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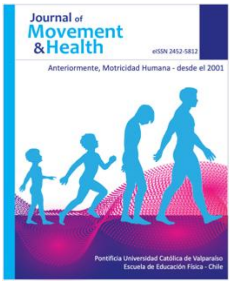


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## Article

# The effect of music on endurance performance: study with females with Down syndrome

El efecto de la música en el rendimiento de resistencia: estudio en mujeres con síndrome de Down

**Rodrigues dos Santos JA[1]; Pinto dos Santos NP[3]; Boppre G[2,3,4]; Cardoso VD[5,6]; Nunes Corredeira RM[3,4,*]**

Correspondence✉
Prof. PhD. Rui Manuel Nunes Corredeira
Research Centre in Physical Activity, Health and Leisure (CIAFEL), Faculty of Sport, University of Porto, Portugal; & Laboratory for Integrative and Translational Research in Population Health (ITR), Portugal.
rcorredeira@fade.up.pt

## Abstract

**Aim:** The purpose of this study was to analyse the effects of self-selected music in an endurance test in females with Down syndrome (DS). **Methods:** Twenty-three women with DS, recruited from Special Schools with a mean age of 25.5 years old, participated in this study. Testing consisted of three trials of a walking/running mile. The first trial was performed without music (WM), the second trial with Fast Tempo Music (FTM), and the third trial with Slow Tempo Music (STM). The following dependent variables were selected: time expenditure and heart rate at progressive distances (400, 800, 1200, and 1609 meters). The comparison between trials and moments was made by the t-test of independent measures. The level of statistical significance was set as $\alpha = 0.05$. **Results:** FTM, except 400m, decreased significantly ($p<0.05$) time expenditure for all the moments of the walking/running test when compared with WM, and STM trials. WM and STM promoted similar results in performance. FTM achieved a higher HR peak when compared to STM. FTM and STM, starting from different heart rate peaks, had similar heart rate recovery. **Conclusion:** It can be concluded that adding preferential FTM to exercise could be an economical, accessible, and effective strategy to motivate and encourage female with DS for exercise, improving their aerobic performance.

**Keywords:** intellectual disability; endurance; cardiovascular fitness; motivation

## Resumen

**Objetivo:** El propósito de este estudio fue analizar los efectos de la música autoseleccionada en una prueba de resistencia en mujeres con síndrome de Down (SD). **Métodos:** Veintitrés mujeres con SD, reclutadas en escuelas especiales con una edad media de 25,5 años, participaron en este estudio. La prueba consistió en tres pruebas de una milla caminando/corriendo. La primera prueba se realizó sin música (WM), la segunda prueba con música de ritmo rápido (FTM) y la tercera prueba con música de ritmo lento (STM). Se seleccionaron las siguientes variables dependientes: tiempo empleado y frecuencia cardíaca en distancias progresivas (400, 800, 1200 y 1609 metros). La comparación entre intentos y momentos se realizó mediante la prueba t de medidas independientes. El nivel de significación estadística se estableció en $\alpha = 0{,}05$. **Resultados:** El FTM, excepto los 400 m, redujo significativamente ($p<0{,}05$) el tiempo empleado en todos los momentos de la prueba de marcha/carrera en comparación con los ensayos WM y STM. WM y STM promovieron resultados similares en el rendimiento. El FTM logró un pico de frecuencia cardíaca más alto en comparación con STM. El FTM y STM, a partir de diferentes picos de frecuencia cardíaca, tuvieron una recuperación de frecuencia cardíaca similar. **Conclusión:** Se puede concluir que añadir FTM preferencial al ejercicio podría ser una estrategia económica, accesible y efectiva para motivar y animar a las mujeres con síndrome de Down a hacer ejercicio, mejorando su rendimiento aeróbico.

**Palabras clave:** discapacidad intelectual; resistencia; aptitud cardiovascular; motivación

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## Highlights

- Regular and systematic cardiovascular exercise is crucial for improving the overall health and well-being of women with Down syndrome.
- Music (in particular, fast tempo music and preferential), can be considered an effective, accessible, and economic strategy of motivation and stimulation for female with down syndrome.
- Music appears to be a factor that alleviates fatigue when physical effort is prolonged over time.

## Introduction

Intellectual disabilities are usually associated with alterations in motor behaviour reducing the trend for action. Individuals with Down Syndrome (DS) are at risk once their lifestyles are essentially sedentary[1]. The genetic disorder that causes this syndrome is by itself enough to induce a larger physical inability related to the general apathy that characterizes this population [2-3]. Behaviours linked to an active rhythm of life are difficult to achieve in subjects with intellectual disabilities. Beyond the tendency towards inactivity, the low basal metabolic rate characteristic of these individuals can prone them to obesity and cardiovascular pathologies in adulthood.

Several authors have highlighted that individuals with DS exhibit lower cardiovascular capacity compared to the general population as well as to their peers with other intellectual disabilities[3-6]. In fact, reduced cardiovascular capacity is greater in females with DS compared to their male counterparts[7-8]. Several reasons can explain the poor cardiorespiratory capacity of DS[9-11]: (i) lack of opportunities for participation in predominantly energetic exercises, (ii) lack of available people to support and to promote this kind of exercise, (iii) the complexity and the "singularity" of these subjects, their clumsiness and above all, (iv) little motivation for high energy expenditure activities. Kunde and Rimmer[11] add also that the cognitive limitation exhibited in most of these individuals induces a lack of motivation to complete persistence tests**.** Some people with DS do not possess a tolerance level capable of resisting fatigue in endurance exercises while others have difficulty understanding the concept of self-rhythm and maintenance of a regular pace.

Research supports the idea that music is an effective means to stimulate individuals with moderate or severe intellectual disabilities[12]. Music may mitigate the sensation of fatigue by diverting the individual's attention to music[13], and can increase motivation for physical exercise[14], namely endurance exercises which are known to have a very positive effect on cardiovascular health[15]. Music can have a positive psychic effect[16]. This not only depends on the exercise type but also the music genre and a critical factor is the "musical tempo" that needs to be synchronized with the exercise type to maximize the benefits, and the musical tempo influences different types of behaviour, both in non-disabled individuals and in individuals with intellectual disabilities[17-23]. Several factors are associated with the positive effects of music on motivation for exercise, for instance: (i) reducing perceived exhaustion, (ii) increasing stimulation levels, (iii) improving coordination and synchronization, and (iv) increasing relaxation features which seem to be related to the amelioration of the brain's left inferior frontal gyrus[18-23]. Some studies[13, 24-25] also show that female individuals reported a greater response than males, to the rhythmic elements of music - melody and harmony. Therefore, we hypothesize that "fast tempo" music can be considered a facilitating factor for a good performance of females with DS in an endurance test.

The results obtained from the literature are controversial and mainly related to non-disabled individuals. It was established that self-selected music improved anaerobic exercise performance[26],

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although other studies confirmed that music associated with exercise could have a positive influence on the aerobic exercise performance of female individuals with or without disabilities[16, 20, 27]. Therefore, the purpose of this study was to examine if music has any impact on the performance of a walking/running endurance test in females with DS.

## Methods

*Subjects*

Twenty-three females with DS, recruited from Special Schools, participated in this study. Participants had the following characteristics (mean ± SD): age 25.5 ± 5.6 years; body weight 63.9 ± 11.3 kg; height 139.0 ± 6.7 cm; Body Mass Index 33.3 ± 6.3 kg/m$^2$; maximum Heart Rate (HR) 195 ± 5.6 bpm.

The selection criteria were: absence of medical contraindications for the tests; present a diagnosis corresponding to DS; regular physical activity (minimum 2 to 3 times a week); minimum level of intelligence to understand what was proposed (IQ not less than 35 as established by the American Association on Mental Disability, for the limit of moderate mental handicap); absence of accentuated hearing deficits (losses not exceeding 25 decibels in the best ear as proposed by the WHO); ability to perform tests autonomously (without assistance).

Written informed consent was received either directly from participants or their legal guardians before participation in the study. Participants were asked to refrain from any intense physical activity the day before testing. Experimental procedures were under the Helsinki Declaration and ethical principles for medical research involving human subjects[28]. Also, the parents or guardians signed the consent form to participate in the study.

*Methodological Procedures and Instruments*

*Instruments*

The following instruments were used: Fitnessgram 1.0 Mile (1.609 m) Walk/Run Test; Record Data File of Fitnessgram 1.0 Mile (1.609 Km Walk/Run Test); MixMeister BPM Analyzer 1.0.; Record Data File of the "Three-choice pictograph response test" (adapted); HRM Triax 100 - Nike (Heart-rate Sensor with Chess Strap); Portable CD-Radio (Technostar RCD 6900R).

*Determination of musical preference*

Together with the technicians and monitors of the institution, a survey was conducted on the musical preferences of the participants. Supported in the specific literature[29-31, 12, 13, 17, 18, 24, 25], a group of 20 musical tracks were selected. The essential criteria were: (i) a genre of music with a "musical tempo" associated with the HR-wanted for the intended intensity of the exercise (Fast Tempo Music (FTM) with a bpm > 120), (ii) music with a strong element of percussion (rhythm), and (iii) music with a language, release date and artists related with the age and the individuals' sociocultural background (familiar music).

Furthermore, the selection of Slow tempo music (STM) was made, using music tracks that presented slow or relaxing *tempos* (between 60 and 80 bpm), not familiar to the participants, and with an unknown language.

Later on, and with the psychologist's support, we collected the musical preferences of four participants using an adaptation of the Three-choice Pictograph Response Test.

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The participants were gathered in a gym and attended to the observation/interpretation of the corporal reactions toward the tracks. It was filled in the Record Data File of the "Three-choice pictograph response test" (adapted). From this observation, 8 tracks, which received the most enthusiastic and animated reaction from the majority of the participants were extracted.

*Adaptation to testing*

Using the same sub-sample of the musical selection, the suitability of the Fitnessgram 1.0 Mile Walk/Run Test, regarding the real capacities of the participants, was verified. In this training trial subjects were familiarized with the Heart-rate Sensor with Chess Strap (HRM Triax 100 - Nike).

*Testing performance*

Considering that each participant completed all three types of intervention this study presented a crossover design. Each participant, with a minimum of two weeks interval, performed the Fitnessgram 1.0 Mile Walk/Run Test individually, under three conditions: First, performing the test without music (WM); second, performing the test accompanied by FTM; finally, the test was accompanied by STM. No verbal reinforcement was provided.

*Data selected*

In each trial, the following data were extracted: Resting heart rate and time expenditure with respective heart rates at different stages during the test: 400 m, 800 m, 1200 m, and 1609 m.

*Statistical analysis*

Values are expressed as means with the standard deviation of the mean. The Shapiro-Wilk test was used to verify the normality of the distributions. Assuming the presupposition of the normality for all the variables, the comparison between trials and periods was made by the t-test of independent measures. The statistically significant value was set as $\alpha = 0.05$. Statistical analyses were conducted using R statistical software (version 4.1.2, R Foundation for Statistical Computing, Vienna, Austria).

## Results

Figure 1 presents the global scores attending to time expenditure in the three trials, in 400 m, 800 m, 1200 m, and 1609 m. Compared to WM and STM, FTM significantly reduced time expenditure at all measured distances except at 400 meters ($p<0.05$). No significant differences were observed between WM and STM.

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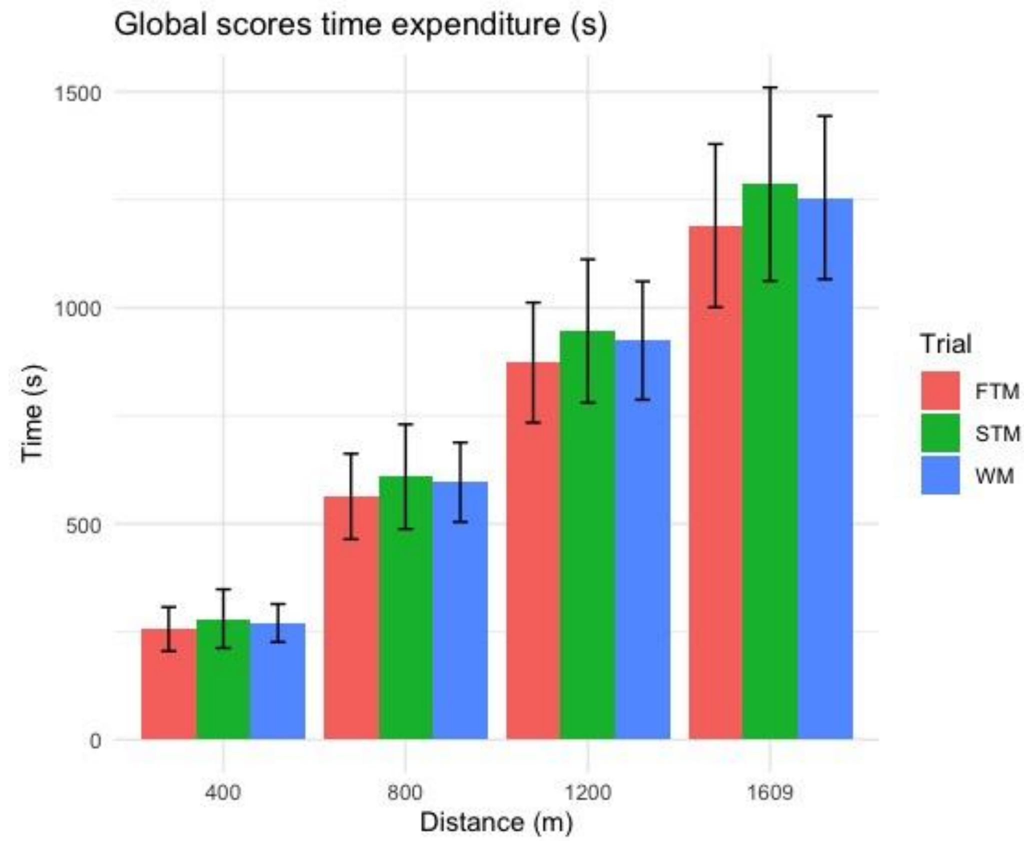


**Figure 1.** Global scores time expenditure (s). Notes: Fast tempo music (FTM), Slow tempo music (STM), Without Music (WM).

Table 1 shows the global scores to HR in the three trials at 400 m, 800 m, 1200 m, and 1609 m. The FTM showed the highest beats per minute, followed by the WM and STM. There were significant differences between FTM and STM in all trials ($p<0.05$). In addition, there was a significant difference comparing HR at 800m between FTM and WM ($p=0.007$). The HR recovery after 1 minute (HR1) was similar among trials, but with significant difference between FTM and STM. FTM elicited a higher peak HR than STM, while both FTM and STM demonstrated similar HR recovery patterns, despite differing initial HR peaks.

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**Table 1.** Global scores for Heart Rate by trials.

| Distance | Trial | Heart Rate |
|---|---|---|
| 400 m | Without Music | 147 ± 18 bpm |
| | Fast tempo music | 154 ± 15 bpm† |
| | Slow tempo music | 147 ± 17 bpm† |
| 800 m | Without Music | 144 ± 17 bpm* |
| | Fast tempo music | 153 ± 17 bpm*† |
| | Slow tempo music | 144 ± 19 bpm† |
| 1200 m | Without Music | 146 ± 18 bpm |
| | Fast tempo music | 150 ± 14 bpm† |
| | Slow tempo music | 141 ± 20 bpm† |
| 1609 m (HRpeak) | Without Music | 151 ± 23 bpm |
| | Fast tempo music | 153 ± 19 bpm† |
| | Slow tempo music | 145 ± 25 bpm† |
| HR1 | Without Music | 122 ± 17 bpm |
| | Fast tempo music | 123 ± 18 bpm† |
| | Slow tempo music | 117 ± 19 bpm† |

Data are presented as mean and standard deviation (SD). Abbreviations: m (metres); Heart Rate (HR); HR Recovery after 1 min (HR1); bpm (beat per minute); significance: * indicates a significant difference ($p<0.05$) compared to the WM; and † indicates a significant difference between FTM and STM.

## Discussion

In contemporary societies, physical inactivity is related to a series of morbidities and to an increase in the mortality rate in the general population. This finding is more pronounced in individuals with DS. In this type of population, the morbidity rate increases with advancing age[47]. Individuals with DS are at increased risk for neurodegenerative conditions, like Alzheimer's, which can directly impact motor function and contribute to hypokinesia[48]. Therefore, intervention programs that have physical exercise as a corrective element for the hypokinesia that normally characterize individuals with DS[49] are extremely important. Knowing the resistance that individuals with this disability have to physical exercise, all pedagogical and methodological interventions that stimulate body movement can contribute to improving health and well-being indicators[50]. Thus, with this study we aim to analyse the influence of musical stimulus on endurance performance in subjects with DS.

The research points to the psychophysiological impact of music on physical performance in non-disabled people although the results are varied and ambiguous[13, 32-38]. However, in the scope of the

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disabled populations, as is the case of the present investigation (female with DS), there was a tendency for a larger homogeneity of results (mainly in aerobic physical exercises). It was shown that the music influenced both the performance and the heart rate. Our results showed that FTM influenced positively the physical performance of female DS, which confirmed the studies with non-disabled individuals[19,39-42], and in studies with intellectual disabled individuals[10-12, 17].

Our results also appear to be corroborated by studies of Silva et al.[51] who also confirmed that the use of music during walking can modulate attentional focus, increasing dissociative thought, and medium-tempo music can reduce the rating of perceived exertion. Referring to populations without disabilities, other studies refer to the relationship between the effect of music and the reduction in the amount of perceived effort during the practice of activities, namely in more strenuous exercises[52, 53, 54]. Another study involving individuals with DS reinforces the idea that music could promote physical performance for health benefits in this population[55].

Music is more beneficial, at the beginning of the exercise than in the intermediate/final period, where the level of effort is more intolerable[35]; however, this statement was not confirmed in our study, once FTM didn't have a significant influence on the reduction of the time expenditure in the initial period.

According to Orsini et al.[56] listening to music can serve as a countermeasure to cope with fatigue, which is not so evident at the beginning of any physical activity. Our study showed that FTM allows overcoming the low appetite for physical activity of female with DS, even in low/moderate intensity exercise, allowing them to overcome boredom and discomfort[18].

We verified that FTM did have a significant influence on the increase of HR (mainly at the beginning of the trial), which confirms in studies with non-disabled individuals[32,40,42] and the study with intellectually disabled individuals[43]. Analysing the recovery profile, STM, FTM, and WM had a similar influence on the decrease of HR, which conflicts with the studies with non-disabled individuals[39,44,45].

HR1 was similar with both types of music (STM and FTM), and even WM, which cannot support the idea defended by studies which suggest that the decrease in the volume or the speed of the music, the absence of persistent or accentuated beats, or a piece of music calm/relaxing could promote a soothing or relaxing effect[17,46]. It is necessary to highlight that HR1 directly depended on the HRmax achieved in each of the trials.

To end up, we can still note that throughout the visual inspection of the different trials, we confirmed that in the case of the WM trial, the females DS manifested little commitment, some bore, and even sometimes discomfort. With FTM trial (preferential) they revealed a larger enthusiasm, satisfaction, vivacity, and some fulfilment; and finally, in the case of STM trial, they seemed to exhibit some indifference and inertness enough.

Two limitations arise from this study: (i) the small sample size and (ii) the difficulty of motivating this kind of population for controlled physical exercise. However, the scarcity of studies in this field fully justifies this research.

*Practical Applications*

After the conclusion of this study, two pieces of evidence stand out as relevant issues for analysis and intervention of the professionals that are devoted to the specific work with this kind of population. The first is the importance of the work's development of cardiovascular exercise with females DS regularly and systematically; the second is that music (in particular, FTM trial and preferential), can be considered an effective, accessible, and economic strategy of motivation and stimulation for females with DS. Future studies should aim to verify the physiological, biochemical, cognitive and socio-emotional effects of different type of intervention through physical exercise from the perspective of strength, flexibility, speed and endurance practical protocols.

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## Conclusions

The type of music (FTM trial /STM trial) influences the performance of young/adult females with DS on an endurance test. The participants' performance is distinct when the test is accompanied by FTM trial (preferential), or STM trial (not preferential). FTM trial can be considered a facilitative agent for increased performance on an endurance test while STM trial cannot be considered a facilitative tool for performance in the same test. Although STM trial tends to promote a lower HR at the end of the endurance test, the recovery profile is similar in the three trials. The preferential music in females with DS improves performance in an endurance running/walking test.

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**Affiliations**
[1]Centre of Research, Education, Innovation and Intervention in Sport (CIFI2D), Faculty of Sport (FADEUP), University of Porto, Portugal.
[2]Nucleus of Research in Human Movement Science. Universidad Adventista de Chile.
[3]Research Centre in Physical Activity, Health and Leisure (CIAFEL), Faculty of Sport, University of Porto, Portugal.
[4]Laboratory for Integrative and Translational Research in Population Health (ITR), Portugal.
[5]Brazilian Paralympic Academy. Brazilian Paralympic Committee (CPB), Brazil.
[6]State University of Roraima (UERR), Roraima, Brazil.

**Authors' contributions**

JARS, NPPS, and RMNC participated in the conception and collection of the data. JARS, NPPS, GB and RMNC performed the analysis and interpretation of data. JARS, NPPS, GB, VDC and RMNC drafted the work and revised it critically for important content, and approving the final version.

**Competing interests**

The authors have no conflicts of interest to declare.

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**Declaration of use of generative AI and AI-assisted technologies in the drafting process**
The authors declare that generative AI and AI-assisted technologies are not used in the writing process.