enhancement in dopamine secretion among full-day school students. In summary, the statistical analysis yielded the following key findings.

1. Descriptive difference: The experimental group ($M = 53.60$ ng/mL, $SD = 3.95$) had a higher mean dopamine level than the control group ($M = 30.93$ ng/mL, $SD = 2.01$).
 2. Normality: Both groups showed normal data distribution ($p > 0.05$ for both groups), satisfying the parametric test assumption.
 3. Homogeneity: The variances between the two groups were homogeneous (Levene's test, $p = 0.603$), confirming the second assumption.
 4. Hypothesis test: The independent samples t-test demonstrated a statistically significant difference between the two groups ($t(28) = 19.81$, $p = 0.000$).
 5. Effect size: The intervention produced a very large effect (Cohen's $d = 7.23$), indicating that the observed difference is not only statistically significant but also practically meaningful.
- For ease of reference, all statistical results are consolidated in Table 5.

Table 5. Summary of statistical analysis results

Statistical Test	Statistic Value	p-value	Criterion ($\alpha = 0.05$)	Conclusion
Shapiro-Wilk (Experimental)	0.764	0.498	$p > 0.05$	Normal
Shapiro-Wilk (Control)	0.693	0.313	$p > 0.05$	Normal
Levene's Test	0.276	0.603	$p > 0.05$	Homogeneous
Independent T-Test	19.81	0.000	$p < 0.05$	Significant Difference

Based on the statistical analyses conducted, it can be concluded that listening to dangdut music for 15 minutes significantly increases urinary dopamine secretion in full-day school students compared to not listening to music. The experimental group's mean dopamine level (53.60 ng/mL) was substantially higher than that of the control group (30.93 ng/mL), with a very large effect size (Cohen's $d = 7.23$). These findings provide empirical support for the hypothesis that culturally relevant musical stimuli, specifically dangdut music, can serve as an effective neuropsychological intervention to enhance dopamine-related reward responses in adolescents within the full-day school environment. The results also confirm that the posttest-only control group design was appropriately applied and that all statistical assumptions were met, strengthening the internal validity of the study's conclusions.

Discussion

Dopamine is widely recognized as a neurotransmitter that plays an important role in the brain's reward system, pleasure, motivation, and emotional regulation. In this study, the experimental group that listened to dangdut music showed higher mean urinary dopamine levels compared to the control group. Although urinary dopamine cannot directly represent central nervous system dopamine activity, the observed difference may indicate a physiological response associated with pleasurable auditory stimulation. From a neurobiological perspective, enjoyable music may activate reward-related brain regions, including the striatum and ventral tegmental area (VTA), which are associated with dopaminergic activity.

These findings suggest that listening to dangdut music may be associated with short-term neurochemical responses related to emotional enjoyment and relaxation among full-day school students. The findings of this study are consistent with previous research demonstrating that music can influence dopaminergic and reward-related neural activity. Study reported that

listening to preferred music was associated with increased dopamine activity in the striatum (Zaatar et al., 2024). Similarly, neuroimaging studies using functional magnetic resonance imaging (fMRI) have shown increased activation and blood flow in brain regions involved in reward and emotional processing when participants listened to enjoyable music (Sulaiman et al., 2025).

Although studies specifically measuring urinary dopamine after music exposure remain limited, previous evidence from neuroimaging and psychophysiological studies supports the possibility that pleasurable music may influence dopaminergic-related responses. Therefore, the higher urinary dopamine levels observed in the experimental group may reflect physiological changes associated with positive emotional stimulation induced by music exposure. The findings of this study are generally consistent with previous research suggesting that pleasurable music may influence dopaminergic-related responses and reward-system activity.

Although studies specifically measuring urinary dopamine after music exposure remain limited, several recent neuroimaging studies have demonstrated that enjoyable music is associated with increased activation in brain regions involved in reward processing, including the striatum, nucleus accumbens, and ventral tegmental area (VTA). Study (Stupacher et al., 2022) reported that rhythmic groove and pleasurable musical stimulation were associated with increased sensorimotor and reward-related neural engagement. Similarly, using functional magnetic resonance imaging (fMRI), found that groove-based music increased activation in brain areas related to emotional regulation and pleasurable experiences (Fukuie et al., 2022).

Another recent study suggested that musical expectation and reward processing are closely linked to dopaminergic-related neural mechanisms (Cheung et al., 2024). Although these studies primarily relied on neuroimaging rather than urinary biomarkers, they support the possibility that enjoyable music exposure may be associated with measurable physiological and neurochemical responses. Therefore, the higher urinary dopamine levels observed in the present study should be interpreted cautiously as a peripheral biomarker potentially associated with positive emotional and reward-related responses induced by dangdut music, rather than as direct evidence of central dopamine activity.

Conclusion

The findings of this study suggest that listening to dangdut music may be associated with positive neurochemical responses in full-day school students and may potentially serve as a culturally relevant approach to supporting students' emotional well-being during prolonged academic activities. This study found that students who listened to dangdut music for 15 minutes showed higher urinary dopamine levels compared to the control group. However, these findings should be interpreted cautiously due to several limitations. First, urinary dopamine was measured only once after the intervention, so the duration and consistency of the response remain unclear.

Second, urinary dopamine is an indirect peripheral biomarker and does not directly represent dopamine activity in the central nervous system. Third, several potential confounding factors, including sleep quality, physical activity, dietary intake, and baseline psychological

condition, were not fully controlled. Therefore, future studies are recommended to apply crossover experimental designs, include more objective neurophysiological measurements such as plasma dopamine, FMRI, or EEG, and implement stricter control of physiological and behavioral variables to better understand the relationship between music exposure and dopaminergic-related responses.

Author Statement

The authors hereby declare that this manuscript has not been previously published, nor is it under consideration for publication elsewhere

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