The Effects of Musical Genres and Age on Blood Pressure

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Abstract

This paper describes the results of a study conducted on finding the effects that different music genres and age have on blood pressure. Our purpose is to determine if a 30 minutes exposure to certain genres of music can significantly reduce blood pressure, and in turn reduce risks of cardiovascular disease and hypertension in different age groups. We used a balanced, basic two factorial design with interaction for our study, using three musical treatments (classical, dance, and no music) and three age groups (younger than 35, 35-54, 55 and older) for a total of 9 treatment combinations. We recruited 180 non-smoking participants from the island and randomly assigned treatments so that we had 20 participants in each treatment combination. We measured the blood pressure of all 180 participants, gave each of them a 30 minute exposure to music with its genre based on the treatment combination they were assigned to (those assigned to no music waited 30 minutes without music), and then measured their blood pressure once again. After analyzing our results, we found that neither classical music, dance music, nor the interaction between music genre and age had a significant effect on systolic or diastolic blood pressure. However, we did find that blood pressure, both systolic and diastolic, increased with age. From our study's finding, we can conclude that older people are more susceptible to hypertension than those in younger age groups, but listening to 30 minutes of classical and dance music does not reduce blood pressure, and thus cannot reduce risks of cardiovascular disease or hypertension in any age group.

Project Purpose and Rationale

It has been discovered through prior studies that music has both psychological and physiological effects on the human body. For example, before their races, many Olympic athletes would often listen to music to help ensure a better performance in their competition (Terry, P.C., & Karageorghis, C.I. 2006). In our study, we are particularly interested in studying the effects that different music genres have on blood pressure. While researching, we came across several interesting articles and literature reviews claiming that listening to about 25 minutes of classical music could help decrease chances of cardiovascular diseases by reducing blood pressure (Loomba, Arora, Shah, et al., 2012). In addition, studies have also indicated that

dance/pop music, such as those of ABBA, could also help reduce blood pressure, although to a lesser extent than classical music (Trappe, H; Voit, G 2016). Another factor that is very important to consider in our study of blood pressure is age. It has been commonly acknowledged, due to numerous studies conducted, that an increase in blood pressure is an inevitable consequence of ageing in industrialised societies (Pinto, E. 2007). In fact, elderlies are particularly susceptible to hypertension (abnormally high blood pressure), with isolated systolic hypertension (an elevation in systolic but not diastolic pressure) being the most prevalent in ages 55 and higher *(American Journal of Hypertension, 1997*).

By studying the effects that music genres, age, and their interaction have on blood pressure, our purpose is to find if introducing certain music into our lives for about 30 minutes a day could potentially reduce blood pressure overall, and thus potentially decreasing the chances of cardiovascular diseases in the future. In addition, we also look at the effects of age and music on systolic and diastolic blood pressure individually to see if they differ and to determine if music could specifically reduce the risk of isolated systolic hypertension (Kühlmann, Etnel, Roos-Hesselink, et al., 2016).

Hypothesis

The hypotheses to be tested in our study include:

1) Classical music and dance music both lower blood pressure, which classical music being more effective in doing so.
2) Blood pressure, particularly systolic blood pressure, increases with age.
3) Music genres affect the blood pressure of people in different age groups differently.

Study Aims

The aim of this study is determine the efficacy of different musical genres in reducing risks of hypertension and cardiovascular diseases for different age groups.

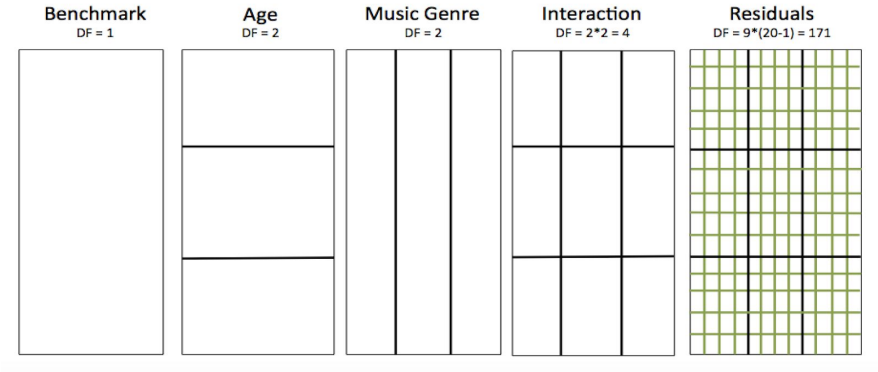
The specific objectives of this study are:

1) To determine the effects that classical music and dance music each have in decreasing diastolic and systolic blood pressure.
2) To determine if age increases blood pressure, in particular systolic blood pressure, which results in hypertension and isolated systolic hypertension for elderlies.

3) To determine if music genres affect the blood pressure of people in different age groups differently, and consequently determine if listening to 30 minutes of music can only reduce risk of hypertension and cardiovascular before or after a certain age.

Research Design and Methodology

Since age and musical genres are the two main factors we are interested in studying in terms of their effect on blood pressure, we decided to use the basic two factorial design with interaction. It will give us the best conclusion of whether these two factors affect blood pressure and whether they have an interaction effect as well.



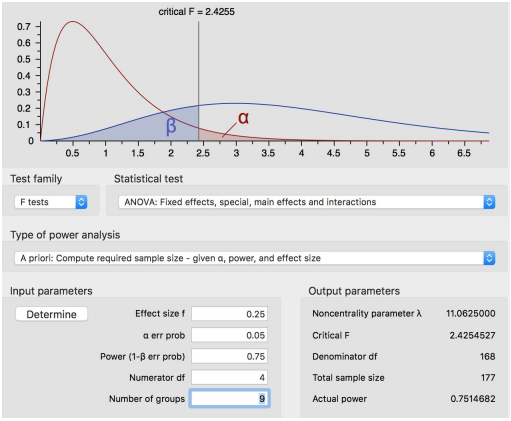
From background research, we found that smoking affects blood pressure (Abrams, Krimmel, Johnson, et al., 2017). Since we did not want to include it in our study as another factor, we decided to hold it constant to eliminate the effects of smoking. We purposefully surveyed all the islanders we were interested in and selected only the ones who did not have any history of smoking. We also decided to use classical music and dance music as the two genres of music in our study as previous studies have successfully indicated a reduction in blood pressure using these two genres. In order to have a control, we have a third group that would not have any exposure to music. Thus there are three different musical treatments: classical, dance, and no music.

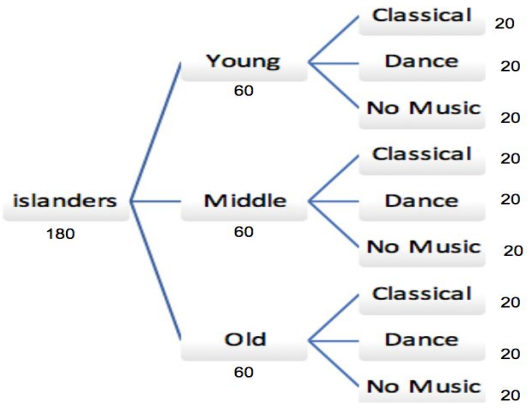
There are also three different levels for age: young (34 and younger), middle (35-54) and old (55 and older). Most studies indicated that hypertension is prevalent among people 50-55 years of age or older, so we seperated people 55 and older into the “old” age gro*up (American Journal of Hypertension, 1997*). Otherwise, we did not find any blood pressure related studies separating the remaining age groups into “young” and “middle”, so we looked up several studies on other topics that separated their participants into three age groups in order to determine the

most common way of separating participants into three age groups in experiments. Based on those, we decided on 35 years old to be the cut off between “young” and “middle” age group.

We used G-power to determine the sample size. Using a power of 0.75 and an effect size of 0.25, we have a total sample size of 177. Since we have 9 different treatments combinations, we round the number up to 180 to ensure a balanced design. Each age group has 60 people and each treatment combination has 20 people receiving it.

We used randomized assignment of treatments in our study by randomly assigning the three musical treatments to participants in each age group. Each age group (60 people) must have an equal number of participants receiving each of the three musical treatments (20 people) to get a balanced design. To do this, we used R. When we put our participants into a spreadsheet, they each occupied a row with a corresponding row number (2 to 181). Since we ordered them on the spreadsheet by age group, #2-61 were in “young”, #62-121 were in “middle”, and #122-181 were in “old”. We created 3 different vectors, one containing numbers 2-61 (A), another with 62-121(B), and a final one containing 122-181(C). We also created another vector (D) that contained 20 repetitions of “classical”, “none”, and “dance” each (total length of 60). We scrambled the order of A and D, and combined them into a dataframe with 60 rows so that each row has a participant number and a musical treatment. We repeated this procedure for vector B with D and C with D. Now each of the 180 participants as been randomly assigned a treatment and the design is still balanced.



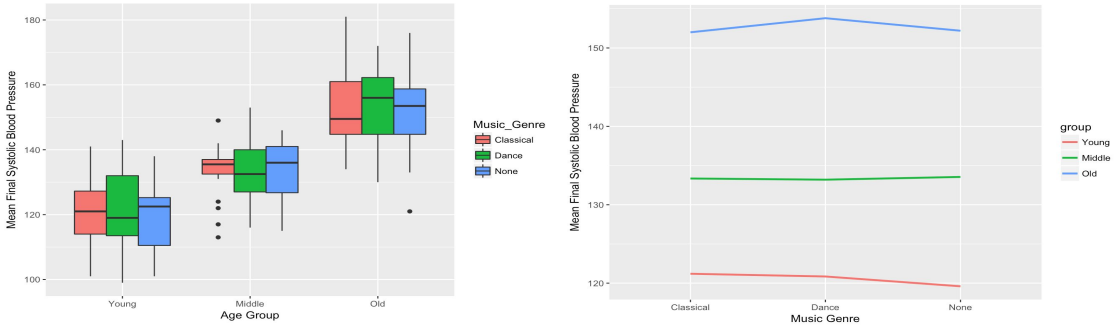


Now that all participants have been assigned to their treatments, we started off by taking the blood pressure of all our participants. Then we gave them 30 minutes of exposure to their music genre (the no-music group simply waits for 30 minutes doing nothing). Due to studies indicating that music takes effect on blood pressure after 25 minutes, and the fact that the island only provides musical treatments with a duration of 10 minutes, we gave each islanders three

back-to-back sessions of musical exposure for a total of 30 minutes. Right after the treatments, we examined their blood pressure again in order to calculate the change in their systolic and diastolic.

Data Management and Analysis

Systolic Blood Pressure After Musical Treatments



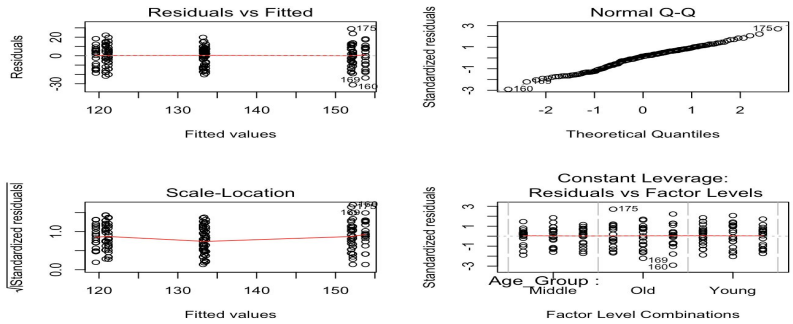
We collected data from 180 islanders and did data analysis in R. Firstly, we look at the exploratory data analysis by using ggplot which shows the mean systolic blood pressure for different age groups after receiving different genres of music as treatments. As we expected, we see there is a difference in the mean systolic blood pressure between age groups, with older age groups having higher mean systolic blood pressure. However, we see that within each age group, there does not seem to be much difference in mean systolic blood pressure for different music genres, potentially indicating that classical and dance music does not have a significant effect on systolic blood pressure compared to the control group. From the interaction graph, it is very evident that there is no significant interaction between age groups and music genre in predicting systolic blood pressure as the interaction lines are pretty much completely parallel. However, to confirm our results, we must look at our ANOVA results and also check that our model is valid.

Anova for Systolic BP After Musical Treatments

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Age_Group	2	31364.74444	15682.37222	129.63990	0.00000
Music_Genre	2	20.84444	10.42222	0.08616	0.91749
Age_Group:Music_Genre	4	47.62222	11.90556	0.09842	0.98284
Residuals	171	20685.65000	120.96871	NA	NA

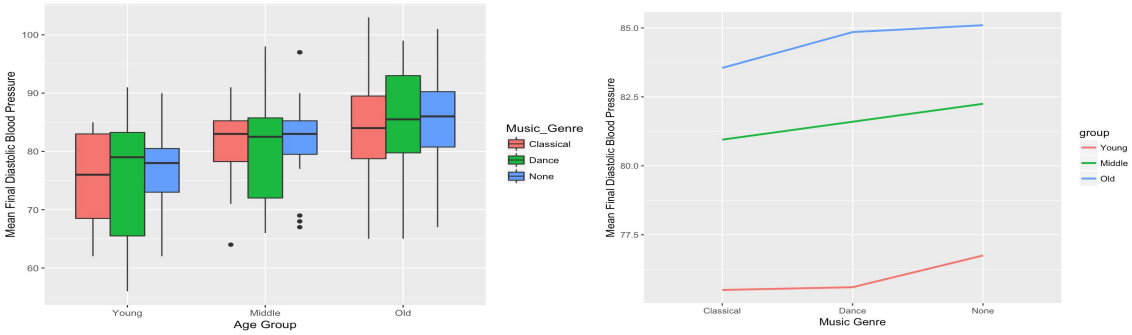
As we expected, neither music genre nor the interaction between music genre and age group have a significant effect on systolic blood pressure with their p-values being close to 1. Thus we reject their null hypotheses and conclude that music genre and interaction between music genre and age group do not have a significant effect on systolic blood pressure.

However, age group has a p-value close to 0. Thus we failed to reject its null hypothesis and conclude that age group does have an effect on systolic blood pressure.



Checking our assumptions, we see that for the most part, there is no violation of constant variance, normal distribution, independence, and leverage for the errors.

Diastolic Blood Pressure After Musical Treatments

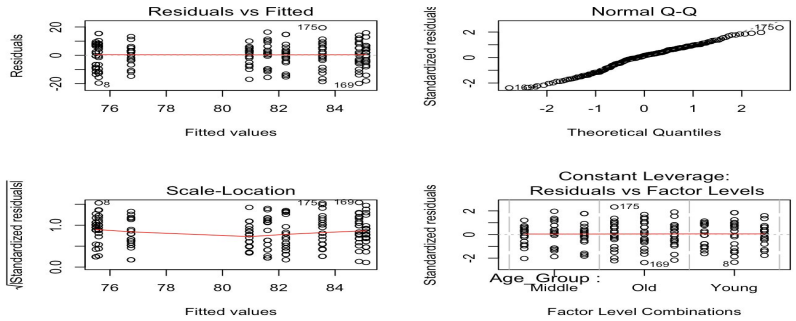


Now we look at the mean diastolic blood pressure for different age groups after receiving different genres of music as treatments. Once again, we see there is a difference in the mean systolic blood pressure between age groups, with older age groups having higher mean diastolic blood pressure. Although this difference does not seem to be as large as it was for systolic blood pressure. Again, within each age group, there does not seem to be much difference in mean systolic blood pressure for different music genres, potentially indicating that music does not have a significant effect on diastolic blood pressure. From the interaction graph, there is again no indication of significant interaction between age groups and and music genre in predicting diastolic blood pressure as the interaction lines are mostly parallel. We must look at our ANOVA results and also check that our model is valid again to confirm our results.

Anova for Diastolic BP After Musical Treatments

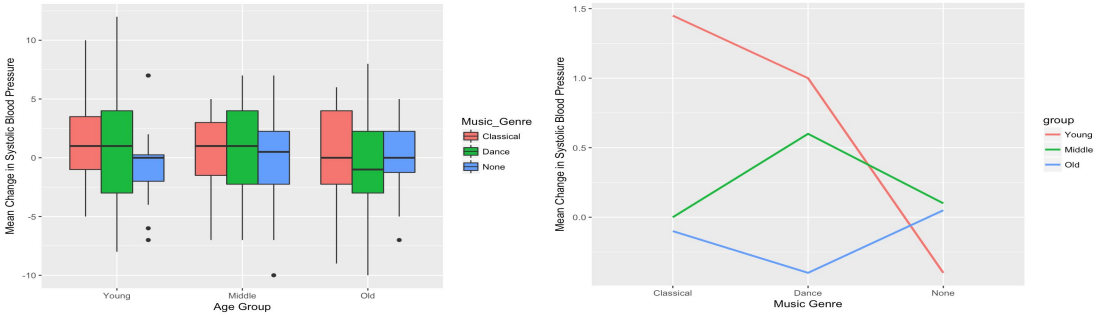
	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Age_Group	2	2268.70000	1134.35000	15.49764	0.00000
Music_Genre	2	56.03333	28.01667	0.38277	0.68255
Age_Group:Music_Genre	4	7.86667	1.96667	0.02687	0.99859
Residuals	171	12516.35000	73.19503	NA	NA

Again, as expected, neither music genre nor the interaction between music genre and age group have a significant effect on diastolic blood pressure with their p-values much larger than 0.05. We reject their null hypotheses and conclude that music genre and interaction between music genre and age group do not have a significant effect on diastolic blood pressure. However, age group has a very small p-value (0 when rounded to 5 digits after decimal). Thus we failed to reject its null hypothesis and conclude that age group does have an effect on diastolic blood pressure.



While the line indicating constant variance of errors is not completely straight, it is very close to being so. Thus overall, there does not seem to be any significant violations in our model.

Change in Systolic Blood Pressure Before and After Musical Treatments



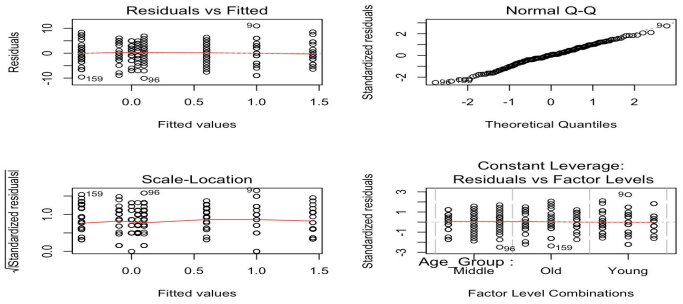
Although we have already seen the effects of music and age on the final systolic blood pressure taken after treatments, we can be thorough and look at the total *change* in systolic blood pressure as it may give us different results than simply looking at it after given treatment. However, *age alone* would now *not* have any effect on our response variable since we are simply looking at *change* in blood pressure before and after musical treatment. The interaction between age and music genre, however, might be significant. So looking at the box-plot, we see once again that there does not seem to be much difference overall between the mean change in systolic blood pressure between the different musical treatments. Looking at the interaction

graph, however, the lines seem to all have different slopes and intersect, indicating a potential significance between the interaction of age and musical treatments. Classical and dance music seem to actually result in increase of blood pressure for the young group compared to control, while dance music increases blood pressure for the middle age group and decrease blood pressure for the old age group. To confirm, we must look at ANOVA as well as check our model.

Anova for Change in Systolic BP

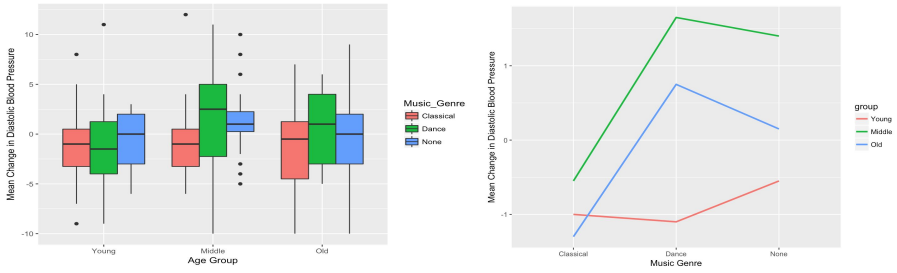
	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Age_Group	2	20.87778	10.43889	0.60512	0.54717
Music_Genre	2	10.41111	5.20556	0.30176	0.73991
Age_Group:Music_Genre	4	33.05556	8.26389	0.47904	0.75109
Residuals	171	2949.90000	17.25088	NA	NA

As expected, music genre (and age group for obvious reasons) does not have a significant effect on change in systolic blood pressure as its p-value is much higher than 0.05. However, it seems like despite the slopes for the interaction graph seemingly indicating a significance in interaction, it is actually not a significant predictor for change in systolic blood pressure due to its large p-value. Thus we fail to reject all the null hypotheses and none of the aforementioned predictors have a significant effect on change in systolic blood pressure.



Once again, there does not seem to be any significant violations in our model.

Change in Diastolic Blood Pressure Before and After Musical Treatments



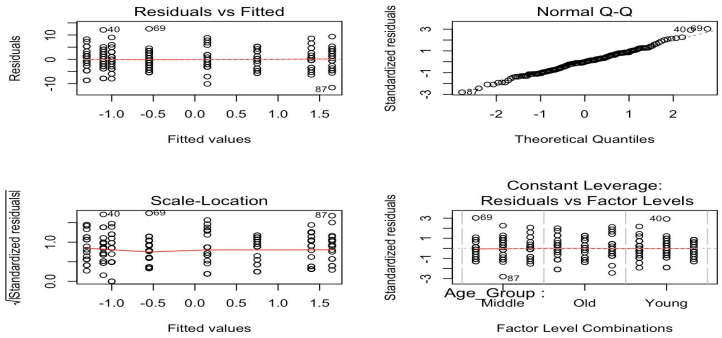
There does not seem to be any significant change in diastolic blood pressure between the different musical treatments. Looking at the interaction graph, however, it seems to indicate

the old and middle age group's diastolic blood pressure decreases more for classical music compared to other musical treatments, while there is not significant difference between treatments for the young group. We now check ANOVA and the validity of our model.

Anova for Change in Diastolic BP

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Age_Group	2	88.87778	44.43889	2.45483	0.08890
Music_Genre	2	71.41111	35.70556	1.97240	0.14228
Age_Group:Music_Genre	4	34.48889	8.62222	0.47630	0.75310
Residuals	171	3095.55000	18.10263	NA	NA

Once again it seems like looking simply at the interaction graph is not enough to indicate a significant interaction. With all the p-values larger than 0.05, we once again fail to reject the null hypotheses and conclude that age group, music genre, and their interaction have no significant effect on change in diastolic blood pressure before and after music treatment.



Once again, our model does not seem to have any significant violations.

Conclusions

From our analysis, it is evident that our first hypothesis stating that listening to 30 minutes of music can reduce blood pressure is incorrect. In addition, our second hypothesis stating that there is a significant interaction between musical treatment and age is also not supported by our results. Our study has instead indicated that listening to 30 minutes of either classical or dance music does not significantly lower systolic or diastolic blood pressure, and there is no significant interaction between age and exposure to different musical treatments in terms of their effects on blood pressure. However, our study did corroborate previous research claims that blood pressure increases with age, leading to a higher risks of hypertension. In addition, systolic blood pressure experiences a larger increase with respect to age as compared to diastolic blood pressure. This supports our second initial hypothesis as well as the fact that isolated systolic hypertension is the most common form of hypertension related to age. From

our study, listening to just 30 minutes of music (classical or dance) would not be an effective way of reducing blood pressure and risks of cardiovascular disease and hypertension. However, our study experienced several limitations and was conducted only once on each participant. There are numerous possible future research questions that can be analyzed and studied upon that can further elaborate on this topic in more effective ways.

Limitations and Future Research Questions

We ran into several limitations during our study. For example, Peter Sleight, a cardiologist at the University of Oxford recently presented a study to the British Cardiovascular Society indicating that slow classical music with 10-second rhythm can reduce blood pressure much more significantly than faster classical music. Music elements this specific was not available on the island so that could be something to explore further in future real life experiments. Also, there were pauses between each 10 minutes music treatments, simply from us trying to navigate the island webpage in order to administer the next treatment. Due to these interruptions in music, the 3 separate 10 minutes treatments we administered might affect blood pressure differently than administering 1 long and continuous 30 minute treatment as used in other researches we found prior to conducting our study.

Finally, although our study proved unsuccessful in finding any significant effect of music in general on blood pressure, it is important to note that we only conducted this once on each of the 180 islanders. The ability for music to reduce blood pressure primarily lies in its ability to help people relax and destress, as stress is often linked to high blood pressure. A long term decrease in stress could be more effective in lowering blood pressure than a short 30 minute de-stressing musical session for one day. Therefore as a future research question, we can design a study to find if listening to 30 minutes of music each day for a duration of 5 years would be able to indicate a significant decrease in blood pressure long term.

References

American Journal of Hypertension, Volume 10, Issue 11, 1 November 1997, Pages 1281–1289, https://doi.org/10.1016/S0895-7061(97)00277-X

Kenneth Abrams, Sam Krimmel, Stacey Johnson, Kate Cieslowski, Helen Strnad, Arielle Melum, Caroline Kryder, Nicotine deprivation attenuates panic reactivity in smokers: Findings from a placebo-controlled nicotine patch study, Depression and Anxiety, 2017, 34, 11, 996

Kühlmann, A. Y. R., Etnel, J. R. G., Roos-Hesselink, J. W., Jeekel, J., Bogers, A. J. J. C., & Takkenberg, J. J. M. (2016). Systematic review and meta-analysis of music interventions in hypertension treatment: a quest for answers. *BMC Cardiovascular Disorders*, *16*, 69. http://doi.org/10.1186/s12872-016-0244-0

Loomba, R. S., Arora, R., Shah, P. H., Chandrasekar, S., & Molnar, J. (2012). Effects of music on systolic blood pressure, diastolic blood pressure, and heart rate: a meta-analysis. *Indian Heart Journal*, *64*(3), 309–313. http://doi.org/10.1016/S0019-4832(12)60094-7

Pinto, E. (2007). Blood pressure and ageing. *Postgraduate Medical Journal*, *83*(976), 109–114. http://doi.org/10.1136/pgmj.2006.048371

Terry, P.C., & Karageorghis, C.I. (2006). Psychophysical effects of music in sport and exercise: An update on theory, research and application. In M. Katsikitis (Ed.), Psychology bridging the Tasman: Science, culture and practice – Proceedings of the 2006 Joint Conference of the Australian Psychological Society and the New Zealand Psychological Society (pp. 415-419). Melbourne, VIC: Australian Psychological Society.

Trappe, H; Voit, G: The Cardiovascular Effect of Musical Genres. Dtsch Arztebl Int 2016; 113(20): 347-52; DOI: 10.3238/arztebl.2016.0347