

Effects of music on well-being and mental-health

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Abstract

The use of music as a health treatment comes from old times. The ancient Greeks used music for treating psychiatric disorders or giving release from accumulated emotions. Nowadays where the fast-paced routine of everyday life, added to different global events such as climate change or the COVID-19 pandemic are driving high levels of social stress, boosting mental health problems, and reducing individual and collective levels of well-being, there is a need to expand the number of tools to be used to address this situation. This paper conducts an empirical study, using the quasi-experimental Propensity Score Matching (PSM) technique, on how musical practice can improve the quality of wellbeing and mental health, proposing public policy initiatives in this direction.

Keywords: Music, Music-based treatments, Well-being, Mental-health, Depression, Stress

JEL classification: I12, I21, J13

1 Introduction

At a time when mental health problems are increasing, and the burden of stress in our daily routine tends to be higher, the need arises to think of new tools that can help to meet these challenges. The ancient Greeks believed that music had the ability to affect human beings and process their emotions. In this sense, there are a number of current scientific studies that study and affirm the potential positive use of music to treat illnesses, such as depression or more severe mental illnesses. This paper addresses through an extensive review of the literature, the usefulness of music in terms of health treatments, and in other fields such as education, social integration, economic development, and the fight against racism. Music helps to improve levels of social well-being because it makes us feel part of a group. The process of learning an instrument can help to generate spaces where one can escape from the daily routine of stress. The following pages also refer to several studies on the positive influence of music on neurological rehabilitation.

In order to study the influence of music on mental health, and the existence of a causal relationship between the practice of music and the possible reduction of depression levels -in preventive terms and as a health treatment-, this empirical study is carried out using the quasi-experimental technique Propensity Score Matching (PSM), and using SOEP - Core V37 database of the Socio-Economic Panel. This longitudinal study of private households in Germany, carried out by the German Economic Research Institute, DIW Berlin, provides the necessary music and health variables in order to develop the study. It is worth mentioning that the health variables used are part of the well-known health questionnaire, SF-12, one of the most widely used tools to assess self-reported health-related quality of life.

Preliminary results are obtained with Ordinary Least Squares (OLS), leading to the causality study using PSM. The fact that young people who study music are defined by a number of observable characteristics is a strong argument in favor of the PSM technique. The latter allows the author to construct both, a control and treatment group with similar characteristics and deal with the potential problem of selection bias. In the application of PSM, propensity scores are computed, using probit regressions.

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Subsequently, the present study develops a series of checks in order to discuss the common support, balancing property, and Conditional Independence Assumption (CIA), and test the robustness of the used technique.

The conclusions section addresses some of the problems faced in the elaboration of this document, such as the difficulty of finding databases with quality musical variables. A series of public policy recommendations are also mentioned. Finally, the potential contribution of this paper to the existing literature is assessed, and possible lines of research for future studies discussed. Last but not least, due to the global weight that the Sustainable Development Goals and the Agenda 2030 of the United Nations are gaining, a small subsection has been added in order to discuss the contribution of music-based health treatments to these goals.

In reference to the structure, this master thesis is organized as follows: section 2. Motivation and literature review, which includes 2.1. Current mental health and well-being situation, 2.2. Contributions of music, and 2.3. The impact of music on the Sustainable Development Goals (SDG) subsections. It is followed by section 3. The positive influence of music on mental health and well-being, 4. Data, and 5. Empirical approach and results, the latter composed by 5.1. Pooled Ordinary Least Squares, and Propensity Score Matching subsections. The paper ends with section 6. Conclusions

2 Motivation and literature review

2.1 Current mental health and well-being situation

The COVID-19 pandemic and its economic and social consequences have boosted the burden of stress that too many people endure, worsening the levels of mental health previously enjoyed and increasing the levels of suicidal ideation (SI) in some cases. As Ma et al. (2022) remarks, the SI rates increased among Chinese students during the COVID-19 pandemic, where the mental cumulative risk played a central role compared to single mental risk and depression was the most influential risk factor for SI. It seems the restrictions adopted by some countries have had a big effect in terms of mental health. Wester et al. (2022) describes that countries with high restriction levels, such as severe lockdowns, increased the risk of individuals feeling depressed, sad or lonely in front of countries with lighter restrictions. At the same time, the feeling of loneliness among the older population increased.

Other seminal studies as the one by Pandya and Lodha (2022), mention how university students' mental health has been affected in the course of the COVID-19 pandemic, due to the transition to online classes. Despite the fact online learning has allowed too many students all over the world to continue with their academic routines, on the other hand, it has also had a negative effect on a variety of factors. Regarding the author, the adaptation to this new online routine may have increased stress levels, headaches, backaches, lack of motivation to study online, or not feeling involved because of not attending in-person classes. In addition, pregnant women were another of the social groups that have been most affected all along the COVID-19 pandemic, in terms of mental health. Wall and Dempsey (2022) asserts that lockdowns during the pandemic amplified the stress factors that impact perinatal¹ women's mental health.

Apart from the aforementioned, the post-pandemic social and economic situation, the current climate change crisis, the war in Ukraine, the energetic crisis or the geopolitics situation in regarding to the Chinese-Taiwanese conflict, added to the hectic days and work routine that individuals suffer, appear as important determining factors that may increase the burden of stress that individuals suffer, increasing mental health-related illnesses. Because of the current situation, and with mental health-related illnesses predicted to increase in the long term, there exist the need of developing tools that will help face this problem.

¹Perinatal is the period of time when women become pregnant and up to a year after giving birth.

2.2 Contributions of music

Ancient Greeks believed that music could influence body and soul, boosting some kind of stability, form personality, or give release from accumulated emotions. Music has been used since the earliest days in the treatment of chronic and psychosomatic diseases, and psychiatric disorders. Patients suffering from depression, used to be prescribed listening to dulcimer music. Not only for depressive cases but music was also used to treat hangovers caused by alcohol consumption, in ancient times.

The ancient Greeks knew the importance of working in favor of a healthy mind in a healthy body, in order to achieve balanced physical and mental health Kleisiaris et al. (2014). They aimed to address both, the psychosomatic entities and the disease's symptoms, through health care and psychological support regardless the origin of the disease was the body or the soul. In this line, according to the Platonic view, many disharmonious states of the soul promote mental dysfunctions, which can be treated with harmony and musical rhythm, thanks to music imitating the movement of the soul. Not only in health-related issues, Plato and Aristotle considered music to be related to the complexities of human nature and the perfection of nature according Schoen-Nazzaro (2012), where both agree on these four ends of music: imitating or moving emotions, giving pleasure, disposing toward moral goodness and disposing toward learning. In the same vein, Stamou (2002) mentions that in ancient Greek there was the belief that music had the power to affect people's attitudes and thoughts.

There is extensive literature that studies the positive effect of music on mental health. Studies such as the one of Rebecchini (2021), affirms how music intervention with patients with mental disorders, has had a positive effect on their mental health. Due to mental illnesses can be costly in terms of psychological care and medication, music could play an important role in this sense. Daily musicking, defined as a minimum of 1 hour of singing or playing a musical instrument per day, is associated with better self-reported health, than individuals that weren't musically active, according to the Danish study by Ekholm et al. (2016). In this regard, according to Sihvonen et al. (2022), pain research is paying higher attention to the evaluation of some music-based complementary treatment, which has emerged as an efficient tool in enhancing the management of acute and chronic pain. Sihvonen et al. (2017), had previously exposed that music-based interventions are emerging as promising neurological rehabilitation strategies, where a large number of studies affirm its positive effect on dementia and stroke cases.

Apart from the aforementioned, music seems to play an important role in emotion regulation and works in favor of the improvement of depressive symptoms, and health-related quality of life in regard to Geipel et al. (2022). In this direction Clift and Morrison (2011) describes how a network of seven singing groups was established in East Kent (UK), which met three times per week; and demonstrated that group singing can have important benefits in boosting the recovery of people with a history of serious and enduring mental health problems. Depression is mainly treated by psychotherapy, pharmaceutical treatments, and electroconvulsive methods. With the main goal of assessing, the music-based therapies for treating depression, Castillo-Pérez et al. (2010) compare the effects of music on depression, with the effects of psychotherapy. They conclude that the group that used music therapy experienced fewer depressive symptoms than the psychotherapy group.

Music therapy may also play a leading role in terms of cost-effectiveness. Depression treatments may increase the economic burden that many countries' public health afford. Pérez-Sola et al. (2021) states that there exist some patients diagnosed with depressive disorders, who show signs of treatment-resistant depression (TRD). This kind of patient have significantly higher costs than the non-TDR ones. In response to the above, some evidence exposes how music-based treatments may be more cost-effective in front of other traditional health treatments. Walworth (2005) describes how music therapy-assisted pediatric procedures, which eliminate the need for sedation and RN supervision, save an estimated amount of \$228,450.00 per year. In the case of Intensive Care Unit (ICU) patients receiving mechanical ventilatory support, Chlan et al. (2018) exposes that treatments based on musical listening with preferred selection, can both reduce ICU costs, and adverse side effects. Patients that receive mechanical ventilation and began with self-initiated music listening, enjoy a lower level of anxiety and sedation, so this type of patient saves approximately a value of eight times the cost of the patient without the music listening. Consequently, the cost-effectiveness analysis of the music-based treatments may be extrapolated to patients with mental health diseases or depression.

Not only in terms of health, but there are also some practical cases like the one described by Egana-delSol et al. (2019), related to the positive effect of the practice of music on the development of cognitive and non-cognitive abilities,

as in the case of the Curanilahue Orquesta in Chile. In this study, the authors prove how the participation of vulnerable children from the Curanilahue commune in the Youth and Child's Orquesta has a positive effect on their educational attainment. Besides that, it is worth mentioning the case of the National System of Youth and Children's Orchestras and Choirs of Venezuela, founded in 1975 by the Venezuelan musician Jose Antonio Abreu, originally named "Accion Social para la Música" (Social Action for Music). This very well-known music program, since its foundation has received a big number of awards due to its contribution to the country, such as the Prince of Asturias Award for the Arts in 2008, Abreu's distinction as UNESCO's Goodwill Ambassador in 1998.

These highlighted cases are not the only programs where music has been used as a vector of life improvement, in social or educational terms. The Medellin Network of Music Schools (REMM) - Red de Escuelas Musicales de Medellin - is another public policy initiative where music has been used as an instrument for social transformation, as Gómez-Zapata et al. (2021) explains in their study. In the 90s, Medellin (Colombia) was suffering high levels of violence due to paramilitarism and common delinquency bands called "combos". Children were the main actors in this problem, suffering from violence and boosting it. In 1996 the REMM was funded, which subsequently became a public policy instrument of Medellin's City Council, and from 2002 to 2005, it was financed by the Iberoamerican Development Bank (IDB), highlighting the importance of this cultural initiative for social transformation.

In order to show further examples of the cross-cutting usefulness of music, Hallam (2010) explains in her work how music engagement during important growth periods of the young's, has a positive impact on their educational attainment. In line with previous articles, Yang (2015) and Southgate and Roscigno (2009) work on studies to analyze the causal effect of music practice in education in Germany, and the USA. On the other side, the presence of culture and music seems to be an important factor for economic improvement in different regions, due to they attract high-skilled workers, according to Falck et al. (2018).

As discussed in this section, music plays a transversal role in the daily lives of many individuals, beyond the work it may play in mental health. As has been proven through different historical events, music has been used as a powerful tool for social transformation, or political issues. Ward (1998) illustrates that American popular music, "Rhythm and Blues", helped to spread the idea among blacks and whites that racism was to be overcome, which absorbed the shifts in the black masses' consciousness. The author either mentions how blues music assisted black people in reaching ownership and management positions within the music industry. Rhythm and blues music and his heritage, not only highly influenced society in the USA. Here is the case of Reggae, the evolution of American popular music in the Caribbean island Jamaica, which played a significant role in the independence of the country - declared by UNESCO as Intangible Cultural Heritage of Humanity in 2018² -. The following work, "Music and the Rise of Caribbean Nationalism: The Jamaican Case" Freeland (2011) disseminates how Jamaican popular music, through its lyrics and rhythms, created a metaphorical, emotional and political meaning that reinforced Jamaican nationalism, and worked in favor of the emancipation of the former British colony.

Baoueb (2020) studies the case where hip-hop music is used to globalize the Tunisian problem and criticize the local social and political degeneration. To conclude, it is worth mentioning the seminal study by Mellander et al. (2018), where they explain how geographical differences in the USA reflect the economic and political division of the society. As this section exposes, the usefulness of music can be understood transversally and not only in terms of mental health and well-being improvement, despite it is the core of this study.

2.3 The impact of music on the Sustainable Development Goals (SDG)

As far as we are facing a crucial moment in global development, promoting a more sustainable life through the Sustainable Development Goals (SDG) from the United Nations Agenda 2030 has become extremely important, where music could contribute. This development agenda launched by a UN Summit in New York on 25-27 September 2015, is composed of 17 different SDGs, 169 targets, and 232 different indicators. Although the influence of music can be seen as transversal along the SDGs, this study focuses on mental health and well-being benefits through musical practice and consumption,

²<https://ich.unesco.org/es/RL/el-reggae-de-jamaica-01398>

and how this can contribute to *SDG 3. Good Health and Well-being* achievement.³

In this line, using music as a potential tool for mental-health improvement, and well-being can help different countries and governments work in favor of goal "3.4. By 2030, reduce by one-third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being", from SDG 3, and more precisely to the indicator "3.4.2 Suicide mortality rate". Music practice and consumption work in favor of lowering individual and social stress loads, which may impact positively in lowering suicide rates in the long term. Not only in the above-mentioned target, but music practice, consumption, and music therapy treatments may help with target "3.5 Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol" through indicator "3.5.1 Coverage of treatment interventions (pharmacological, psychosocial and rehabilitation aftercare services) for substance use disorders". This indicator informs the extent to which a range of evidence-based interventions for the treatment of substance use disorder are available, and are accessed by the population in need of these in a country, region, or globally. As Ghetti et al. (2017) mentions, music-therapy treatments may help reduce the amount of substance used, as well as their frequency of consumption, or the severity of substance dependence. At the same time, it could play a complementary role to other psychosocial interventions such as cognitive behavioral therapy and social support, when treating the consequences generated by substance abuse.

This is not the first study that brings to the front the potential contribution of music to Agenda 2030. There are other studies, such as the one from the Center for Music Ecosystems (2022) called "Your Guide to Music and SDGs", that exposes successful cases where music is used for health affairs. According to it, there are some music initiatives working in this direction. Initiatives like Music in Care Homes in the UK, or Singing for Seniors are some of the cases mentioned before, which can work as important tools in aging and care crises. There exist evidence about the use of music to deal with diseases such as dementia or loneliness, as the authors of the document from the Center for Music Ecosystems (2022) affirm. A weekly concert, community choir, and engaging music program can be rolled out anywhere, to anyone, and it can significantly improve the health and well-being of those who take part in it.

It is worth recalling that in 2019, projects such as Music at Work Week were launched in the UK, with the partnership of the English National Opera, and important music industry brands such as Sennheiser or Gibson. The fact that many workers face heavy stress loads, due to the amount of work they have at their jobs, causes a negative impact on their daily lives, which is transformed into sleep problems, high levels of daily stress, and other types of health problems. This as a last resort, can highly distort the psycho-emotional stability and healthy daily routine, and in extreme cases over a prolonged period of time mixed with other negative factors, may trigger suicide cases.

3 The positive influence of music on mental health and well-being

There are different mechanisms through which music may affect the human body, improving individual well-being and mental health. In this respect, there exists extensive literature that argues in favor of different factors or mechanisms through which music works on facing this kind of disease. One of the listed mechanisms is the one related to the discipline and its effect on emotional stability. Discipline and daily stable routines prevent a life of highs and downs, which may help to avoid emotional and psychological dysregulation, and slow down the triggering of depressive disorders in the long run, or more acute mental health problems such as dementia or schizophrenia. Learning any kind of musical instrument requires high effort in terms of self-discipline, persistence, and perseverance as Covay and Carbonaro (2010) mentions, imposing a stable routine thanks to daily musical practice.

Human nature is known to be social, and in periods where social interaction has been drastically reduced, the likelihood of occurrence of mental and physical diseases increases. During the COVID-19 pandemic period, social isolation was established for different periods, where the probability of experiencing depressive symptoms and anxiety conditions by children and adolescents, both during and after this time increased according to Loades et al. (2020). In

³Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development: <https://unstats.un.org/sdgs/indicators/indicators-list/>

this sense, the musical practice may help to face this problem due to its practice boosts social well-being, by instilling a sense of belonging to a group in individuals according to Covay and Carbonaro (2010).

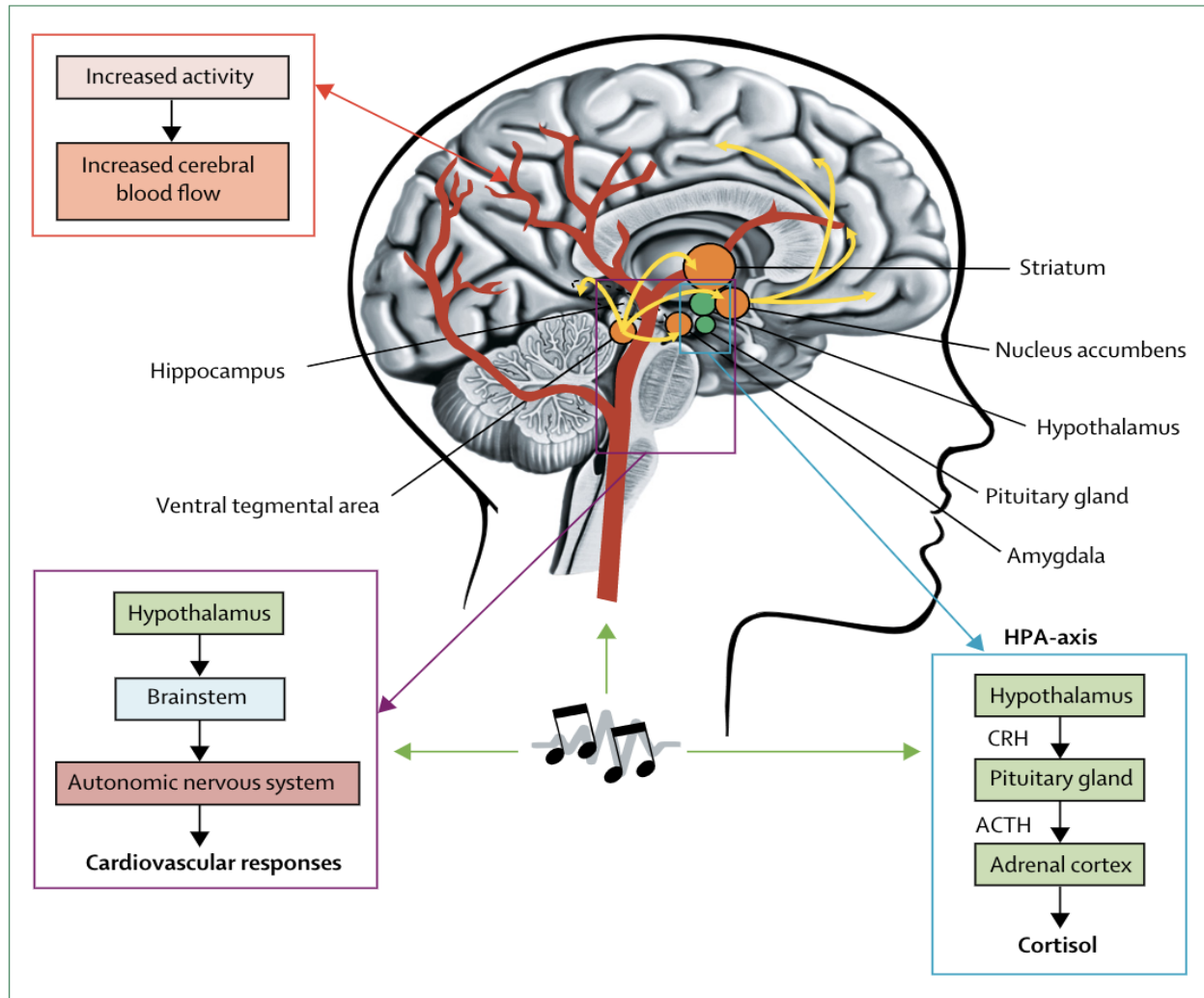


Figure 1: Possible neurobiological mechanism for the rehabilitative effect of music. Orange circles and yellow arrows represent the mesolimbic system, and the green circles represent the HPA axis. ACTH=adrenocorticotrophic hormone. CRH=corticotropin-releasing hormone. HPA axis=hypothalamic-pituitary-adrenal axis. Sihvonen et al. (2017)

According to Shipman (2016), individuals that spend time learning a musical instrument build during that span period peaceful and relaxing moments, that help to escape from the stresses of every day, preventing potential mental health issues in the long run. In her article, she explains how adults over 65 years old who participated in music playing reported self-esteem. Following this line of reasoning, people who play any type of instrument send positive signals to their social environments - for example through concerts or exhibitions, improving their social recognition- a fact that plays against social isolation and potential depression condition. Thanks to music, students learn how to collaborate with their peers. As far as they have to interact with each other in orchestras or bands, participants improve their social skills by staying away from the possibility of becoming isolated in life, and reducing the likelihood of developing depressive conditions

Some of the potential mechanisms can be understood in terms of brain activity, where music plays an important role in neurological rehabilitation. Music in its different forms, such as music training, learning, or listening has a direct effect on some parts of the brain, helping to modulate memory, attention, executive functions, mood, or pleasure. More specifically, music affects the dopaminergic mesolimbic system -the part that is in charge of regulating the before-mentioned capacities

and attitudes-, through the nucleus accumbens (Figure 1) according to Sihvonen et al. (2017). Patients that suffer from neurological disorders, seem to be positively affected by increased levels of extracellular dopamine, as a result of the activation of the nucleus accumbens, in response to music-generated intense emotional response. At the same time, music-driven mood improvement and relief of confusion, help recovering cognitive functions, while helping to face neurological problems and improving mental health. Not least, studies such as Särkämö et al. (2014) talks about the positive plastic effects in terms of memory, for individuals that listen to music.

Bateman (2015) confirms that cognitive problems are some of the core characteristics of mental health problems like schizophrenia, bipolar disorder, or depression, being cognitive enhancement one of the potential mechanisms through which music influences. Studies such as the one done by Schellenberg (2011), lists that music can help to improve cognitive skills through the following mechanisms: influence of subdomains of cognitive functions -auditory processing or visual memory- or through the stimulation of executive functions such as judgment and problem-solving. Seminal studies such as Koelsch (2009) also state that listening to music activates a wide range of brain structures, that are usually involved in cognition and emotional development, engaging processes like perception-action meditation or attention, which affects positively in the psychological and physiological health of the individuals.

The following academic work confirms that during improvisation, several cognitive processes are executed simultaneously, strengthening neural connections and facilitating a more efficient transfer connection. Joormann and Gotlib (2010) mentions how maladjusted emotion regulation, and sad moods or depressive conditions are related. Therefore another plausible explanation of the effects of music on depressive conditions is the fact that musical practice, or being part of music experiences helps in emotion regulation, as described by Baltazar and Saarikallio (2016)

4 Data

One of the big challenges, in order to be able to carry out this work, has been the limited availability of quality musical data. For this purpose, it has been used the SOEP - Core V37 of the Socio-Economic Panel. This longitudinal study of private households in Germany is carried out by the German Institute for Economic Research, DIW Berlin. The Socio-Economic Panel is one of the biggest longitudinal surveys worldwide, which takes place every year, where approximately 30,000 people and 15,000 households are interviewed. For this longitudinal database, information is collected at both, individual and household levels. Apart from the musical variables of interest, the database provides information about a big range of topics such as the necessary well-being or "mental health" indicators, family satisfaction, employment biographies, migration background, or education level. Information about hours of sleep during a weekday, paid work in the last 7 days or repeating a school year are included, which allows controlling of these characteristics in the empirical model.

One of the most valuable instruments included in the Socio-Economic Panel is the questionnaires on early life or retrospective questions on youth. These ask the interviewee if she plays an instrument or pursues singing seriously, what type of music she makes, if it is done alone or in a group, how old the interviewee was when she started playing music, or if she has even taken music lessons outside of school, framed within the section of leisure time. It is not very common to have this type of information included in a longitudinal database. This gives the possibility of addressing the impact of music on well-being and mental health, from different perspectives. For the construction of the database that has been used in this study, the author combines the following datasets from the SOEP. *Individual questionnaire (pl)*, *Household questionnaire (hl)*, and the *Youth questionnaire for first-time respondents at age17 (jugendl)*, datasets containing respondents' direct information and reflecting the content of the survey instruments. SOEP team prepared datasets, *Generated household data (hgen)*, *Generated biographical information (bioparen)* and *Generated biographical information (biosib)*. The *ppfad* and *hbrutto* datasets, containing raw data have been also used in the construction of the main database.

The *Individual questionnaire (pl)* is the standard instrument of the SOEP, which has been part of it since the first year the survey was performed, in 1984. It asks for information on the individual level from all the members of the households that are over 18 years old, each year. Secondly, the *Household questionnaire (hl)* is the other core survey, being part

of the database since the same year as the individual questionnaire, where the head of the household is questioned on issues such as type of dwelling, neighborhood, household net monthly income or expenses from renting/leasing, among others. Added to this, the *Biography questionnaire (biol)* - dataset not used in this case, due to the necessary biographical variables are obtained from the databases generated by the SOEP team- provides information on basic individual characteristics such as education, occupation, partnership/marriage, or nationality, which is needed to control along these individual traits. Finally, *Youth Questionnaire (jugendl)*, ask young people who turn 17 and are considered adults but don't participate in the biography questionnaire. The main purpose of the youth questionnaire is to substitute a bunch of questions that do not apply to a 17th year old young as relationships or employment history and substitute them with information about relationships with their parents, school or vocational training, or leisure activities such as musical practice. The latter was launched in 2000 and was answered together with the individual questionnaire, until 2005. Since 2006 only the Young Questionnaire was answered by the young.

More precisely, for the elaboration of this study, the *Youth Questionnaire (jugendl)* plays a key role, with the music variables as the core part of it. These music variables question several different topics, such as if the individual is musically active, the type of music played or trained in, if the individual has played in a group, band, or alone, and how old the individual was when she started instrument training or singing, which are the used ones in the empirical model to define the treatment of the treated group and subsequently compare it with the control group, formed with individuals that have not been part of any kind of music activity. The above-mentioned instrument asks about another type of activity related to music, such as how often the individual listens to music, plays or sing, or if there is any kind of musical instrument at home among others, but these variables are not used in the study. In reference to the databases generated by the SOEP team, the *Generated household data (hgen)* contains household data. The database *bioparen* contains biographical variables about the respondent's parents and background, meanwhile, in *biosib* variables about siblings living in the same household are available. As above-mentioned, variables such as the german federal state in which the household is located, are obtained from the raw databases *ppfad* and *hbrutto*, among others.

Individual questionnaire (pl) offers a wide range of variables through which the different levels of mental health can be measured. Among others, the survey asks the respondents if they have ever been diagnosed with depressive psychosis or dementia by a doctor, or how often have been bothered over the last two weeks by any of the following problems, defined as depressive traits: little interest, depressed, nervous and worries can't stop. One of the most remarkable aspects of the *Individual questionnaire (pl)* is that it includes questions from the SF-12 health questionnaire. The SF-12 questionnaire, used in seminal studies such as the one of Grozdev et al. (2012), is one of the most used instruments to evaluate the multidimensional health-related quality of life, worldwide. It includes important variables that measure the level of mental health/wellbeing of the respondent, which answers the question of *How often in the last four weeks found himself in one of the following situations*: pressed, run-down, or melancholy, well-balanced, energetic, accomplished less due to emotional problems, or less careful due to emotional problems, being these variables the used ones in the study (Table 1).

Recalling, young respondents provide musical information when they are 17 years old, at that age the *Youth Questionnaire (jugendl)* survey is realized. From 18 years of age and older, individuals - using in the database constructed, those who previously participated in the survey of young people - take part in the *Individual questionnaire*, where they respond to questions related to mental health and well-being. This study uses data for even-numbered years, from the period of time 2002 to 2020, due to SF-12 multidimensional health questions are asked each 2 years. Although it is a longitudinal database, the musical variables to be used do not have a specific time reference, which rules out the use of empirical methods such as diff-in-diff.

In reference to the used variables, Table 1 shows the most important and some explanations for these. Table 2 shows some descriptive statistical values for the music and mental health/well-being variables. The rest of the variables used in the study can be seen in Table 9, and Table 10 in Appendix A. It is worth mentioning that the music variables used are constructed on the basis of variables provided by the database. The first treatment dummy variable *How often play music or sing*, which defines whether the respondent sings or plays an instrument at least once a week, is constructed on the basis of the categorical variable, *How often play music or sing*. Regarding the second treatment dummy variable, it is constructed on the basis of the variables *Musically Active*, which defines whether the respondent is musically active or not, and the variable *Musical Lessons Outside Of School*, which defines whether the young person has received musical lessons outside of school. Therefore, this treatment variable determines the two conditions, since the interview gives way to asking whether the respondent has received musical lessons outside of school, once the young has answered that

is musically active.

Table 1: List of the main variables of interest

Variable	Years	Measure	Dataset
How Often Play Music Or Sing	2000-2020	1. Every day - 5. Never	jugendl
Musically Active	2000-2020	1. Yes - 2. No	jugendl
Musical Lessons Outside Of School	2000-2020	1. Yes - 2. No	jugendl
Pressed For Time Last 4 Weeks	2000-2020 (Even years)	1. Always - 5. Never	pl
Run-down, Melancholy Last 4 Weeks	2000-2020 (Even years)	1. Always - 5. Never	pl
Accomplished Less Due To Emotional Problems	2000-2020 (Even years)	1. Always - 5. Never	pl
Less Careful Due To Emotional Problems	2000-2020 (Even years)	1. Always - 5. Never	pl

Full list of variables in *Appendix A. Table 9*

Run-down variable, Melancholy Last 4 Weeks, is used in the OLS model. As independent variables of interest, the frequency with which the young plays music or sings, and if she has received musical lessons outside the school are included. In these regressions, it is controlled for the following variables, *Grade Mathematics*, *Sex*, *Year*, *Grade Repeated*, *Paid Work In Last 7 Days*, *Nationality of Mother*, and *Hours of Sleep, Normal Workday*, which are expected to influence the young's mood or level of depression. In the case of the Propensity Score Matching methodology, *Pressed For Time Last 4 Weeks*, *Run-down, Melancholy Last 4 Weeks*, *Accomplished Less Due To Emotional Problems*, and *Less Careful Due To Emotional Problems* variables are used, in order to obtain the difference in Average Treatment effect for the Treated group (ATT), and analyze whether there is a causal relationship between musical practice and well-being. Not least, a series of controls - observable characteristics - are defined in order to define the individuals to be treated.

Young people who attend music classes are defined by a number of characteristics, which differentiate them from those who do not participate in these types of activities. In the first place, the academic level of the young and her environment are conditioning factors for the propensity to participate in musical activities. Historically, households with a higher level of education have had members who have attended music classes to a greater extent. In this sense, the variables *Grade Mathematics*, *Grade German*, *Grade 1. Foreign Language*, and *Year, Grade Repeated*, are used as proxies to measure her academic level. The educational level of the mother is also measured, by means of the variable, educational level of the mother - constructed through the variable *Vocational Training Mother* -, where the lowest value (1) defines that the mother has not completed Vocational Training studies, and the highest value (3) indicates that the mother has completed university studies. The migration status of the mother is also taken into account, due to immigrant families are less likely to include their children in music classes.

On the other hand, it is important to consider variables such as *Monthly Household Net Income*, since enrolling young people in extracurricular music classes involves an extra expense that not all families will be able to bear. It is worth mentioning that the influence of family income may not be as significant in a country like Germany, and may be more pronounced in underdeveloped countries. Also, the variable *Condition Of House* is included as a proxy for household socioeconomic status. It is considered important to control for the number of siblings the young person has, given that the more siblings, the more likely it is that their family environment will want to devote fewer resources to her musical studies.

Finally, a series of variables that show the tendency of parents to be concerned about their children's education are taken into account; given that the greater their involvement, the greater the tendency for them to want their children to enjoy complete education and enroll them in musical activities. For this purpose, dummy variables that indicate whether parents take part in Parent Teacher Association (PTA) meetings, whether they visit the teacher during and outside school hours, whether they are school representatives, or whether they do not participate in any kind of activity are included. Another variable is also added, which indicates whether the parents help their child to study. Finally, the German *Federal State* of residence variable is used when controlling for state fixed effects. The full list of variables can be found in Table 9 of Appendix A.

Table 2: *Descriptive statistics of the main variables of interest*

	Mean	SD	Min	Max	N
How Often Play Music Or Sing	3.80	1.53	1.00	5.00	36,693
Musically Active	1.73	0.44	1.00	2.00	36,815
Musical Lessons Outside Of School	1.27	0.44	1.00	2.00	9,969
Pressed For Time Last 4 Weeks	3.03	1.00	1.00	5.00	19,269
Run-down, Melancholy Last 4 Weeks	3.60	0.97	1.00	5.00	19,255
Accomplished Less Due To Emotional Problems	4.39	0.93	1.00	5.00	19,174
Less Careful Due To Emotional Problems	4.46	0.86	1.00	5.00	19,146

Full list of variables in *Appendix A. Table 10*

5 Empirical approach and results

5.1 Pooled Ordinary Least Squares

As a first approach, the following Table 3 gives the output of 5 different OLS regressions. The used data is from the even years, in the time period from 2002 to 2020, for which observations for the dependent variable are available. As mentioned in the Data section, the variable *Run-down, Melancholy Last 4 Weeks* from the SF-12 health multidimensional questionnaire, is used as the dependent variable, measuring the level of the mood of the respondent in the five regressions. It answers the question, *How often have you felt Run-down, Melancholy in the last 4 weeks?*, where 1 (Always) is the highest value, and 5 (Never) is the lowest.

As main independent variables of interest, the frequency with which the young plays music or sing and if she has received musical lessons outside the school are included.

Table 3: Pooled OLS output table

	(1)	(2)	(3)	(4)	(5)
How Often Play Music Or Sing	0.0398** (0.019)	0.0425** (0.018)		0.0380** (0.019)	
Grade Mathematics	0.0372** (0.015)	0.0367** (0.015)	0.0645** (0.026)	0.0430*** (0.016)	0.0689** (0.028)
Sex	-0.287*** (0.060)	-0.306*** (0.060)	-0.260** (0.112)	-0.307*** (0.060)	-0.272** (0.116)
Year, Grade Repeated	-0.0153 (0.076)	-0.0198 (0.075)	-0.0148 (0.160)	-0.0113 (0.076)	-0.00404 (0.167)
Paid Work In Last 7 Days	0.0787 (0.062)	0.0743 (0.061)	-0.00563 (0.118)	0.0390 (0.062)	-0.0170 (0.124)
Nationality of Mother	0.120 (0.102)	0.113 (0.101)	0.166 (0.234)	0.0935 (0.101)	0.107 (0.238)
Hours of Sleep, Normal Workday		0.117*** (0.026)	0.103** (0.051)	0.121*** (0.026)	0.106** (0.052)
Musical Lessons Outside School			0.122 (0.130)		0.167 (0.138)
Time fixed effects	No	No	No	Yes	Yes
State fixed effects	No	No	No	Yes	Yes
r2	0.0353	0.0540	0.0583	0.0830	0.108
N	1021	1021	298	1021	298

Standard errors in parentheses

Dependent variable: Run-down, Melancholy Last 4 Weeks [1. Always - 5. Never]. A lot of endogeneity in this specification.

Ind. Variables: How Often Play Music or Sing [1. Every day - 5. Never], Music Lessons outside School [1. Yes - 0. No]

Data source: SOEP - Core V37

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

It is noteworthy that in the 5 columns, variables relating to mathematics grade, sex, and hours of sleep in a normal work day are statistically significant. Regarding the music variables, *How Often Play Music Or Sing* is statistically significant at 5% in the three regressions, while *Musical Lessons Outside School*, does not appear to be statistically significant in any of the cases. *Grade Mathematics* is used as a proxy for the level of education of the young. It appears

intuitive that the better math grades or educational level, the young sit with a higher mood, as shown in all cases. According to the *Sex* variable, in all of the cases when female - 1. Male, 2. Female -, the individual has felt run-down or melancholy most often. For the variable determining hours of sleep, when the number of hours increases the mood improves.

In reference to music variables, the estimations provide different results. First, as the individual enjoys more musical activity, she shows a worse mood in the last 4 weeks. Second, although not statistically significant, when reporting having attended music lessons outside of school, she reports not having felt depressed as often during the last four weeks. When comparing output (4), with output (3), where *Hours of Sleep, Normal Workday* variable has been included in both cases, controlling for fixed effects, slightly corrects the coefficient of the variable, *How Often Play Music Or Sing*. Notwithstanding, noting the R² values in the 5 cases, these results cannot be understood in the context of a musical causality on the state of mind. Only correlation conclusions can be drawn.

Finally, there are potential endogeneity problems, for which the OLS regressions do not correct, as omitted variable bias or measurement error, due to *Run-down, Melancholy Last 4 Weeks* is a health self-reported variable, an important source of bias in these cases. Because the decision to take music lessons or develop a musical activity is not made randomly but is based on a series of characteristics of the individual and her environment, such as socio-economic status, level of education of the individual and her parents, or propensity to culture, a problem of selection bias could be incurred. To correct this, PSM quasi-experimental methodology is used.

5.2 Propensity Score Matching

As mentioned in the previous subsection, the decision to sing or play music, or take music lessons outside school is not a random fact. In this sense, it has been decided to use the Propensity Score Matching methodology to measure the causal effect of musical practice on mental health and well-being, which would simulate an RCT. Seminal studies such as the one of Gómez-Zapata et al. (2021), analyze the effect of musical practice on marginalized individuals in Colombia and its potential benefits, or Hille and Schupp (2015), make use of this technique. The main goal of this empirical methodology is to create a control group, which works as a counterfactual, that is going to be similar in the observable characteristics, to the treated group. For this purpose, is assumed that treatment participation is based on some selected observable characteristics of the individuals, while assuming that unobservable characteristics do not condition it.

In this line, taking into account the observable characteristics that are going to conditionate the participation of the individuals, propensity scores are calculated for each individual in the treatment and control groups. Once each individual has been assigned a propensity score, individuals in the control group and treatment group who have similar propensity scores are matched - there are different rules for this, such as Nearest Neighbor matching (NN) where individuals with the closest propensity score are linked⁴ - which allows the causal effect of the treatment on the variable of interest to be measured. As stated before, no unobserved characteristic should be a conditioning factor in the treatment participation, otherwise, biased estimates would result.

In order to apply this technique in a robust way, there are a number of conditions to be taken into account when proceeding. According to Gertler et al. (2016) (Figure 2) the condition of common support has to be fulfilled. The range of propensity scores assigned to individuals in the control group, and the treatment group has to be matched. In this case, individuals from either group, with propensity scores above or below this common space will be eliminated and disregarded. In case the common support condition is not validated, it will not be possible to proceed with this methodology. Another important condition is the balancing property, where after matching it is checked that there is no significant difference in the mean values of the control variables, between the treatment group and the control group. Finally, the Conditional Independence Assumption (CIA), must be satisfied. It states that after conditioning on a set of observed covariates, treatment assignment is independent of potential outcomes.

As described, one of the most important steps when using Propensity Score Matching is to define the observable characteristics that are going to determine the treatment. As in the previous subsection, two treatment statuses are going

⁴There are other of matching procedures: i. Caliper and radius, ii. Metric matching, iii. Stratification and interval matching, iv. Kernel or v. Local linear matching

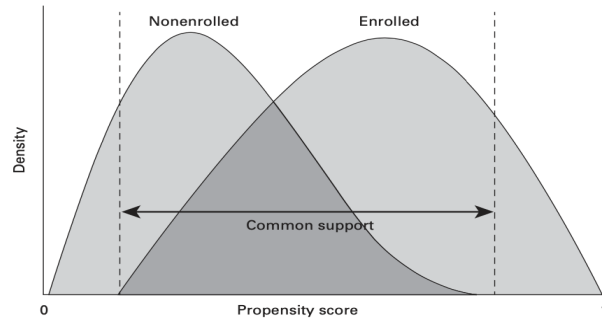


Figure 2: *Propensity Score Matching. Common Support. Gertler et al. (2016)*

to be considered in this part. The first one refers to individuals who sing or play an instrument. The second treatment group, and the one of greatest interest in this study, corresponds to young who have declared themselves to be musically active, and have received music lessons outside school. It is considered that the individuals belonging to this second treatment group may have had a greater depth in the practice of music, because they have been constant in their musical study, and, therefore, this activity may have a greater impact on their state of mental health or well-being. Unlike in the previous subsection, where the variable *Run-down, Melancholy Last 4 Weeks* was exclusively used, in order to make a light robustness check of the results, the following variables are included across this methodology: *Pressed for time Last 4 weeks*, *Accomplished less due to emotional problems Last 4 weeks* and *Less careful due to emotional problems Last 4 Weeks*. It is worth mentioning that the used data for the elaboration of the Propensity Score Matching corresponds to the even years of the following time period 2006 - 2014.

Prior to the calculation of the ATT difference, a probit model is used to calculate the propensity score, as shown in Table 4. In columns (1) and (2) the dependent variable corresponds to whether the young person usually sings or plays an instrument, and in columns (3) and (4) the one related to if the young person has received music lessons, being the latter the treatment of greatest interest in the present study. The full list of control variables used, has been described in the data section. It is worth noting that the probit model controls for German federal state of residence -state fixed effects-, and time fixed effects. It is assumed that there is no unobserved variables conditioning participation in musical activities. It could be the case that certain skills or cognitive abilities of the young person condition the progress in musical learning, but not their participation in musical activities as such.

Results vary depending on whether the dependent variable is the frequency of musical practice by the young person, or whether the young person has attended music lessons. It is clear the importance of the mother's level of education and family income, which seem to condition the young person's participation in musical activities in the same direction in all four cases, as well as it is statistically significant at 1%. The higher the mother's level of education and family income, the higher the probability that the young person will be involved musically - musical classes outside the school dependent variable's marginal effect is 0.502 in (3) when the mother's education increases one level, and 0.585 in (4) when controlling for fixed effects-.

The main results of interest are in columns (3) and (4). Age variable, significant at 1% in column (3) and 5% in column (4), indicates that the probability of participation decreases with age. Sex variable -significant at 1%- shows that females are less likely to participate in extracurricular music classes, which would confirm the existence of gender inequality in this field. In regard to mathematics grade, it would be expected that the higher the educational level -better grade-, the higher the probability of participation, something that the results does not show. This can be observed with the other language grade variables, but they are not statistically significant. It could be that *Grade Mathematics* is not a good proxy to measure the academic level of the young person, or to the fact that an individual who obtains better grades in maths demands more time outside school to study, time not dedicated to cultural activities.

The variable *Year, Grade Repeated* takes value 2 when the young person has not repeated a grade, and 1 when she has. A pupil who has not repeated a grade has a higher educational level, which confirms that the higher the educational level, the greater the probability of receiving music lessons. In the case of the mother's nationality variable, it is significant in both cases, and it confirms that in case the mother is a foreigner, the probability that she points her offspring to musical

Table 4: Probit Output table

	(1)	(2)	(3)	(4)
Age	-0.0400*** (0.007)	-0.0493*** (0.007)	-0.0276*** (0.011)	-0.0280** (0.011)
Sex	-0.0486 (0.039)	-0.0315 (0.040)	0.299*** (0.065)	0.273*** (0.068)
Grade Mathematics	0.00500 (0.019)	0.00814 (0.019)	-0.148*** (0.030)	-0.167*** (0.031)
Grade 1. Foreign Language	0.0618*** (0.019)	0.0574*** (0.019)	0.0202 (0.033)	0.0522 (0.034)
Grade German	-0.0891*** (0.024)	-0.0928*** (0.024)	0.0730* (0.039)	0.0629 (0.041)
Year, Grade Repeated	0.0876* (0.049)	0.0695 (0.050)	0.312*** (0.085)	0.350*** (0.087)
Mother's education level	0.186*** (0.044)	0.228*** (0.045)	0.502*** (0.074)	0.585*** (0.078)
Nationality of Mother	0.0834 (0.065)	0.0533 (0.067)	-0.193* (0.113)	-0.266** (0.125)
Monthly Household Net Income (EUR)	0.0000604*** (0.000)	0.0000484*** (0.000)	0.0000622*** (0.000)	0.0000557*** (0.000)
Condition Of House	-0.0304 (0.036)	-0.0442 (0.038)	-0.151** (0.059)	-0.115* (0.061)
Number Of Siblings in SOEP	0.00543 (0.018)	0.00890 (0.018)	0.0136 (0.027)	0.00839 (0.029)
Parents take part in parents-evening	0.109* (0.057)	0.0805 (0.059)	0.0799 (0.092)	0.0535 (0.098)
Parents come to teacher office hour	0.0228 (0.042)	-0.00771 (0.045)	-0.233*** (0.071)	-0.190** (0.076)
Parents visit teacher outside office hour	-0.0206 (0.048)	-0.0197 (0.049)	-0.0780 (0.080)	-0.144* (0.084)
Involved as parents representatives	-0.0496 (0.053)	-0.0669 (0.055)	0.287*** (0.088)	0.359*** (0.092)
Parents not involved	-0.0282 (0.090)	-0.0401 (0.092)	-0.412*** (0.146)	-0.491*** (0.155)
Parents help with study	-0.178*** (0.046)	-0.149*** (0.047)	-0.0456 (0.076)	-0.0329 (0.079)
Time fixed effects	No	Yes	No	Yes
State fixed effects	No	Yes	No	Yes
N	6210	6164	2034	2034

Standard errors in parentheses

Dependent Variables: (1) (2) How Often Play Music or Sing [1. Minimum once per week, or more - 0. Less than once per week or never]

(3) (4) Music Lessons outside School [1. Yes - 0. No]

Data source: SOEP - Core V37

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

activities is reduced. Regarding the variables defining parental involvement with the child, mixed results are obtained. In both cases, the dummies that indicate that the parents are school representatives, increase the probability of treatment, while the dummy indicating that the parents are not involved, reduces the probability of participation in extracurricular musical activities on the part of the child.

The results given by the dummies indicating that parents meet with the teacher, -in the opposite direction to what would have been expected- are striking at a first sight. Parents may meet more regularly with teachers because their child is performing poorly at school and they have a need to continuously follow up with the school teachers. Thus, this variable would not strictly be indicating parents' closeness to their children, but rather the young's poor academic performance, therefore, reducing the likelihood of being enrolled in music lessons. In order to control for possible endogeneity problems, fixed effects are included, which corrects for the bias of variables such as the mother's level of education, or the mother's nationality, among others.

Table 5: Propensity Score Matching output

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Pressed For Time Last 4 weeks	Unmatched	2.43758389	2.42463235	.01295154	.099131627	0.13
	ATT	2.45815603	2.06879433	.389361702	.16429884	2.37
Run-down, Melancholy Last 4 weeks. No F.E.	Unmatched	3.06040268	3.01470588	.045696802	.106034649	0.43
	ATT	3.05034965	3.04195804	.008391608	.167841862	0.05
Run-down Melancholy last 4 weeks	Unmatched	3.06040268	3.01470588	.045696802	.106034649	0.43
	ATT	3.0787234	2.68510638	.393617021	.173984105	2.26
Accomplished less due to emotional problems. No F.E.	Unmatched	3.86644295	3.75	.116442953	.115724216	1.01
	ATT	3.86713287	3.79160839	.075524476	.182488255	0.41
Accomplished less due to emotional problems.	Unmatched	3.86644295	3.75	.116442953	.115724216	1.01
	ATT	3.89858156	3.38652482	.512056738	.190648004	2.69
Less careful due to emotional problems	Unmatched	3.9295302	3.8125	.117030201	.115703157	1.01
	ATT	3.95957447	3.38652482	.573049645	.190794306	3.00

Treatment Variable: Music Lessons Outside School.

S.E. does not take into account that the propensity score is estimated.

Once the propensity scores are obtained, individuals with similar values are matched. For this, the Nearest Neighborhood (NN) criterion is used, where each individual from one group is matched with the individual from the other group with the closest propensity score. Table 5 shows the outcomes of the individuals in the control group and those in the treatment group, for each of the mental health/wellbeing outcome variables mentioned above, when treated are the young that received music lessons outside school hours. The causal effect of music lessons on mental health and well-being is measured in terms of the difference in ATT, between individuals in one group and another, for each outcome variable. As can be seen in all four cases, the response of the individuals with respect to their mood improves when they have received music lessons, as the differences are positive.

The results can be considered significant at 5% for the variables *Pressed For Time Last 4 weeks* and *Run-down, Melancholy Last 4 weeks* since the T-stat value is higher than 1.96. In the case of variables *Accomplished less due to emotional problems* and *Less careful due to emotional problems*, the results are significant at 1%, as their T-stat is above the cut-off value of 2.58. The results of the variables *Run-down, Melancholy Last 4 weeks*, and *Accomplished less due to emotional problems* are also included for the case in which the probit regression did not control for fixed effects, where although the ATT difference remains slightly positive, the results are not statistically significant.

Table 6: Propensity Score Matching output

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Run-down	Unmatched	3.20277778	3.29681353	-.094035755	.062023827	-1.52
Melancholy last 4 weeks	ATT	3.19888476	3.10966543	.089219331	.099773419	0.89

Treatment variable: How Often Play Music or Sing

S.E. does not take into account that the propensity score is estimated

Table 6 shows the results *Run-down, Melancholy Last 4 weeks* variable when the treatment group is defined as those who sing or play an instrument at least once a week, if not every day. As can be seen in this case, the effect is not statistically significant.

Table 7: Common support

Treatment assignment	Off support	On support	Total
Untreated	0	544	544
Treated	80	1410	1490
Total	80	1954	2034

Lastly, Table 7 shows some data about the common support, when the treatment group is defined as the young guys who received music lessons, and fixed effects controls have been included -the main case of analysis-. As mentioned above, it is strictly necessary that this condition is met, otherwise, no potentially comparable groups would be generated. Out of 2034 total observations, only 80 corresponding to the treatment group, have been left out of the common support. According to the 1954 observations that are established within the common support, 544 correspond to the control group and 1410 to the treatment group. Figure 3 shows that those individuals who have been left out, are those in the treatment group who enjoyed the highest probability of being treated.

Concerning the balancing property, I proceeded to test whether the differences in the means of the control variables of the treated and untreated individuals were not significant after matching. For this purpose, Table 8 with the corresponding values has been included in Appendix A. According to the obtained results, and following the criterion that the differences in the means are not significant when the difference is below 10%, in terms of what Zhang et al. (2018) proposes, the result of this robustness test can be considered positive. The only control that shows a bias above 10%, is *Involved as parents representatives* variable. To conclude, regarding the Conditional Independence Assumption (CIA) there is no way of proving it, it must rely on a theoretical argumentation. It says that the treatment assignment is independent of the potential outcomes after conditioning on a set of observed covariates. This can be validated in this case, as the young person's participation in music lessons is unlikely to be conditioned by her later mental state.

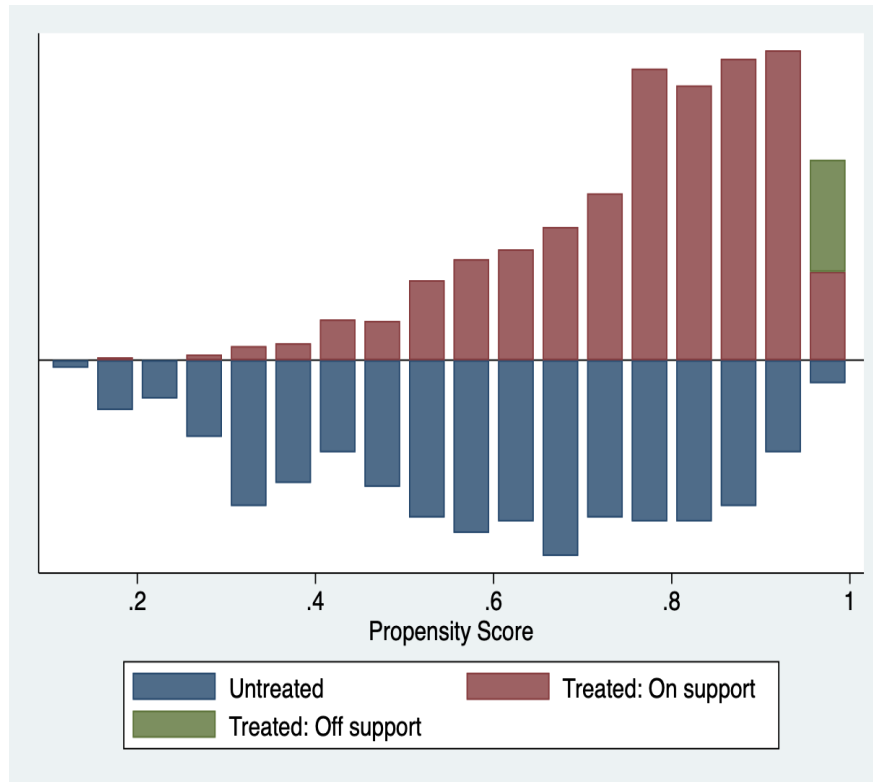


Figure 3: *Propensity Score Matching. Common Support.*

6 Conclusion

Music seems to be an important public policy instrument to face or prevent one of the big challenges the society will have to face globally, mental health problems and well-being. As described in this study, high levels of stress can jeopardize the individual and collective well-being levels that have been achieved over decades, in too many parts of the world. The fast pace of life, the lack of disconnection from the workplace, the post-COVID-19 pandemic period consequences, climate change, the war in eastern Europe and its potential consequences on energy and food markets, or the geopolitical tensions generated by the conflict between China and Taiwan, among others, seem to appear as important factors that will place more weight on the stress levels commonly endured. In a way, the musical practice in its different forms may work as a stabilized factor, thanks to its contribution in terms of discipline, socialization, improvement of cognitive abilities -which can be reflected in academic terms- or brain functioning, among others, as described before. On the other side, it can be used as a medical tool for existing cases of mental health illnesses, other health problems, or medical treatments as described by Blichfeldt-Ærø et al. (2020), which demonstrates its effectiveness as an accompanying treatment in invasive cardiac procedures, or İçel and Baçoğul (2021), who exposes that music therapy helps relaxation training in controlling anger and increasing sleep quality in chronic psychiatric patients. In other cases, as Schäfer et al. (2020) state, it can work as the treatment itself, whereas periodical musical listening works as a social surrogate, providing a solution to loneliness problems.

Not only in terms of being a useful tool for helping in the treatment of various diseases, but music-based health treatments may also reduce the economic burden that governments and public health care bear, due to the excessive cost that many drugs and technology have, when treating chronic mental health illnesses. Music therapy is a worldwide growing field, in line with what Kern and Tague (2017) says. In this sense, there are a certain number of academic institutions as the Norwegian Academy of Music - which is working on the path of strengthening music therapy studies-, or the Berklee Music and Health Institute ⁵ which promotes research in this field. Renowned institutions such as Harvard

⁵<https://college.berklee.edu/music-health-institute/remix>

Medical School⁶ have also pronounced themselves on the utility of music during the period of the COVID-19 pandemic to face the problems that have arisen.

Music therapy is a growing field. Despite music's benefits and contributions in different fields -not only in terms of health- such as economic development, or empowerment tooling in the fight against racial discrimination have also been proved over the years, there is not a big amount of high-quality open data that allows empirically demonstrating the before mentioned. Most of the scientific studies found during the elaboration of this master thesis, use their own source data or experimental data obtained for the case study. This fact hampers the elaboration of econometric studies that might deepen the economic research in music affairs. For this reason, there is an imperative need for national statistical institutes, public and private institutions, universities, or other types of organizations to collect data and create high-quality open databases, containing a wide range of musical variables -such as musical consumption, musical training, types of musical training, age at which the study of music is developed, music consumption levels for areas with different GDP per capita-, which will allow researchers in fields such as cultural economics work on this kind of academic literature. This at the same time may improve the quality of the public policy recommendations made by scientists and academic institutions, related to the utility music has for the whole society, and thus rescuing it from the lack of prominence it has suffered throughout history.

This study uses the non-parametric technique PSM, due to young people who participate in musical activities differ in several observable characteristics from those who do not. This allows a simulation of an RCT, addressing potential problems such as selection bias. For the matching of individuals with similar characteristics, from the control group and the treatment group, the propensity scores are calculated by probit regressions. In this way, the difference in ATT of the mental health/well-being variables between the two groups, measures the potential causal effect of musical participation on mental health wellbeing. As specified in the empirical approach and results section, two different musical treatments are defined, with the group that has attended music classes outside school hours being the one of main interest. Four variables - belonging to the SF-12 health questionnaire and used in other studies, such as in Grozdev et al. (2012) - are used to measure the different levels of mental state. Regarding the four variables measuring stress levels, young people who attended music classes outside school report better levels of well-being, where statistically significant and positive differences in ATT are obtained.

According to the results obtained in this study, it could be argued that there exist a causal relationship between the practice of music, and levels of mental health/well-being. It is worth to mention, the fact that there is practically no literature that analyses the hypothesis proposed by this work, using empirical methods, makes it difficult to validate the econometric technique used and the results with other studies. On the other hand, the usefulness of the variables selected to measure levels of mental health is debatable, given that there may be more appropriate variables that are not self-reported and are diagnosed by a physician.

In this regard, this study is intended to be a first scientific approach that may pave the ground for future academic studies, that will work in the same line with the main goal of deepening in the causal relationship between musical practice and well-being, and will take into account existing methodological deficiencies in the current work and literature, improving and strengthening the hypothesis of the usefulness of music in health affairs.

It also aims to expose the need for the promotion of music and music therapy treatments from public institutions. Cases as the one described by Gómez-Zapata et al. (2021), where a publicly promoted musical program in Medellín (Colombia) has had a huge impact on social or educational terms, demonstrate how music-based public policy initiatives have big contributions. The possibility of extrapolating them to fields such as health, by earmarking public and private investment items, may be a proper response to the growing problem of a depressed society and mental-health diseases. It seems reasonable to highlight the importance of investing in music education schools, in order to increase this kind of offer from an early age, and be used as a preventive tool to reduce future levels of depression and mental health-related problems, those young people may suffer. It also appears to be beneficial, to urge authorities to promote media campaigns on the contributions of musical practice and consumption in health, as has been done before with sport.

⁶Music and the brain. As COVID-19 spread insidiously around the globe this spring, people sought solace in music: <https://neuro.hms.harvard.edu/centers-and-initiatives/harvard-mahoney-neuroscience-institute/about-hmni/archive-brain-1>

Last but not least, music and its application in health treatments could help to achieve the SDG from the United Nations Agenda 2030. Its direct contribution to indicators "*3.4.2 Suicide mortality rate*" and "*3.5.1 Coverage of treatment interventions (pharmacological, psychosocial, and rehabilitation aftercare services) for substance use disorders*", adds a further argument to promote music-based health initiatives.

This is also the first academic work within the scope of health economics research, elaborated with a multidisciplinary perspective. Although it should not be forgotten that this work corresponds to the final work of the master's degree in economics, where the econometric analysis is the core part, the author includes touches from such diverse fields as historical philosophy, health or neuroscience, with the main goal of drawing a holistic picture and reinforce the idea that bringing different areas together enhances the usefulness of these.

To conclude, future research may work in the line of using panel databases, which would allow using another range of empirical techniques, such as diff-in-diff, to better address potential endogeneity problems and thus show more robust results. For this, there is an urgent need for quality open databases. Not only in terms of music's contribution to well-being and mental health issues, but it is also recommended to develop a future econometric study that it can encompass other branches where the contribution of music has been significant. It appears interesting to reinforce in terms of empirical approach academic works such as Freeland (2011), where music is exposed to be a potential political tool. Future research may be either focused on the role of music and culture in the economic development of different regions.

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Appendix A. Tables

Table 8: *Balancing control between matched treated and matched untreated*

Variable	Mean			T-test	
	Treated	Control	%bias	t	p > t
Age	21.178	20.893	9.4	2.55	0.011
Sex	1.5738	1.5993	-5.2	-1.38	0.169
Grade Mathematics	1.9504	2.039	-4.5	-1.13	0.261
Grade 1. Foreign Language	1.9922	1.9759	0.8	0.21	0.833
Grade German	1.9277	1.9638	-1.9	-0.49	0.626
Year, Grade Repeated	1.8823	1.8894	-1.9	-0.57	0.566
Mother's education level	2.1121	2.0816	6.4	1.81	0.071
Nationality of Mother	1.0433	1.044	-0.2	-0.09	0.930
Monthly Household Net Income (EUR)	4091.8	4080.4	0.5	0.12	0.908
Condition Of House	1.3028	1.3426	-7.3	-1.95	0.051
Number Of Siblings in SOEP	2.7965	2.7156	6.6	2.20	0.028
Parents take part in parents-evening	.80142	.78582	3.7	1.02	0.306
Parents come to teacher office hour	.57021	.55674	2.7	0.72	0.471
Parents visit teacher outside office hour	.21844	.22624	-1.9	-0.50	0.619
Involved as parents representatives	.23262	.18865	11.4	2.87	0.004
Parents not involved	.06596	.0766	-3.8	-1.10	0.272
Parents help with studying	.77801	.80071	-5.4	-1.48	0.140

Table 9: List of the variables used

Variable	Years	Measure	Dataset
How Often Play Music Or Sing	2000-2020	1. Every day - 5. Never	jugendl
Musically Active	2000-2020	1. Yes - 2. No	jugendl
Musical Lessons Outside Of School	2000-2020	1. Yes - 2. No	jugendl
Grade Mathematics	2000-2020	1. Grade 1 - 6. Grade 6	jugendl
Grade Foreign Language	2000-2020	1. Grade 1 - 6. Grade 6	jugendl
Grade German	2000-2020	1. Grade 1 - 6. Grade 6	jugendl
Year, Grade Repeated	2000-2020	1. Yes - 2. No	jugendl
Parents Take Part In Parents-Evening	2000-2020	1. Yes	jugendl
Parents Visit Teacher Outside Office Hrs.	2000-2020	1. Yes	jugendl
Involved As Parents Representative	2000-2020	1. Yes	jugendl
Parents Not Involved In Any Of Above	2000-2020	1. Yes	jugendl
Parents Help With Studying	2000-2020	1. Yes - 4. No	jugendl
Pressed For Time Last 4 Weeks	2000-2020 (Even years)	1. Always - 5. Never	pl
Run-down, Melancholy Last 4 Weeks	2000-2020 (Even years)	1. Always - 5. Never	pl
Accomplished Less Due To Emotional Problems	2000-2020 (Even years)	1. Always - 5. Never	pl
Less Careful Due To Emotional Problems	2000-2020 (Even years)	1. Always - 5. Never	pl
Paid Work In Last 7 Days	1999-2020	1. Yes - 2. No	pl
Hours of Sleep, Normal Workday	2008-2013, 2015, 2017, 2019, 2020	Number [0 - 18]	pl
Vocational Training Mother	Time constant	Classification [0 - 51]	bioparen
Nationality of Mother	Time constant	1. German - 2. Other	bioparen
Number Of Siblings in SOEP	Time constant	Number [2 - 12]	biosib
Monthly Household Net Income (EUR)	1984-2020	EUR	hgen
Condition Of House	1984-2020	1. Good - 4. Dilapidated	hgen
Federal State	1984-2020	Classification [1 - 16]	hbrutto
Year Of Birth	Time constant	Number	ppfad
Sex	Time constant	1. Male - 2. Female	ppfad

Table 10: Descriptive statistics of all variables

	Mean	SD	Min	Max	N
How Often Play Music Or Sing	3.80	1.53	1.00	5.00	36,693
Musically Active	1.73	0.44	1.00	2.00	36,815
Musical Lessons Outside Of School	1.27	0.44	1.00	2.00	9,969
Pressed For Time Last 4 Weeks	3.03	1.00	1.00	5.00	19,269
Run-down, Melancholy Last 4 Weeks	3.60	0.97	1.00	5.00	19,255
Accomplished Less Due To Emotional Problems	4.39	0.93	1.00	5.00	19,174
Less Careful Due To Emotional Problems	4.46	0.86	1.00	5.00	19,146
Year Of Birth	1,990	6	1,982	2,002	39,134
Sex	1.50	0.50	1.00	2.00	39,134
Grade Mathematics	2.96	1.05	1.00	6.00	33,670
Grade 1. Foreign Language	2.96	0.94	1.00	6.00	32,890
Grade German	2.89	0.83	1.00	6.00	33,719
Year, Grade Repeated	1.79	0.41	1.00	2.00	38,855
Vocational Training Mother	23.86	6.93	0.00	51.00	38,990
Nationality of Mother	1.09	0.29	1.00	2.00	39,028
Monthly Household Net Income (EUR)	3,533.56	2,240.74	0.00	70,000.00	36,065
Condition Of House	1.36	0.54	1.00	4.00	28,059
Number Of Siblings in SOEP	2.86	1.18	2.00	12.00	33,199
Paid Work In Last 7 Days	1.41	0.49	1.00	2.00	39,109
Hours of Sleep, Normal Workday	7.12	1.14	0.00	16.00	21,331
Parents Take Part In Parents-Evening	1.00	0.00	1.00	1.00	29,081
Parents Come To Teacher Office Hours	1.00	0.00	1.00	1.00	21,769
Parents Visit Teacher Outside Office Hrs.	1.00	0.00	1.00	1.00	8,679
Involved As Parents Representative	1.00	0.00	1.00	1.00	6,628
Parents Not Involved In Any Of Above	1.00	0.00	1.00	1.00	3,584
Parents Help With Studying	2.05	1.18	1.00	4.00	38,442