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Exploring the Potential of Traditional Javanese Gamelan Music as an Early Screening Tool for Monitoring Fetal Well-being During the Third Trimester of Pregnancy

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Abstract

Fetal movement is a recognised marker of fetal well-being, and its monitoring plays a crucial role in prenatal care. Simple, non-invasive, and culturally-appropriate stimulation methods are needed, particularly in settings with limited access to advanced fetal monitoring technologies.

Aims: This study aims to explore the potential use of traditional Javanese gamelan music as an early screening tool to monitor fetal well-being during the third trimester of pregnancy.

Study design: A pre-experimental study design using a one-group pretest post-test method was applied to ≥28 weeks low risk pregnant women (n=30). Data were collected through two measurements: the first during a 30-minute observation before the exposure to Javanese gamelan music, and the second during a 30-minute period while the participants listened to the music.

Place and duration of study: The data for the study was collected from an independent midwifery practice in Malang during August 2022.

Methodology: The used sampling technique was the total sampling technique. The variables studied were Traditional Javanese Gamelan instrumental as independent variable and the frequency of fetal movement as dependent variable measured with *kick counter* application.

Results: The average of fetal movement frequency before the intervention was 6.4 movements, and during the intervention, it increased to 13.3 movements. Data analysis was performed using a paired t-test, which yielded a calculated t-value of 4.79, exceeding the critical t-value of 1.73. The result was statistically significant, with a p-value of 0.000, which is less than the alpha level of 0.05 [95% CI].

Scientific novelty: While previous research has commonly utilised gamelan music to stimulate fetal intelligence, this study explores its potential as a simple, local wisdom-relevant, and non-invasive auditory stimulation tool to aid in the early detection of fetal well-being issues during the third trimester of pregnancy.

Conclusion: Traditional Javanese gamelan music may serve as a simple instrument for pregnant women to stimulate fetal movements and support self-monitoring of fetal well-being during the third trimester.

Keywords: Fetal movement; fetal well-being; auditory stimulation; cultural intervention.

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Introduction

Stillbirth, or Intrauterine Fetal Death (IUFD), refers to a condition in which a baby is born without signs of life [1]. It is characterised by the absence of a fetal heartbeat, umbilical cord pulse, and fetal movements during pregnancy (2). Globally, IUFD is the leading cause of perinatal mortality. Approximately 75% of perinatal deaths worldwide are attributed to IUFD, with a significantly higher incidence in developing countries compared to developed nations (3). Indonesia, as one of the developing countries, ranks among the top ten nations with the highest perinatal mortality rates, with an estimated 18.4 deaths per 1,000 live births [4]. Stillbirth is primarily associated with risk factors such as advanced maternal age, grand multiparity, diabetes mellitus, obesity, hypertensive disorders, suspected intrauterine growth restriction (IUGR), small for gestational age, placental abruption, and umbilical cord abnormalities [2, 5–8]. Active fetal movements are a sign of the baby's well-being during pregnancy and suggest the integrity of the cardiovascular, musculoskeletal, and nervous systems of the fetus. The abnormal perception of active fetal movements is associated with an increased risk of adverse perinatal outcomes such as stillbirth and brain damage (8).

Research Problem

Among the three primary signs of intrauterine fetal demise (IUFD), fetal movement is the most accessible and observable indicator without the need for advanced medical equipment such as cardiotocography (CTG) or non-stress tests (NST) [9], which are typically available only in healthcare facilities and not designed for continuous, everyday monitoring by pregnant women themselves. Traditionally, fetal movement counting has been employed as a practical, low-cost method for monitoring fetal well-being [10–12]. Maternal perception of fetal movements generally commences at approximately 19 weeks of gestation; however, other factors such as advanced maternal age, nulliparity, high BMI, and anterior placenta implantation may delay this onset [13]. Monitoring fetal movements empowers pregnant women to participate in early detection of potential fetal compromise [14–16]. This underscores the need for an approach that encourages awareness and timely response without causing unnecessary clinical action. In general, currently pregnant women in resource-limited areas rarely screen for fetal movement, or a few of them only count manually based on the mother's perception. Gamelan music is something that is easily accessible to all levels of society, as it is available on social media, radio, and cassette tapes.

However, fetal movement counting remains a passive approach, offering limited insights into the fetus's neurological responsiveness to external stimuli — an essential marker of central nervous system function [17]. To address this gap, there is growing interest in empowering pregnant women to engage in simple, culturally relevant stimulation methods that actively assess fetal responsiveness. Leveraging traditional auditory tools such as Javanese gamelan music, combined with accessible mobile applications (e.g., kick counters), may offer a feasible and non-invasive way to both stimulate and monitor fetal activity — not as high-tech dependence, but as a form of maternal participation and self-awareness.

Research Focus

This study proposes fetal stimulation as a method for assessing the condition of the fetus based on the responses it elicits. One of the safe and non-invasive stimulation methods is auditory stimulation, which utilises sound or music. Previous research has demonstrated that classical music can elicit fetal responses, including increased fetal movement, by activating the sensory and motor nervous systems [18, 19]. Studies on the potential of traditional music based on local culture, such as gamelan music, have yet to be extensively explored. Gamelan is one of the typical musical instruments and originated from Indonesia, which is played in an ensemble (together) and uses Pentatonic scales. Gamelan is dominated by instruments that are played by beating, including both idiophones (Bronze-based instruments) and membranophones (Kendhang). Javanese gamelan music is an intriguing candidate for research due to its stable rhythmic characteristics, slow tempo, and harmonious tone frequencies that are unlikely to cause overstimulation. Additionally, gamelan holds significant cultural value, making it a more socially acceptable form of intervention within Indonesian society.

Research Aim and Research Questions

No studies have been found that specifically evaluate the potential of gamelan as an early screening tool to monitor fetal well-being based on fetal movement responses to music exposure. Therefore, this study aims to explore the use of Javanese gamelan music as a non-invasive, culturally-based auditory stimulation method, with the potential for self-monitoring by pregnant women to assess fetal well-being during the third trimester of pregnancy.

Research Methodology

General Background

In this study, traditional Javanese gamelan music was utilised as a form of auditory stimulation to observe its effect on fetal movements during the third trimester of pregnancy. The selected musical piece was *Ladrang Mugi Rahayu*, performed in the slendro pathet manyura and a moderate tempo (*Irama 2/Tanggung*) at approximately 80 dB, using traditional instruments such as *gendhang*, *rebab*, *gender*, *barong*, *slenthem*, *saron*, *peking*, *gambang*, *kempul*,

kethuk kenong, *slinter*, *bonang barong*, and *bonang penerus* [20, 21]. This piece was chosen due to its calming rhythmic structure and cultural significance, symbolising peace and well-being [20, 21]. Its steady, repetitive tone is hypothesised to induce a soothing physiological response in fetuses [20, 21]. The slendro tuning system, characterised by a pentatonic scale with equidistant tones, is believed to produce a gentler auditory experience suitable for prenatal stimulation [20, 21].

To support the accurate and consistent measurement of fetal movement, this study utilised the Kick Count mobile application, an Android-based tool explicitly developed to empower pregnant women to monitor fetal well-being (22) independently. The app enables users to log fetal movements in real-time by tapping the screen each time a movement is perceived, while also providing time reminders and weekly movement trend summaries [22]. This technology enhances data accuracy and reduces the recall bias commonly associated with manual fetal movement counting, making it highly suitable for integration in studies that require real-time, user-friendly monitoring.

Sample/Participants/Group

The subject of this study consisted of 30 pregnant women in their third trimester who attended prenatal check-ups at an independent midwifery practice in Malang during August 2022. The sampling technique used in this study was total sampling. Total sampling was employed because all individuals in the population met the inclusion criteria. The inclusion criteria for the subject in this study were as follows:

- Pregnant women with a gestational age of ≥ 28 weeks.
- No complications during pregnancy (such as pregnancy-induced hypertension, gestational diabetes, anaemia, etc.).

Instrument and Procedures

The independent variable in this study is Javanese gamelan music. A recording of the gamelan melody titled "*Ladrang Mugi Rahayu*" was played for 30 minutes on the subject's abdomen using a mini speaker device. The dependent variable in this study is the frequency of fetal movement, which was observed using the Kick Counter application. This study employed a pre-experimental research design with a one-group pretest-posttest design to examine the effect of Javanese gamelan music on the frequency of fetal movement in pregnant women during the third trimester. In this research design, only one group of subjects (a single case) was used, with measurements taken before the intervention (pretest) and after the intervention (posttest). Fetal movement was recorded for 30 minutes using the Kick Counter before and during the exposure to Javanese gamelan music. The Javanese gamelan music was also played for 30 minutes during the second measurement.

Data Analysis

Before hypothesis testing, a prerequisite test was conducted, which included a normality test using the Kolmogorov-Smirnov (K-S) test. The data were considered normal if the significance value from the Kolmogorov-Smirnov test was greater than 0.05 [95% CI]. The results of the Kolmogorov-Smirnov test before the intervention showed a significance value of 0.601, which is > 0.05. The results of the Kolmogorov-Smirnov test during the intervention showed a significance value of 0.658, which is also > 0.05. Therefore, both data sets in this study were found to be normally distributed. After the normality test assumption was met, data analysis was continued using inferential methods. The Paired T-test is one of the methods used to analyse the data. This test is used to compare or contrast two variables. The purpose of this test is to determine whether there is a difference in the mean between one sample with two paired treatments. Since this is a paired test, the two sample datasets are of equal size and come from the same source. In this study, the data used were the fetal movement counts obtained before and during exposure to the gamelan music.

Research Results

Following a one-month data collection period at an Independent Midwifery Practice in Malang City in August 2022, the following results were obtained.

Table 1. Frequency Distribution of Respondents' Characteristics

Criteria	N (30)	%
Age (years old)		
<20	1	3
20-35	24	80
>35	5	17
Employment status		
Employed	7	23
Unemployed	23	77
Parity		
Primiparous (1)	9	30

Multiparous (>2)	21	70
Gestational age (weeks)		
28-32	7	23
33-36	12	40
37-40	11	37
Activity prior to fetal movement counting		
Eating	11	37
Sleeping	3	10
Other unspecified activity	16	53

Note: n total number of subjects, %= proportion of subjects based on criteria

Table 1 illustrates that: a) almost all respondents are between the ages of 20-35 years, b) almost all respondents are not employed, c) the majority are multiparous mothers, d) nearly half of the respondents are in the gestational age range of 33-36 weeks, and e) the majority of respondents, approximately 10 minutes before the intervention, were engaged in activities other than eating and sleeping, such as cleaning the house, watching TV, cooking, etc.

Table 2. Distribution of Fetal Movement Frequency Among Respondents Before and During Traditional Javanese Gamelan Music Exposure

Frequency of fetal movement (times)	Before		During	
	N (30)	%	N (30)	%
1-5	14	47	3	10
6-10	10	33	7	23
11-15	5	17	8	27
16-20	0	0	7	23
21-25	1	3	3	10
26-30	0	0	0	0
31-35	0	0	2	7

Table 2 shows the frequency of fetal movements before and during exposure to Javanese gamelan music in the group of third-trimester pregnant women. Before exposure, the majority of respondents (47%) recorded fetal movements within the range of 1–5 times, followed by 33% within the range of 6–10 times. Only a few respondents recorded more than 10 fetal movements, and none reached more than 20 movements. However, during the exposure to gamelan music, there was a significant shift in the distribution towards higher frequencies of movement. The number of respondents experiencing 1–5 movements decreased from 47% to only 10%, while the mid-to-high frequency categories (11–15 times and 16–20 times) increased substantially to 27% and 23%, respectively. Additionally, 2 respondents (7%) recorded 31–35 fetal movements– a category that did not appear before the exposure.

Table 3. Normality Test Results Using the Kolmogorov-Smirnov Test

Stimulus	K-S value	*p*-value	Interpretation
Before traditional Javanese Gamelan music exposure	0.762	0.607	Normal
During traditional Javanese Gamelan music exposure	0.540	0.932	Normal

Table 3 presents the results of the normality test, conducted using the one-sample Kolmogorov-Smirnov test. Based on the K-S test results, the K-S value for fetal movement before the intervention was 0.762 with a p-value of 0.607. Meanwhile, during the intervention, the K-S value was 0.540 with a p-value of 0.932. Since the p-value is greater than 0.05, the data distributions before and during the intervention are considered normal and suitable for analysis using the paired T-test.

Table 4. T-Test Results on Differences in Fetal Movement Among Respondents Before and During Traditional Javanese Gamelan Music Exposure

Stimulus	Fetal movement	
	Before	During
Mean	6.6	14.1

Median	6	13
Modus	3	13, 16, 23
Standard deviation	4.8	7.3
Mean difference	7.5	
p-value paired T-test	0.000	

Table 4 shows that the average fetal movement before exposure to Javanese gamelan music was 6.6 times, while during exposure to the music, the average fetal movement increased to 14.1 times. The average fetal movement was higher during exposure to the Javanese gamelan music. This is also reflected in the mode and standard deviation of fetal movement. Before exposure to the gamelan music, the mode of the data was 3 movements, and during exposure to the music, it shifted to 13, 16, and 23 movements.

The results of the paired T-test show that the difference in the mean fetal movement before and during the intervention was 7.5. Based on the T-test results, the calculated T value was -7.608, and the p-value was 0.000. The critical T value at a 95% confidence level was 1.699. Since the calculated T value (-7.608) is less than the critical T value (-1.699) and the p-value (0.000) is less than 0.05, it can be concluded that there is a significant difference in fetal movement frequency before and during the intervention.

Based on the summary of the paired T-test and Table 4, it can be interpreted that the results of this study show a significant effect. The effect is evident in the difference in the mean before and during the intervention, as well as the paired T-test values before and during the intervention, where the p-value = 0.000, which is smaller than 0.05.

Discussion

This study demonstrated a significant increase in fetal movements following exposure to traditional Javanese gamelan music, suggesting that auditory stimulation may support fetal well-being during the third trimester of pregnancy. The results of this study showed a statistically significant increase in fetal movements after 30 minutes of exposure to traditional Javanese gamelan music, with a p-value of 0.000 (Table 4). Since fetal movement is a widely accepted clinical indicator of fetal health, the increase in activity supports the hypothesis that gamelan music can be used not only as a stimulant but also as an indirect method for assessing fetal well-being.

Traditional Javanese gamelan music, with its stable rhythm, moderate tempo, and pentatonic tuning (slendro), creates a consistent and gentle acoustic environment. These qualities are believed to be optimally received by the fetal auditory system, particularly in the third trimester when auditory pathways have matured. The positive response observed in this study reinforces the idea that auditory stimuli – especially culturally familiar ones–can measurably influence fetal behaviour. The use of a kick-counting mobile app further enhances the practicality of this approach, allowing pregnant women to participate in self-monitoring in a systematic yet straightforward manner.

The physiological mechanism behind this response can be explained by the maturation of the fetal auditory system during the third trimester of pregnancy. Auditory stimuli such as music are received by the fetal ear, processed by the brainstem and cerebral cortex, and translated into somatic responses, including movement [23–25]. Previous studies have shown that fetal response to sound reflects not only auditory pathway development but also central nervous system integrity [26, 27]. Thus, an absence or reduction of fetal response following auditory stimulation may be an early sign of neurodevelopmental or physiological compromise [28]. The increase in fetal movements observed in this study indicates that gamelan music may effectively activate fetal sensorimotor pathways, supporting its potential role in fetal health screening.

Compared to prior studies involving classical music or white noise, this study emphasises the use of traditional, culturally embedded music. The selection of *Ladrang Mugi Rahayu*, played in the slendro scale with a steady irama tanggung tempo, is based on its repetitive and calming acoustic profile [21]. Unlike many Western compositions, gamelan music offers rhythmic predictability and tonal softness that may reduce maternal stress and enhance fetal receptivity. These characteristics align with previous findings suggesting that consistent, low-frequency sound patterns have a more favourable impact on fetal behaviour [23, 24]. However, this study goes further by positioning gamelan not just as a relaxing background stimulus but as a functional and accessible screening tool for assessing fetal responsiveness.

The concept of using music–particularly gamelan–as a non-invasive auditory stimulus introduces a culturally grounded, low-cost alternative for early screening, especially in settings where access to advanced fetal monitoring tools is limited. The Non-Stress Test (NST) is a widely used clinical method for assessing fetal well-being by monitoring the fetal heart rate response to spontaneous fetal movements [29]. A healthy fetus is expected to show temporary increases in heart rate (accelerations) following its own movements, reflecting adequate oxygenation and intact neurological function. Similarly, the approach used in this study – measuring fetal response to auditory stimulation using traditional Javanese gamelan music–adopts the same physiological logic. Fetal body movements are more closely associated with sympathetic nervous system activity, which is responsible for responding to external stimuli or increased levels of activity [17, 30, 31]. These movements begin spontaneously as early as 7.5 weeks of gestation and include a variety of patterns such as general body movements, limb movements, hiccups, and

breathing motions. Some movements, like yawning and smiling, even resemble behaviours that persist throughout life [32].

Rather than waiting for spontaneous fetal movements, an external stimulus is introduced to trigger a response, and the resulting movement is used as an indicator of fetal activity and well-being [33]. When a fetus does not respond to such stimulation, it may serve as an early red flag. Therefore, further examinations—sometimes invasive—can be performed when there is a clear indication of decreased fetal movement, making these assessments clinically justified, such as Doppler ultrasound, NST, and CTG [34]. This aligns with the global call for more accessible, preventive strategies in maternal-fetal health, positioning traditional music not just as relaxation therapy, but as a functional tool within the continuum of prenatal care [35–38]. Significantly, this approach contributes to women's empowerment by positioning pregnant women as active participants in safeguarding their own pregnancy outcomes. Rather than relying solely on clinical visits, women are equipped to engage in preventive health practices daily – even when no overt symptoms are present [39]. Given that decreased fetal movement can be an early warning sign of stillbirth, especially in the third trimester, empowering mothers with tools to monitor fetal activity can significantly enhance timely care-seeking behaviour and reduce adverse outcomes [40, 41]. Fetal movements are also influenced by several factors that were not controlled for in this study, such as gestational age, number of fetuses, placental position, maternal physical activity, and overall fetal health. Mothers who have had previous pregnancies are usually more sensitive to early fetal movements and may feel them more frequently due to previous experience.

Beyond health benefits, the process of self-monitoring through music stimulation may strengthen maternal-fetal bonding, as women develop a deeper awareness of their baby's responsiveness. Economically, this method offers a cost-effective alternative to facility-based assessments, particularly in low-resource settings, thereby reducing financial and geographical barriers to care [9]. By promoting autonomy, connection, and accessible monitoring, this intervention exemplifies how culturally grounded innovations can support holistic and equitable maternal health [42, 43]. Despite its proven clinical utility, fetal movement counting is underutilised due to limited maternal awareness of the method [44]. Melati (2024) identified insufficient information as the primary barrier, highlighting the need for targeted education to enable accurate self-monitoring [45].

Conclusions and Implications

The use of traditional Javanese gamelan music presents a novel, culturally embedded, and low-cost approach to support fetal well-being monitoring. In settings with limited access to advanced technologies, this method could serve as an early screening strategy to prompt further clinical evaluation when fetal response is absent or reduced. The integration of auditory stimulation with digital tools such as mobile fetal movement counting applications provides a feasible pathway for self-monitoring by pregnant women. This approach could be particularly beneficial in contributing to improved maternal awareness, early detection of fetal distress, and potentially lower rates of stillbirth. Gamelan-based fetal stimulation may also complement routine antenatal care by enhancing maternal–fetal bonding and reducing prenatal anxiety.

In conclusion, this study supports the potential of traditional Javanese gamelan music as a tool for early screening and monitoring fetal well-being during the third trimester. The observed increase in fetal movements indicates that auditory stimulation can be used not only to soothe but also to assess fetal responsiveness. When paired with mobile technology and culturally sensitive implementation, this approach may offer a simple yet transformative addition to prenatal care.

Limitations

While the findings of this study offer promising insights, several limitations must be acknowledged. First, the study utilised a single-group pretest-posttest design without a control group, which limits the ability to fully attribute changes in fetal movement to the musical stimulus alone. Second, the measurement of fetal movement relied on maternal perception, which can introduce subjectivity and variability, particularly among primiparous participants who may be less familiar with fetal movement patterns. Third, the study involved only a one-time 30-minute exposure to music, making it difficult to assess sustained or cumulative effects over time and a lack of long-term follow-up. Lastly, the sample size was relatively small and drawn from a single clinical setting, which may limit the generalizability of the findings.

Recommendations for Future Research

Future studies should consider using a randomised controlled trial (RCT) design with larger and more diverse populations to strengthen the evidence on the efficacy of gamelan music as a fetal monitoring tool. Incorporating objective fetal monitoring methods such as cardiotocography (CTG) or ultrasonography alongside maternal kick counting would enhance the reliability of fetal response assessments. Further investigation into the optimal duration, timing, and frequency of music exposure is also needed, as well as application to different gestational age groups and high-risk pregnancies.

Declarations

Author Contributions

Conceptualisation, Fajrin, Yudianti, and Apsari; methodology, Yudianti; software, Fajrin; validation, Yudianti and Apsari; formal analysis, Fajrin; writing—original draft preparation, Fajrin; writing—review and editing, Yudianti; visualisation, Yudianti; supervision, Yudianti and Apsari; project administration, Fajrin; funding acquisition, Fajrin. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

Data available on request due to restrictions eg privacy or ethical: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to confidentiality agreements and ethical restrictions involving human subjects.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of the Health Research Ethics Committee of Poltekkes Kemenkes Malang (protocol code number: 604/KEPK-POLKESMA/2022, approved in 22nd of July, 2022).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors

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