

Alzheimer's Disease and Music Engagement Economic Impact Analysis



NEUROARTS BLUEPRINT
INITIATIVE

DECEMBER 2021

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List of Acronyms

AD	Alzheimer's Disease
ADLs	Activities of Daily Living
BPSD	Behavioral and Psychological Symptoms of Dementia
FDA	Food and Drug Administration
GDP	Gross Domestic Product
I/O	Input-Output
NAICS	North American Industry Classification Systems
QoL	Quality of Life
RCTs	Randomized Controlled Trials

Executive Summary

- **Key Findings:** KPMG’s economic impact analysis found that adopting music engagement for people with Alzheimer’s disease (AD) could significantly benefit the US economy. The potential economic impact increases with the rate at which music engagement is adopted for this population.

Scenario A: With a 30% adoption rate, the participation of people with AD in music engagement could generate **total output of \$996 million**, contribute a **total of \$830 million in Gross Domestic Product (GDP)**, sustain a **total of 7,784 jobs** across the US, generate a **total of \$369 million in labor income**, and generate a **total of \$126 million in government tax revenues**.

Scenario B: With a 50% adoption rate, the participation of people with AD in music engagement could generate **total output of \$1.7 billion**, contribute a **total of \$1.4 billion in GDP**, sustain a **total of 13,509 jobs** across the US, generate a **total of \$615 million in labor income**, and generate a **total of \$210 million in government tax revenues**.

Scenario C: With a 70% adoption rate, the participation of people with AD in music engagement could generate **total output of \$2.3 billion**, contribute a **total of \$1.9 billion in GDP**, sustain a **total of 19,234 jobs** across the US, generate a **total of \$861 million in labor income**, and generate a **total of \$294 million in government tax revenues**.

- **Key Recommendations:** KPMG concluded that further research is needed to understand the efficacy of music engagement as an intervention, the impact of music engagement for people with Alzheimer’s disease on quality of life (QoL), the economic impact of other arts interventions on Alzheimer’s disease, and the economic impact of arts interventions on other health conditions and in other countries.

PROJECT BACKGROUND AND OBJECTIVES

KPMG LLP (KPMG or “We”) was engaged by the Aspen Institute to prepare an independent assessment of the potential economic benefits and costs of using the arts to advance health and wellbeing on the US economy. KPMG’s analysis focused on evaluating the potential **economic impact of engaging individuals with**

Alzheimer's disease with music in various formats across the US¹ in terms of its contribution to output, GDP, job creation, labor income, and tax revenues. It is important to note that AD is only one form of dementia and was the exclusive focus of this study.

The goal was to inform *The NeuroArts Blueprint: Advancing the Science of Arts, Health, and Wellbeing*, a partnership between the Johns Hopkins International Arts + Mind Lab: The Center for Applied Neuroaesthetics ("Johns Hopkins"), and the Aspen Institute's Health, Medicine and Society Program (NeuroArts Blueprint 2021). As the *Blueprint* states, "With its advocacy of deep systemic changes, this groundbreaking global initiative aims to shake up the status quo and set forth an actionable roadmap to strengthen, formalize, and propel the emerging field of neuroarts" (NeuroArts Blueprint 2021).

For purposes of the NeuroArts Blueprint project, neuroarts is defined as the "transdisciplinary and extradisciplinary study of how the arts and aesthetic experiences measurably change the body, brain and behavior and how this knowledge is translated into specific practices that advance health and wellbeing. As used here, aesthetic experiences are the feelings, emotions, and perceptions that derive from any of the art modalities" (NeuroArts Blueprint 2021).

The NeuroArts Blueprint partners believe that assessing the potential economic benefits and costs of neuroarts on the US economy is a key step in propelling the adoption of art-based interventions to advance health and wellbeing. Alzheimer's disease and music engagement were chosen for the initial analysis because of the prevalence and severity of the disease, the absence of effective treatments, and the widespread use of music in this population.

Music engagement to improve the health and wellbeing of people with AD could directly impact the US economy in three key ways:

- Increased expenditure on music engagement for people with AD.
- Decreased expenditures on medication and healthcare services resulting from the improvements in the health and wellbeing of people with AD who respond positively to music engagement.
- Increased employee income earned by unpaid caregivers who are able to work more paid hours due to improvements in the health and wellbeing of people with AD.

This report summarizes the analysis undertaken by KPMG and its key findings and recommendations.

ANALYTICAL APPROACH

KPMG conducted a three-phase analysis:

PHASE 1: DATA GATHERING

DEFINING THE ART MODALITY AND POPULATION OF STUDY

¹ For the purposes of KPMG's analysis, music engagement is defined as any type of music session (e.g., singing, passive music listening, playing a musical instrument, etc.) occurring under an individualized or group setting and undertaken with the intention of improving the health and wellbeing of the individual living with Alzheimer's disease. Music engagement can be provided by a registered music therapist, but also by any other music professional or provider, or even the individual's caregiver.

Through a collaborative process based on discussions with Johns Hopkins and the Aspen Institute, as well as a review of primary literature, music was selected as the art modality and people living with Alzheimer's disease in the US as the population of study. Dementia due to Alzheimer's disease was chosen as the condition of study because it is a **prevalent disease** of increasing public health concern. Further, **current treatments** for Alzheimer's disease are **ineffective** and **expensive**. Music engagement was chosen as the intervention of study for two key reasons: first, it is one of the primary art modalities used to enhance health and wellbeing in people with Alzheimer's disease, and second, a body of scientific evidence indicates that music is an effective treatment for people with AD, with no evidence of a negative effect on any of the primary outcomes studied.

SUMMARY OF LITERATURE REVIEW

Once the scope of study was defined, KPMG performed a targeted and detailed review of publicly available academic literature and information on the effects of music engagement on people with Alzheimer's disease, including identifying and reviewing relevant peer-reviewed journal articles. The articles reviewed were largely meta-analyses, systematic literature reviews, and some randomized controlled trials (RCTs). The findings indicated that **there is some evidence that music engagement has a positive effect on the health and wellbeing of people living with Alzheimer's disease**. The most notable primary outcomes studied for which there was a positive effect from music engagement were behavioral and psychological symptoms of dementia (e.g., depression, mood, anxiety, aggression). **None of the articles noted a negative effect of music on any of the primary outcomes** studied. While there is a fair amount of literature on the efficacy of music engagement on dementia, **many of the studies conclude that more robust scientific research in this field is needed**.

ADDITIONAL DATA GATHERING

KPMG conducted further research to gather publicly available population and treatment cost data on Alzheimer's disease. This step provided a deeper understanding of the **demographics and distribution of the population of study** as well as the **costs of treating the disease**, including the **costs of delivering music engagement**. Data sources included the Centers for Medicare & Medicaid Services (n.d.), the Centers for Disease Control and Prevention (n.d.), the Alzheimer's Association (2021a), and the American Music Therapy Association (2021). The data gathered in this step was used to build the economic analysis model described in Phase 3.

INTERVIEWS WITH EXPERTS

KPMG conducted confidential interviews with **experts** in the **neuroscience, neurology, psychiatry and behavioral sciences, music and health science research, and music therapy fields**. The interviewees included experts who conduct research on dementia and aging, as well as on music and health; practicing music professionals; and an organization that develops apps and programs for delivering music therapy. These interviews were designed to gain a deeper understanding of the impact of music on people living with Alzheimer's disease and their caregivers. The experts provided important information and insights on Alzheimer's disease, the currently available treatments, and experiences with the effectiveness of music engagement. The experts also confirmed KPMG's understanding that a significant amount of additional rigorous scientific research is required to effectively evaluate the efficacy of music on dementia in all of its forms. Nevertheless, the **general opinion among the experts was that music engagement has a positive effect on the health and wellbeing** and quality of life of people with AD.

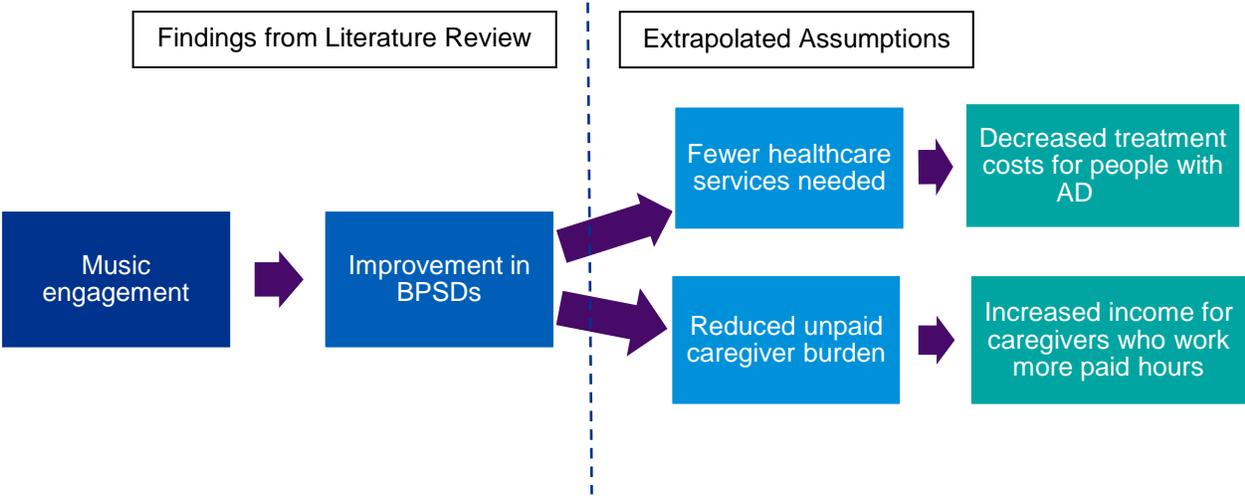
PHASE 2: DEVELOPING THE FRAMEWORK

Based on the detailed literature review and expert interviews in Phase 1, KPMG developed certain key economic assumptions by building on and extrapolating from the documented improvement in behavioral and psychological

symptoms of dementia (BPSDs) among people with AD who respond positively to music engagement. These improvements are anticipated to result in the following:

- A decrease in the need for various healthcare services, such as medication, inpatient hospital stays, outpatient care, skilled nursing facility stays, and home healthcare services, which, in turn, could decrease treatment costs.
- A decrease in the need for care, giving unpaid caregivers more time and capacity to work more hours in a paid job, and earn more income.

The logic flow of these two key assumptions is presented in the diagram below:



The aforementioned experts in the healthcare and music therapy fields reviewed these and other assumptions to ensure that they were reasonable. The majority of the experts either agreed that the set of assumptions were reasonable or concurred that they had no contradicting data or evidence to challenge the assumptions.

Based on these two assumptions we developed seven logical “events” or “shocks” to the economy that were then used to quantify the economic impact of music engagement. These seven events, which either increase or decrease expenditures, and increase labor income, are summarized in the table below.

Increased Expenditure	Decreased Expenditure
Music engagement	BPSD prescription medication
Outpatient care	Inpatient hospital stays
Income of unpaid caregivers	Skilled nursing facility stays
	Home healthcare services

KPMG modeled the cost savings or increases from each of these events and then entered them into the input-output (I/O) model.

PHASE 3: INPUT-OUTPUT MODELING

KPMG employed an I/O model for the analysis. An I/O model divides the economy into a matrix of industries and products/services. It captures all monetary market transactions between industries in a given time period. Using

the I/O model, we estimated the changes to the US economy generated by increasing the use of music engagement among people with AD.

KPMG used IMPLAN (IMPLAN 2020), a US-based regional economic analysis software and data application that is designed to estimate the impact of the results of a shock to the US economy for one or more industries within a specific geographic area (Clouse 2021).

Within the analysis, KPMG analyzed three scenarios where the adoption rate of music engagement among people with AD was 30% (Scenario A), 50% (Scenario B), and 70% (Scenario C). We assumed that not all people with AD who participate would respond positively. By stage of disease, we assumed that approximately **52% of people with mild AD** would respond positively, while approximately **28% of people with moderate AD** and approximately **14% of those with severe AD** would respond positively. We also assumed that it would take five years to ramp up music engagement to achieve a steady state in Year 5; **all figures in the economic analysis are for the steady state.**

The I/O model measured the following dimensions of economic impact:

- **Direct impacts:** Effects that are directly associated with the use of music to enhance the health and wellbeing of people living with Alzheimer's disease.
- **Indirect impacts:** Effects that are associated with business-to-business purchases in the supply chain that stem from the input purchases made by the sectors directly impacted by the use of music to advance the health and wellbeing of people living with Alzheimer's disease.
- **Induced impacts:** Effects that stem from household spending of labor income, after taxes, savings, and in-commuter income.² Induced effects are generated by the spending of employees within the supply chain.

² In-commuter income are types of fringe benefits received by employees that are not taxed as income (see US federal tax code section 132(f)), such as monthly parking or public transit deductions.

SUMMARY OF FINDINGS

The potential economic impact of music engagement is estimated under three scenarios, each using a different rate of adoption among the total population diagnosed with AD.

<i>Potential Economic Impact</i> <i>(2021 dollars)</i>	Scenario A (30%)	Scenario B (50%)	Scenario C (70%)
Output	\$996M	\$1.7B	\$2.3B
GDP	\$830M	\$1.4B	\$1.9B
Employment	7,784 jobs	13,509 jobs	19,234 jobs
Labor Income	\$369M	\$615M	\$861M
Tax Revenues	\$126M	\$210M	\$294M

Scenario A: With a 30% adoption rate, the participation of people with AD in music engagement could generate **total output of \$996 million**, contribute a **total of \$830 million in GDP**, sustain a **total of 7,784 jobs** across the US, generate a **total of \$369 million in labor income**, and generate a **total of \$126 million in government tax revenues**.

Scenario B: With a 50% adoption rate, the participation of people with AD in music engagement could generate **total output of \$1.7 billion**, contribute a **total of \$1.4 billion in GDP**, sustain a **total of 13,509 jobs** across the US, generate a **total of \$615 million in labor income**, and generate a **total of \$210 million in government tax revenues**.

Scenario C: With a 70% adoption rate, the participation of people with AD in music engagement could generate **total output of \$2.3 billion**, contribute a **total of \$1.9 billion in GDP**, sustain a **total of 19,234 jobs** across the US, generate a **total of \$861 million in labor income**, and generate a **total of \$294 million in government tax revenues**.

KPMG further found:

- Based on literature reviewed, music engagement has a positive effect on behavioral and psychological symptoms in a significant percentage of people with Alzheimer’s disease. This conclusion was validated through discussions with experts in a wide variety of fields, including neuroscience, neurology, psychiatry and behavioral sciences, music and health science research, and music therapy.
- Based on data gathered, music is accessible and far less costly compared to pharmacologic treatments for Alzheimer’s disease. Under the KPMG economic model assumptions, the average annual music engagement costs are approximately \$802 (2020 dollars) per person with AD, regardless of disease severity. This is in contrast to average annual per-person prescription costs of approximately \$3,500 (2020 dollars) (Alzheimer’s Association 2021b).
- Based on these assumptions, the use of music as a health intervention could result in treatment cost savings for people with Alzheimer’s disease who respond positively.

Alzheimer's Disease Stage of Individuals Who Respond Positively to Music Engagement	Estimated Annual Medical Treatment Cost Savings (2020 dollars)
Mild-Stage AD	\$2,102
Moderate-Stage AD	\$1,636
Severe-Stage AD	\$1,324

Note that the costs in this table were determined by subtracting the reduced total medical treatment costs from the original total medical treatment costs for people with AD who respond positively to music engagement.

RECOMMENDED NEXT STEPS

KPMG recommends the following next steps to further the understanding of the economic impact of music engagement (and other art modalities) as interventions for advancing health and wellbeing for all.

FURTHER SCIENTIFIC RESEARCH ON THE EFFICACY OF MUSIC ENGAGEMENT AS AN INTERVENTION

While there is some literature on the efficacy of music engagement on Alzheimer's disease, more robust scientific research is needed. Current limitations are primarily due to a lack of consistency in the methodology across studies, such as variances in number of participants, participant age, disease severity, cognitive level, outcome measures, type of intervention (active versus passive), and length of intervention. Further, many of the existing studies have very small sample sizes and are not RCTs. Larger sample sizes increase the likelihood of statistically significant results; RCTs would provide the most reliable evidence of the effectiveness of music interventions because they minimize the risk of confounding factors.

Given the potential benefits of music engagement on people with AD, their caregivers, and the community in terms of improved health, wellbeing, and quality of life, the next step is to pursue further scientific research in this area.

CONDUCT A MORE COMPREHENSIVE ANALYSIS TO EXAMINE IMPACT ON QUALITY OF LIFE

The scientific studies we reviewed provide evidence that quality of life for individuals with AD can be positively impacted by music engagement. Music can also positively impact the QoL of their caregivers and families. QoL encompasses life satisfaction, including physical health, emotional wellbeing, social relationships, quality of environment, work, financial and material wellbeing, personal safety, and a sense of belonging. This economic analysis has not measured those impacts.

Given the potential importance of this measure of health and wellbeing, KPMG recommends that the analysis be expanded to consider QoL benefits of music engagement for people with AD, their families, and other caregivers.

CONDUCT ANALYSES IN OTHER COUNTRIES

The increasing prevalence of Alzheimer's disease is a global concern; indeed, the World Health Organization has call it a public health priority (World Health Organization 2021). Given this, and the ease and low cost associated with providing art-based treatments, it would be valuable to conduct similar economic (and social) analyses in other countries to assess and potentially establish the arts as a viable and cost-effective intervention for people with AD.

CONDUCT ANALYSES OF THE ECONOMIC IMPACTS OF OTHER ART-BASED INTERVENTIONS ON ALZHEIMER'S DISEASE

Music engagement is one of several art modalities that could be used to enhance the health and wellbeing of people with AD. Other modalities include dance and movement, theatre, visual arts, and more (NeuroArts Blueprint 2021). This analysis could be advanced by performing a multimodal analysis that evaluates economic impacts under a scenario where people with AD engage with more than one type of art intervention.

CONDUCT ANALYSES OF THE ECONOMIC IMPACTS OF MUSIC AND OTHER ART MODALITIES ON OTHER HEALTH CONDITIONS

The model developed for this economic analysis could be applied to evaluate the economic impact of other types of art-based interventions on other populations with a range of mental and physical health conditions. Expanding such work to include QoL analyses would also lead to a more comprehensive understanding of the economic, social, and health impacts of various art modalities on different populations.

It should be noted that the potential contribution of these analyses depends on the availability of quality research measuring the impact of art-based interventions on health and wellbeing—that is, the power of the economic assessments is directly correlated with the strength of the underlying research. As neuroarts research progresses so, too, will the value of economic analyses in furthering the goals of the *NeuroArts Blueprint*.

USE OF A CONSERVATIVE APPROACH FOR THE ECONOMIC ANALYSIS

KPMG's overall approach to this economic analysis was to be as conservative as reasonably possible to avoid overestimating the economic benefits and costs to the economy. KPMG's efforts to ensure a conservative approach included

- Developing and using conservative assumptions, with inputs provided from experts in relevant fields.
- Using three scenarios for the rate of music engagement, none of which assumes a 100% participation rate by the population of study, which would likely be unrealistic. Instead, we used 30%, 50%, and 70% participation rates.
- In each scenario, none included a 100% effective rate. As noted earlier, by stage of disease it was assumed that approximately 52% of people with mild AD would respond positively to music engagement, while approximately 28% of people with moderate AD and approximately 14% of people with severe AD would respond positively.

Further, the economic impacts estimated by the I/O model are likely underestimates because it is a partial equilibrium; that is, the I/O model does not adjust for the fact that demand for healthcare services in the US generally outpaces the supply. The results reflect a total reduction in the output, GDP, and labor force of hospitals and skilled nursing facilities (i.e., negative economic impacts) due to the anticipated decrease in demand and spending on various healthcare services by people with AD who respond positively to music engagement. However, given that the demand for healthcare services generally outpaces the supply, it is reasonable to assume that the hospital and nursing facility capacity freed up due to a decrease in use by people with AD would be used for other individuals needing care, rather than resulting in an economic contraction of this sector. The I/O model does not adjust to this new equilibrium.

Project Background and Objectives

BACKGROUND

The NeuroArts Blueprint: Advancing the Science of Arts, Health, and Wellbeing is a partnership project of the Johns Hopkins International Arts + Mind Lab: The Center for Applied Neuroaesthetics and the Aspen Institute's Health, Medicine & Society Program (NeuroArts Blueprint 2021). This global initiative seeks to strengthen, standardize, and propel the emerging field of neuroarts—defined for purposes of the project as the “transdisciplinary and extradisciplinary study of how the arts and aesthetic experiences measurably change the body, brain, and behavior and how this knowledge is translated into specific practices that advance health and wellbeing. As used here, aesthetic experiences are the feelings, emotions, and perceptions that derive from any of the art modalities” (NeuroArts Blueprint 2021).

PROJECT GOALS

The Aspen Institute engaged KPMG to prepare an independent assessment of the potential economic benefits and costs of using the arts to advance health and wellbeing on the US economy. KPMG's analysis focused on evaluating the potential **economic impact of engaging individuals with Alzheimer's disease with music in various formats across the US**³ in terms of the contribution to output, GDP, job creation, labor income, and tax revenues. The use of music engagement to improve the health and wellbeing of people with AD could directly impact the US economy in three key ways:

- Increased expenditure on music engagement for people with AD.
- Decreased expenditures on medication and healthcare services resulting from the improvements in the health and wellbeing of people with AD who respond positively to music engagement.
- Increased employee income earned by unpaid caregivers who are able to work more paid hours due to improvements in the health and wellbeing of people with AD.

ANALYTICAL APPROACH

³ For the purposes of KPMG's analysis, music engagement is defined as any type of music session (e.g., singing, passive music listening, playing a musical instrument, etc.) occurring under an individualized or group setting and undertaken with the intention of improving the health and wellbeing of the individual living with Alzheimer's disease. Music engagement can be provided by a registered music therapist, any other music professional or provider, or even the individual's caregiver.

KPMG's analysis consisted of the following key phases:

- **Data gathering:** This phase entailed holding discussions with Johns Hopkins and the Aspen Institute, reviewing preliminary literature to define the art modality and population of study, performing a literature review to gather clinical information on the effects of music engagement on people with AD, gathering demographic and treatment cost data on those individuals, and conducting interviews with experts in neuroscience, psychiatry and behavioral sciences, music and health science research, and music therapy to gather information on the progression of Alzheimer's disease and the resulting cognitive and behavioral symptoms, the available treatments for the disease, and the impact of music engagement on people living with AD and on their caregivers.
- **Developing the framework:** This phase involved developing key economic assumptions by extrapolating the impact of the improvement in BPSDs on the healthcare services and unpaid care needed by people with AD who respond positively to music engagement. The aforementioned experts in the healthcare and music therapy fields reviewed these assumptions to validate them as reasonable.
- **Input-output modeling:** This phase consisted of employing an input-output model of the US economy to estimate the potential benefits and costs to the US economy of music engagement on people with AD, in terms of output, GDP, job creation, labor income, and tax revenues.

The sections that follow detail the analysis undertaken by KPMG in each phase, as well as the key findings.

Phase 1: Data Gathering

DEFINING THE ART MODALITY AND POPULATION OF STUDY

KPMG and the NeuroArts Blueprint team discussed various art modalities and their application to various health conditions. Through a collaborative process, we initially agreed that music would be the art modality and people living with dementia in the US would be the population of study. KPMG then conducted preliminary research in order to assess whether music for dementia would be an appropriate test case, based on the availability of scientific studies, the prevalence of the disease and its significance to the US economy, and the availability of demographic and treatment cost data.

The targeted population was individuals **age 65 years and older with dementia due to Alzheimer's disease** because AD is the most common form of dementia, accounting for 60% to 80% of all dementia cases in the US (Alzheimer's Association 2021b). Further, its prevalence is anticipated to grow as the US population ages. There is also a relatively significant amount of literature on the impact of art on people living with AD. Additionally, publicly available population and cost data on dementia due to Alzheimer's disease was the most robust compared to other types of dementia.

Music was chosen as the art intervention of choice for two key reasons:

- Music is one of the key art modalities used to enhance the health and wellbeing of people living with AD.
- Some scientific evidence shows that music is an effective treatment for AD, with no evidence of a negative effect on any of the primary outcomes being studied.

For purposes of this study, music engagement encompasses more than music therapy, which is defined as the clinical and evidence-based use of music interventions to accomplish individualized goals through a therapeutic relationship by a credentialed professional who has completed an approved music therapy program (American Music Therapy Association 2021). Rather, we define music engagement here as any type of music session (e.g., singing, listening to music, playing a musical instrument, etc.) occurring in an individual or group setting, with the intention of improving the health and wellbeing of people living with AD. Music engagement can be either active or passive. Active music engagement usually consists of singing, playing instruments, or introducing movements into music (e.g., dance) to improve range of motion, flexibility, and tension. Passive music engagement usually involves listening to certain types of music to improve pain management, improve emotional wellbeing, and help with sleep. Music engagement can be provided by a registered music therapist, another music professional or provider, or a caregiver.

DEMENTIA IN THE US

Dementia is defined as the loss of memory, language, visual perception, problem-solving, and other cognitive abilities that impact functioning and interfere with an individual's activities of daily life (National Institute on Aging n.d.). Dementia is not a specific disease, and the word is used to describe any of several diseases that can cause a decline in mental ability. Alzheimer's disease is the most common cause of dementia.

ALZHEIMER'S DISEASE

In the US, **Alzheimer's disease accounts for an estimated 60% to 80% of dementia cases.**⁴ Compared to other forms of dementia, it is among the slowest to progress, taking up to 20 years before minor symptoms become apparent. The initial, or preclinical, stage has no symptoms. Early signs of Alzheimer's disease can be seen in the mild cognitive impairment (MCI) phase, manifesting as very mild symptoms that do not interfere with everyday activities. As Alzheimer's progresses, individuals commonly experience multiple symptoms that change with time, including noticeable memory loss and thinking or behavioral symptoms that impair the ability to function in daily life. These symptoms reflect the degree of damage to nerve cells in different parts of the brain. Following the mild cognitive impairment phase, Alzheimer's disease has mild, moderate, and severe stages:

- **Mild AD:** In this stage, most people can function independently in many areas, such as driving, working, and socializing, but are likely to require assistance to maintain independence and safety.
- **Moderate AD:** Often the longest stage of the disease, moderate disease is characterized by individuals having difficulties communicating and performing routine tasks, including activities of daily living, such as bathing or dressing, and personality and behavioral changes, including agitation and suspiciousness.
- **Severe AD:** Individuals with severe AD need help with activities of daily living and are likely to require around-the clock care. The impact of Alzheimer's disease on the individual's physical and mental health is most apparent at this stage and the individual is more vulnerable to other health conditions.

The progression of Alzheimer's disease is depicted in the graphic below.



The pace at which symptoms of dementia advance from mild to moderate to severe differs from person to person.

As of 2021, an estimated **6.2 million**⁵ people **age 65 and older** live with AD in the US. AD is officially listed as the sixth-leading population-wide cause of death and is the **fifth-leading cause of death for those over 65**. The long duration of illness before death contributes significantly to the public health impact of AD, amounting to **hundreds of billions of dollars in costs**, because so much of that time is spent in poor health, disability, and dependence. In 2021, Alzheimer's disease and other dementias will cost the US economy an estimated \$355 billion. People

⁴ All facts and data in this section are drawn from Alzheimer's Association (2021b), unless stated otherwise.

⁵ The population of people ages 65 and over living with AD is 6.2 million. Any differences from this figure stated later in this report are due to rounding.

living with AD require assistance with one or more activities of daily living, as well as managing the behavioral and psychological symptoms of the disease. For older adults in the US, 83% of the help provided comes from family members, friends, or other unpaid caregivers, of which 48% is for someone with AD. In 2020, these caregivers provided an estimated **15.3 billion hours of unpaid care valued at nearly \$257 billion**. Caring for a person with Alzheimer's disease or another form of dementia can cause economic, emotional, and physical stress to the unpaid caregiver who often engaged in full-time employment before a family member's diagnosis. As a result of an AD diagnosis, caregivers often reduced their working hours, gave up work entirely, or retired early.

Available Therapies for AD

While there is no cure for AD, there are some treatment options, each with different levels of effectiveness and side effects. For purposes of comparison to music engagement and to facilitate an understanding of relative costs, an overview of available treatments and therapies is as follows:

- **Pharmacologic Therapy for AD:** Pharmacologic treatment options for AD have been extremely limited. Most approved drugs provide symptomatic improvement but do not halt disease progression and often cause significant side effects. The drugs used to treat symptoms of AD can be classified in two main categories (Alzheimer's Association 2021c):
 - **Drugs that treat cognitive symptoms:** These drugs are AD specific and are prescribed to treat symptoms related to memory, thinking, language, judgment, and other cognitive processes. While these medications do not stop or reverse the damage Alzheimer's disease causes to brain cells, they may delay progression for a limited time. The following types of medications have been approved by the US Food and Drug Administration (FDA) to specifically treat cognitive symptoms of Alzheimer's disease: cholinesterase inhibitors, glutamate regulators, and a combination of cholinesterase inhibitors and glutamate regulators.
 - **Drugs that treat behavioral and psychological symptoms of dementia:** AD affects more than just cognitive function, causing a variety of behavioral and psychological symptoms. In the early stages of the disease, these may include irritability, anxiety, and depression. In the later stages, other symptoms include aggression, anger, agitation, emotional distress, physical or verbal outbursts, restlessness, pacing, hallucinations, delusions, sleep issues, and sundowning (increased confusion, anxiety, agitation, pacing, and disorientation beginning at dusk and continuing throughout the night).

Currently the FDA has approved one drug, suvorexant, to address insomnia in people living with dementia. Other medications have been prescribed off label to treat these symptoms but have not been approved by the FDA specifically for BPSD. These include psychotropic medications such as antidepressants to treat mood and irritability; anxiolytics to treat anxiety, restlessness, verbally destructive behavior, and resistance; and antipsychotic medications to treat hallucinations, delusions, aggression, agitation, hostility, and uncooperativeness (Alzheimer's Association 2021d).

- **Recent developments in pharmacologic treatments:** In June 2021, the FDA approved Aducanumab, which is sold under the brand name *Aduhelm*, the first new drug for Alzheimer's disease since 2004. Its approval is controversial due to ambiguous efficacy findings. While clinical trials showed that Aducanumab reduced the level of amyloid plaques in the brain, there was no evidence of an associated reduction in clinical decline (Peripheral and Central Nervous System Drugs Advisory Committee Meeting 2020).

The side effects of Aducanumab observed during the clinical trials include brain swelling, tiny brain bleeds, headaches, falls, diarrhea, and confusion. The wholesale cost of Aducanumab—which requires an infusion once every four weeks—is about \$4,312 per infusion, or \$56,000/year for a high dose. This exceeds the estimated average annual total costs of caring for a person with AD of approximately \$53,000 (in 2021 dollars), which includes medication (excluding Aducanumab), outpatient care, inpatient hospital stays, and home healthcare services.

- **Nonpharmacologic Therapy for AD:** Nonpharmacologic therapies are designed to maintain or improve cognitive function, overall QoL, or the ability to perform activities of daily living. These therapies may also be used to reduce BPSDs. Examples of nonpharmacologic therapies include computerized memory training, listening to or playing favorite music to stir recall, and using special lighting to lessen sleep disorders. As with pharmacologic therapies, nonpharmacologic therapies do not slow or stop the progression of AD.

Assessing effectiveness is difficult because of the large number of unique therapies tested, the diversity of therapeutic aims, the range of dementia stages presenting, and the lack of a standard method for carrying out any individual therapy.

SUMMARY OF LITERATURE REVIEW

KPMG performed a targeted and detailed review of publicly available academic literature to evaluate the existing scientific evidence on the effects of music engagement on people with Alzheimer’s disease. This phase consisted primarily of identifying and reading peer-reviewed journal articles on the effects of music on individuals living with AD.

The peer-reviewed journal articles reviewed by KPMG consisted largely of meta-analyses, systematic literature reviews, and some randomized controlled trials. The articles were primarily found in publicly available sources, with some made available through the Johns Hopkins University Library. The reviewed articles were published between 2009 and 2021, with studies performed by scientific researchers around the globe. A bibliography of the journal articles and other data sources that were reviewed can be found in Appendix 1.

The purpose of this literature review was to understand the changes in health and wellbeing outcomes of persons living with Alzheimer’s disease that result from music engagement. The outcomes in the various scientific studies we reviewed included

- Cognitive function (Moreno-Morales et al. 2020; Ceccato et al. 2012)
- BPSDs (i.e., depression, agitation, aggressive behavior, anxiety) (Pedersen et al. 2017; Raglio et al. 2015)
- QoL (Cooper et al. 2012; Mittelman & Papayannopoulou 2018)
- Emotional wellbeing (van der Steen et al. 2018; Sakamoto, Ando, & Tsutou 2013)
- Physiological, psychobiological and neuropsychiatric markers (McDermott, Orrell, & Ridder 2014; Sittler et al. 2021)

Most often, the studies were conducted with an experimental group receiving music therapy and a control group continuing to receive standard care. The data were typically analyzed after each intervention to measure any changes in the primary outcome being studied.

There are many variations across the studies. For example, studies evaluated different interventions, such as making music, singing, and other interactive approaches, as well as passive approaches, such as listening to music (Leggieri et al. 2019; Sung et al. 2012; Ridder et al. 2013). The interventions were done in either individual or group settings and lasted for various lengths of time. For example, some studies used twice-weekly sessions of 30 minutes apiece, while others involved once-a-week sessions of 60 minutes. Further, the methodology differed; for example, in some regimens, participants listened on headphones while others streamed music throughout the room. Lastly, there was little consistency in the population under evaluation, with participants varying in ages and stage of dementia.

Based on the aggregate journal findings, we noted that **music** was most frequently cited as having a **positive effect on anxiety, overall behavior, and quality of life**. Music engagement was also very frequently cited as having **positive effects on depression, mood, and emotional wellbeing**. Positive effects of music on cognitive function and agitation were least frequently cited. **None of the articles noted a negative effect of music on any of the primary outcomes** being studied (i.e., music either had a positive or neutral effect). The table below summarizes this review.⁶

Positive Effects of Music Engagement			
Outcomes Measured	Number of Articles That Cited a Positive Effect	Total Articles Reviewed	Positive Effect %
Physiological/psychobiological/neuropsychiatric markers (McDermott et al. 2013)	3	3	100%
QoL and emotional wellbeing (Kishita, Backhouse, & Mioshi 2020)	9	10	90%
Anxiety (Guetin et al. 2009)	9	10	90%
Depression/mood (Vasionyte & Madison 2013)	10	13	77%
Overall behavior, or one of more BPSD outcomes (aggregate) (Lam et al. 2020)	15	20	75%
Cognitive function (Zhang et al. 2016)	6	9	67%
Agitation/aggressive behavior (Vink & Hanser 2018)	5	12	42%

Note that positive effects are not mutually exclusive; a person with AD receiving music engagement may experience positive effects in more than one measured outcome. Given the lack of consistency in methodology across studies, many of the studies we reviewed concluded that **more robust scientific research in this field of study is required** (van der Steen et al. 2017).

ADDITIONAL DATA GATHERING

To conduct the input-output modeling phase, we needed additional data in the economic analysis, including the current costs of treating AD and the nature of the current population of persons living with AD in the US.

We reviewed a variety of information from the following sources:

⁶ The citations in the following table are not exhaustive of all the articles that were reviewed during the literature review.

- Administration for Community Living
- Alzheimer’s Association
- American Music Therapy Association
- Centers for Disease Control and Prevention
- Centers for Medicare and Medicaid Services
- Social Security Administration
- US Bureau of Economic Analysis

Most of the information and data figures related to the population and costs of AD were taken from the Alzheimer’s Association’s *2021 Alzheimer’s Disease Facts and Figures* report, with some conclusions drawn from peer-reviewed journal articles (Koller, Hua, & Bynum 2016). Information on the costs of medication came from the Centers for Medicare and Medicaid Services interactive drug databases (Centers for Medicare & Medicaid Services 2020a; Centers for Medicare & Medicaid Services 2020b).

Information and data figures related to the costs and structure of music engagement sessions were taken from the *American Music Therapy Association 2020 Workforce Analysis* report.

The following table summarizes some of the key statistics (Alzheimer’s Association 2021b).

Population Data	
Total Alzheimer’s Population	As of 2021 , approximately 6.2 million US adults ages 65 and older live with Alzheimer’s disease.
Distribution by Gender	Almost two-thirds of Americans with Alzheimer’s disease are women .
Distribution by Stage of Disease	Of those living with Alzheimer’s disease, 28% are in the mild stage (1.8 million), 31% are in the moderate stage (1.9 million), and 41% are in the severe stage (2.6 million). ⁷
Average Life Expectancy and Mortality Rate	People 65 and older survive an average of 4 to 8 years after a diagnosis of Alzheimer’s disease. The average mortality rate of a person living with Alzheimer’s disease is 6.5% (Statista 2021).
Duration of Each Disease Stage	Based on the assumption of 8 years of life expectancy starting from the mild stage and on the Reisberg Scale (Dementia Care Central 2020). ⁸ The time spent in each disease stage is as follows: mild, approximately 2 years; moderate, approximately 4 years; and severe, approximately 2 years.
Treatment Costs (Alzheimer’s Association 2021b)	
Total Cost	In 2021 , Alzheimer’s disease and other dementias cost the US economy \$355 billion , including \$239 billion in combined Medicare and Medicaid payments.

⁷ Note that the sum of these numbers add up to 6.3 million instead of 6.2 million due to differences from rounding. The population of people with AD in the US should be 6.2 million.

⁸ The Reisberg Scale—also known as the Global Deterioration Scale for Assessment of Primary Degenerative Dementia—is the most commonly used scale for rating dementia by the stage of the disease. The Reisberg Scale has a total of seven stages, from Stage 1: No Cognitive Decline to Stage 7: Very Severe Cognitive Decline (late dementia). See Dementia Care Central (2020).

Average Care Costs by Disease Stage	In 2020 dollars, the average total AD care costs per person are estimated to be \$50,742 . Average annual costs are \$34,158 in the mild stage, \$43,381 in the moderate stage, and \$67,674 in the severe stage.
Music Engagement Costs (American Music Therapy Association 2020)	
Average Cost of an Individual Music Session	The average cost of an individual music session in the US in 2020 was \$76.22 per hour.
Average Cost of a Group Music Session	The average cost of a group music session in the US in 2020 was \$85.38 per hour.

INTERVIEWS WITH EXPERTS

To gain additional insights, KPMG conducted individual, confidential interviews with experts in the fields of neuroscience, neurology, psychiatry and behavioral sciences, music and health science research, and music therapy. The interviewees included practicing geriatric physicians, clinical researchers who actively conduct research on dementia and aging, as well as on music and health, practicing music professionals, and an organization that develops apps and programs for delivering music therapy. The interviews generally lasted one hour and were conducted virtually.

The primary objective of conducting these interviews was to gather more information on dementia, AD, and the efficacy of music engagement on people living with dementia. KPMG also wanted to gain a better understanding of the common causes of dementia, the progression of the disease, and the standard treatment protocols. We also wanted to understand the existing evidence on the efficacy of music engagement on people with AD, as well as whether the efficacy of music engagement varies by how it is delivered, the environment in which it is delivered, the age of onset, or the stage of disease.

Based on these discussions, KPMG confirmed its understanding that the most common cause of dementia is Alzheimer’s disease. The **widespread opinion** was that there is a **positive effect of music engagement on the health and wellbeing on people with Alzheimer’s disease**, as it relates to the improvement of behavioral and psychological signs of dementia and quality of life. Many of the experts pointed out that the evidence of a positive impact on cognitive function is not as strong as it is on BPSD outcomes. As with the literature review, there was a consensus that no form of music engagement would make a person with AD worse (i.e., the effect is either positive or neutral). Several of the experts noted that the current Alzheimer’s drugs were limited in efficacy and only delay disease onset or progression for one to two years, with notable side effects. Experts working in music therapy fields emphasized that it is important to engage individuals in their preferred music of choice and that no prior music experience is required to reap the full benefits of music engagement.

The experts interviewed concurred with the literature review finding that further scientific research needs to be conducted to definitely determine the benefits of music engagement on AD. For the economic analysis, KPMG created a logic framework of assumptions, anchored in the primary conclusion that there is some scientific evidence of music engagement’s positive effect on people with AD. These assumptions were vetted with these experts to ensure that they were reasonable and are discussed in further detail in the next section.

Phase 2: Developing the Framework

ASSUMPTIONS

In the context of this economic analysis, an assumption is defined as an initial condition that is used to isolate the effects of a change in one variable on the outcome being measured. Assumptions are accepted as true, or at least plausible, and are crucial in determining and measuring the outcome of the economic analysis.

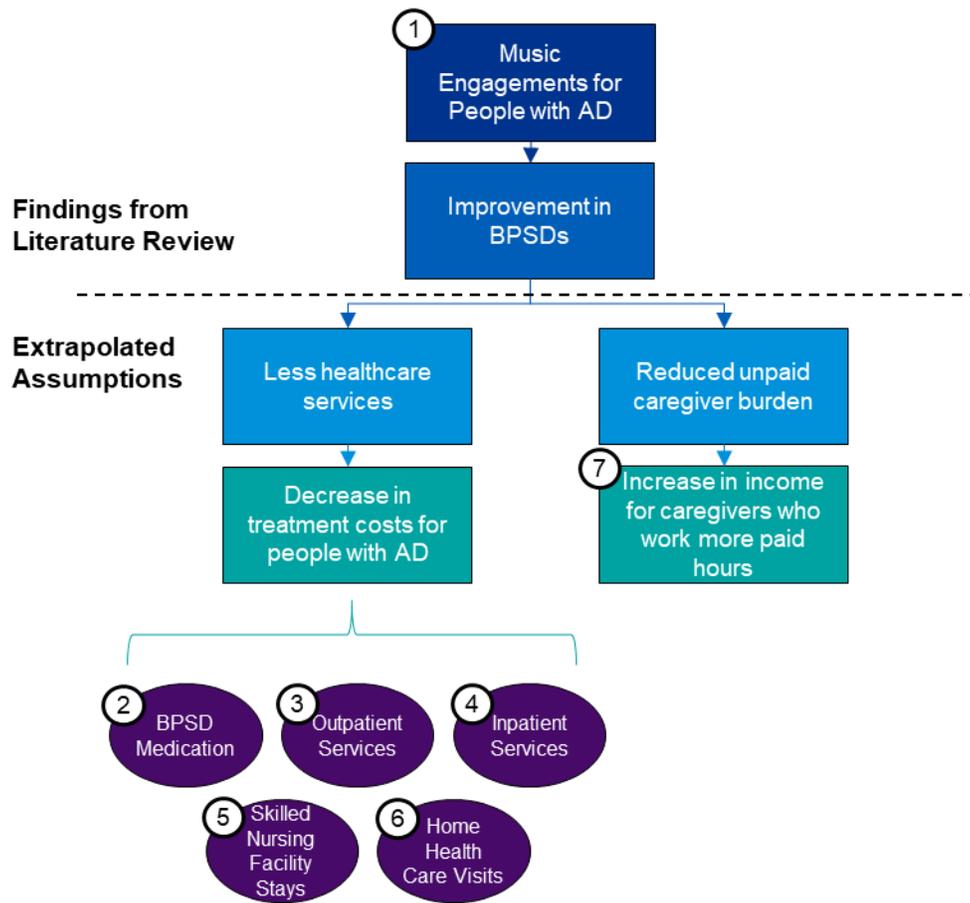
The key assumptions for this analysis are anchored in the conclusion from the literature review and expert interviews in Phase 1—that a body of scientific evidence demonstrates that music engagement has a positive effect on BPSDs in a significant percentage of people with AD. Specifically, KPMG developed certain key economic assumptions by building on and extrapolating from the documented impact of the improvement in BPSDs on the healthcare services and unpaid care needed by people with AD who respond positively to music engagement.

The documented improvement in BPSDs resulting from music engagement is anticipated to result in the following:

- A decrease in the need for various healthcare services such as medication, inpatient hospital stays, outpatient care, skilled nursing facility stays, and home healthcare services, which could in turn decrease treatment costs.
- A need to provide less care to people with AD, giving unpaid caregivers more time and capacity to work more hours in a paid job, and therefore the ability to earn more income.

These and other assumptions were reviewed by a group of experts in the neuroscience, neurology, psychiatry and behavioral sciences, music and health science research, and music therapy fields to obtain their feedback. The majority of experts either agreed that these assumptions were rational or concurred that they had no contradicting data or evidence to challenge them.

The following diagram illustrates the flow of logic used to develop the assumptions and outlines the seven economic events or shocks. The first event is the increased use of music engagement.



DECREASE IN TREATMENT COSTS FOR PEOPLE WITH ALZHEIMER'S DISEASE

Within each set of assumptions about reduced treatment costs, there are nuances in the response to music engagement. KPMG assumes that a positive response exists at any stage of AD but the response differs across stages and rates of cognitive decline. In general, people with mild-stage AD are anticipated to exhibit the largest overall decrease in the level of treatment and care required, while in the severe stage, they are anticipated to exhibit the smallest overall decrease; people in the moderate stage of AD fall somewhere in between.

KPMG assumed there would be an improvement in BPSDs among every person with AD who responds positively to music engagement. As with existing therapies, music engagement treats only AD symptoms, not their causes. As such we assumed that if music engagement effectively treats symptoms, the need for other treatments and therapies would be reduced. KPMG extended this rationale to assume that the use of music engagement would lead to the following impacts and associated costs:

- BPSD prescription medication:** KPMG assumed that people with AD who responded positively to music engagement would require less medication to treat their BPSDs, either through smaller or less frequent doses. BPSD medication usage would be reduced more in the mild stage of AD compared to the moderate stage, which in turn would be reduced more than in the severe stage.

- **Outpatient care:** KPMG assumed that people with mild AD who responded positively to music engagement would achieve a level of health, wellbeing, and independence such that they would require significantly fewer inpatient hospital stays and more outpatient care (defined as a medical procedure or test that can be done without an overnight hospital stay, such as a consultation, lab services, physician’s visit, or emergency room visit). KPMG also assumed that given their levels of cognitive decline, people with moderate and severe AD would not achieve the same level of independence as people with mild AD and their level of inpatient hospital stays would not decline significantly. However, KPMG assumed that people with moderate and severe AD who responded positively to music engagement would require slightly less outpatient care, such as emergency room visits linked to falls or mental health crises.
- **Inpatient hospital stays:** KPMG assumed that people with AD who responded positively to music engagement would require fewer inpatient hospital stays (defined as a hospital admission for an overnight stay of any period of time). People with mild AD would require significantly fewer inpatient hospital stays compared to people with moderate AD, who in turn would require fewer inpatient hospital stays compared to people with severe AD.
- **Skilled nursing facility stays:** KPMG assumed that people with AD who responded positively to music engagement would require fewer skilled nursing facility stays (defined as inpatient nursing and therapy care in a rehabilitation or treatment center).⁹ Again, the drop in usage would be most significant in the mild stage, less so in the moderate stage, and even less in the severe stage.
- **Home healthcare services:** KPMG assumed that people with AD who responded positively to music engagement would require fewer home healthcare visits (defined as supportive care provided by a professional caregiver in the individual’s home).¹⁰ People with mild AD would require significantly fewer home healthcare visits compared to people with moderate AD, who in turn would require fewer home healthcare visits compared to people with severe AD.

REDUCED UNPAID CAREGIVER BURDEN

Increase in income for caregivers able to work more paid hours. KPMG assumed that people with AD who responded positively to music engagement would require less immediate care from their unpaid caregivers. Accordingly, KPMG assumed that these caregivers would have a modest amount of newfound time, some of which they would devote either to working additional hours for their current employers (for which they receive payment) or reentering the labor force and being paid. KPMG assumed that more such hours would be made available for caregivers of people with mild AD compared to caregivers of people with moderate AD. Similarly, KPMG assumed that more such hours would be made available for caregivers of people with moderate AD compared to severe AD.

The key assumptions resulting from changes in treatment costs and reduced unpaid caregiver burden in the economic model are summarized in the tables below.

POPULATION ASSUMPTIONS	
Assumption	Description
Total Alzheimer’s Population	As of 2021, approximately 6.2 million US adults ages 65 and older live with Alzheimer’s disease (Alzheimer’s Association 2021b).

⁹ Skilled nursing facilities provide direct medical care that is performed or supervised by registered nurses.

¹⁰ Home healthcare visits include part-time skilled nursing care, home health aide (personal hands-on) therapies, and medical social services in the home.

Distribution by Disease Stage	Of those living with Alzheimer’s disease, 28% are in the mild stage (1.8 million), 31% are in the moderate stage (1.9 million), and 41% are in the severe stage (2.6 million). ¹¹
Average Life Expectancy and Mortality Rate	For the analysis, it was assumed that the average life span from the beginning of the mild stage to the end of the severe stage is approximately 8 years . The average mortality rate of a person living with AD is 6.5% —meaning that, on average, 6.5% of the population with AD over age 65 die each year. ¹²
Duration in Each Stage of Disease	Based on the assumption of 8 years of life expectancy starting from the mild stage and on the Reisberg Scale (Dementia Care Central (2020)), the time spent in each disease stage was assumed as follows: mild for approximately 2 years, moderate for approximately 4 years, and severe for approximately 2 years.
Percentage of the Population on Medication	Studies have indicated that approximately 32% of the total prevalence of Alzheimer’s disease is treated with anti-dementia drugs (Koller, Hua, & Bynum 2016).
Growth Rates for the Population	It was assumed that the compound annual growth rate of people with AD is 3.3% for people with mild AD and 3.1% both the moderate and severe stage (Alzheimer’s Association 2015).

HEALTH AND WELLBEING ASSUMPTIONS	
Assumption	Description
Reduction in Use of BPSD Prescription Medication	It was assumed that with music engagement, the use of prescription medication to treat BPSD symptoms for people with AD would decrease. KPMG assumed a 30% decrease in BPSD drug use in people with mild AD , a 16% decrease in the moderate stage , and an 8% decrease in the severe stage.
Reduction in Outpatient Care	It was assumed that with music engagement, the frequency of outpatient care for people with AD would increase by 5% in the mild stage and decrease by 2% in the moderate stage and by 1% in the severe stage. The increase in the mild stage is a result of the need for less inpatient care.
Reduction in Inpatient Hospital Stays	It was assumed that with music engagement, the frequency and duration of stay for inpatient care for people with AD would decrease. KPMG assumed a 15% decrease in the mild stage , an 8% decrease in the moderate stage , and a 4% decrease in the severe stage.
Reduction in Skilled Nursing Facility Stays	It was assumed that with music engagement, the frequency and duration of skilled nursing facility stays for people with Alzheimer’s disease would decrease. KPMG assumed a 15% decrease for people with mild stage AD , an 8% decrease in the moderate stage , and a 4% decrease in the severe stage.
Reduction in Home Healthcare Visits	It was assumed that with music engagement, the frequency of home healthcare visits for people with AD would decrease. KPMG assumed a 10% decrease for people with mild stage AD , a 5% decrease in the moderate stage , and a 2.5% decrease in the severe stage.

¹¹ Note that the sum of these numbers is 6.3 million, due to differences from rounding. The population of people with AD over 65 in the US is 6.2 million.

¹² Derived from the average mortality rate of people age 65 and over in the US in 2018 (Statista 2021).

MUSIC ENGAGEMENT ASSUMPTIONS

Assumption	Description
Response to Music Engagement	<p>For the analysis, KPMG assumed that the probability of responding positively to music engagement exists at any stage but differs by disease stage and rate of cognitive decline. It was assumed that every individual who responds positively would use somewhat fewer healthcare services and require less care from unpaid caregivers. It was also assumed that not everyone who receives music engagement would have a positive response and would instead have no response (i.e., no change or no reduction in use of healthcare services).</p> <p>By stage of disease, KPMG assumed that approximately 52% of people with mild AD would respond positively to music engagement, while approximately 28% of people with moderate AD and approximately 14% of people with severe AD would respond positively.</p>
Music Engagement Session Delivery	It was assumed that 20% of all those with AD who receive music engagement would receive the intervention in an individual session and 80% would receive the intervention in a group setting .
Length and Frequency of Music Engagement Sessions	It was assumed that for both individual and group sessions, there would be 2 30-minute sessions each week .
Average Numbers of Hours Worked by Music Practitioners	It was assumed that each music practitioner spent an average of 35 hours a week providing music engagement sessions.
Average Cost of an Individual Music Session	The average cost of an individual music session in the US in 2020 was \$76.22 per hour (American Music Therapy Association 2020).
Average Cost of a Group Music Session	The average cost of a group music session in the US in 2020 was \$85.38 per hour (American Music Therapy Association 2020).
Average Cost of Music Engagement per Person with AD	Based on music therapy costs obtained from the American Music Therapy Association's 2020 Workforce Analysis (American Music Therapy Association 2020) and KPMG's assumptions on the frequency with which people with AD participate in music engagement, we estimated that the annual average cost of music engagement per person with AD is \$801.57 , with the weekly average cost being \$15.41 (in 2020 dollars).

UNPAID CAREGIVER ASSUMPTIONS

Assumption	Description
Ability for Caregiver to Reenter the Workforce	It was assumed that with music engagement, unpaid caregivers would be able to increase their hours at work or reenter the workforce. KPMG assumed an additional 1.8 hours of paid work per week for unpaid caregivers caring for someone with mild AD , an additional 1 hour of paid work per week for unpaid caregivers caring for someone with moderate AD , and an additional 0.9 hours of paid work per week for unpaid caregivers caring for someone with severe stage AD . KPMG assumed that each additional hour worked by the caregivers would be compensated at an hourly rate of \$7.25 , the current US federal minimum wage.

ANNUAL AVERAGE TREATMENT COSTS

In order to estimate the impact of music engagement on average costs, KPMG had to first estimate current costs. Based on the assumptions and data discussed above, KPMG was able to estimate the current average annual costs for individuals over age 65 diagnosed with AD.

As the disease progresses, people with AD require more assistance from their caregivers, spend more on medication, and access more health services. It is thus important to factor in differences in costs by stage of disease. For the economic analysis, KPMG assumed that the formal costs of treating Alzheimer’s disease increase by 27% from the mild to moderate stage, and 56% from the moderate to severe stage (equivalent to an increase of 98% from the mild to the severe stage) (Leon & Neumann 1999). KPMG applied these ratios to the average annual overall costs per person with AD to derive the average cost by stage.¹³

Type of Cost (US\$, 2020 Dollars)	Average Overall per Person ¹⁴	Average per Person, Mild AD	Average per Person, Moderate AD	Average per Person, Severe AD
Outpatient care	\$5,862	\$3,946	\$5,012	\$7,818
Inpatient hospital stays	\$11,933	\$8,033	\$10,202	\$15,915
Skilled nursing facility stays	\$7,405	\$4,985	\$6,331	\$9,876
Nursing home stays	\$16,964	\$11,420	\$14,503	\$22,625
Hospice	\$2,240	\$1,508	\$1,915	\$2,987
Home healthcare services	\$2,804	\$1,888	\$2,397	\$3,740
BPSD prescription medications	\$3,534 ¹⁵	\$2,379	\$3,021	\$4,713
Total	\$50,742	\$34,158	\$43,381	\$67,674

ECONOMIC IMPACT MODEL FRAMEWORK

Based on the assumptions and data discussed above, KPMG created a cost model to measure the economic impacts of music engagement for people living with AD, which could directly impact the US economy in three key ways:

- Increased expenditure on music engagement for people with AD.
- Decreased expenditures on medication and healthcare services resulting from improvements in the health and wellbeing of people with AD who respond positively to music engagement.
- Increased employee income earned by unpaid caregivers who are able to work more paid hours due to improvements in the health and wellbeing of people with AD.

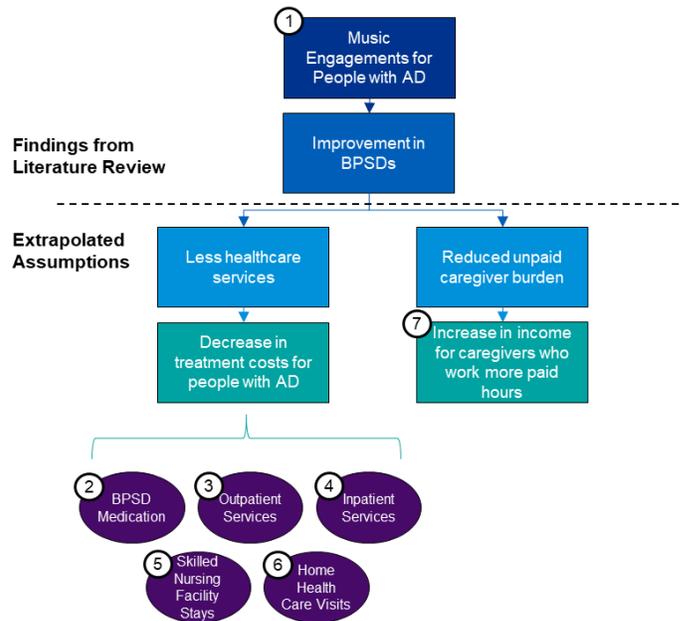
¹³ For example, for outpatient care, the average costs for a mild-stage AD patient total \$3,946. For a moderate-stage AD patient, the average outpatient care costs are 27% higher, which is equal to \$5,012 (= \$3,946 * 127%). For a severe-stage AD patient, the average outpatient care costs are 56% higher than the average outpatient care costs for a moderate-stage AD patient. Thus, for a severe-stage AD patient, the average outpatient care costs are \$7,818 (= \$5,012 * 156%). Then, to arrive at the average overall per person costs for the entire AD population, calculate the sum product of the average outpatient care costs per stage of disease and the proportion of the AD population in each stage of disease (i.e., \$5,862 = [(\$3,946 * 28%) + (\$5,012 * 31%) + (\$7,818 * 41%)]).

¹⁴ The figures in this column were obtained from Alzheimer’s Association (2021b).

¹⁵ Based on the average Medicare spending per beneficiary on BPSD drugs, relative to all drugs used to treat dementia-related symptoms (i.e., BPSD and antidementia drugs), it is assumed that approximately 22% of these total medication costs relate to BPSD drugs, with the remaining 78% related to spending on antidementia drugs.

Within these three areas, KPMG included a total of seven “events” or “shocks” to the economy that are used in the input-output model to measure the economic impact. These seven events are listed below and are also depicted in the accompanying graphic.

- Increased expenditure on music engagement.
- Decreased expenditure on BPSD prescription medication.
- Increased expenditure on outpatient care.
- Decreased expenditure on inpatient hospital stays.
- Decreased expenditure on skilled nursing facility stays.
- Decreased expenditure on home healthcare services.
- Increased employee income earned by unpaid caregivers re-entering the workforce or working more hours.



Phase 3: Input-Output Modeling

METHODOLOGY

The adoption of music engagement for people with AD would result in certain expenditure increases and decreases (i.e., the seven events or shocks described earlier) across the US economy. To assess the economic impact of these changes in spending, KPMG employed economic input-output (I/O) modeling. An I/O analysis is an approach for understanding interindustry relationships within an economy.¹⁶ It captures all monetary market transactions among industries in a given time period. This allows for the effects of a change in one or more economic activities on an entire economy to be examined (impact analysis).

The results of an I/O analysis are broken down into direct, indirect, and induced effects or impacts. The total of these economic impacts is typically greater than the initial economic input.

- **Direct impacts** are the set of expenditures applied to I/O multipliers for an impact analysis.¹⁷ It is one or more production changes or expenditures made by producers/consumers as a result of an activity or policy. Direct effects can be positive or negative.
- **Indirect impacts** are economic effects stemming from business-to-business purchases in the supply chain. When an industry purchases inputs from its suppliers, this spending is shown through the indirect impacts.
- **Induced impacts** are economic effects stemming from household spending of labor income, after removal of taxes, savings, and in-commuter income. Induced impacts are generated by the spending of the employees within the supply chain.

KPMG's economic impact analysis examined the following economic indicators:

¹⁶ For the I/O analysis KPMG used IMPLAN and the IMPLAN multipliers. IMPLAN is a regional economic analysis software application designed to estimate the impact or ripple effect of a given economic activity within a specific geographic area through the implementation of its I/O model. See IMPLAN (2020).

¹⁷ Multipliers are rates of change that describe how a given change in a particular industry generates impacts in the overall economy (e.g., for every dollar spent in a certain industry, an additional \$0.30 of economic activity is generated locally, implying a multiplier of 1.3).

- **Output.** This is a measure of the total value of goods or services produced within a sector. This measure sums all final outputs and intermediate inputs, and therefore results in the double counting of intermediate purchases.
- **GDP (or value added).** This is a measure of the economic value created through the production of goods or services. It is the value a producer adds to its intermediate inputs by producing its own inputs (i.e., total output less intermediate inputs). GDP is a large component of output.
- **Employment.** This is a measure of the annual average employment that accounts for full-time, part-time, and seasonal jobs within each sector.
- **Labor income.** This is a measure of the total value of all forms of employment income, including employment compensation (wages, salaries, and benefits) and proprietor income. Labor income is a component of GDP.
- **Tax revenues.** This is a measure of personal income taxes, corporate income taxes, property taxes, sales taxes, excise taxes, and custom duties paid to federal, state, county, subcounty general, subcounty special districts, and local governments.

Note that an I/O model is a partial equilibrium model that does not factor in supply-side constraints, input substitution effects, price changes, or household and government budget constraints. Despite its limitations, an I/O model is a commonly used and accepted method for economic impact analysis.

DETERMINING THE INPUTS

KPMG needed to calculate the set of expenditures to be applied against the I/O multipliers to quantify the potential economic impacts. This calculation was performed in three primary steps:

1. KPMG estimated the total population of people with mild, moderate, and severe AD over the next five years.
2. KPMG assumed three different scenarios for the adoption of music engagement, and calculated the population that would participate from Year 1 to Year 5.
3. With respect to the AD population participating in music engagement as determined in step 2, KPMG calculated the negative and positive expenditures associated with each of the seven events or shocks, based on the assumptions described previously.

The results of the calculations from these three steps are summarized below.

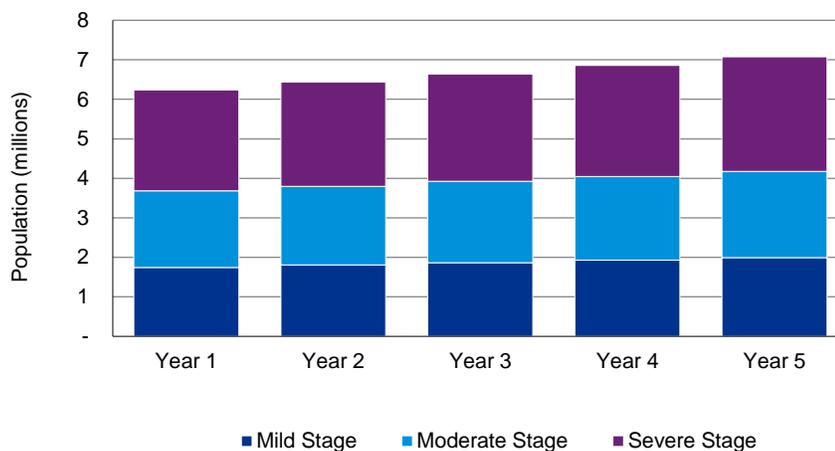
TOTAL POPULATION DATA

The first step in the economic modeling was to determine the total population of people with AD. Following the population assumptions outlined in Phase 3, KPMG modeled the population growth¹⁸ over the next five years as follows:

¹⁸ KPMG assumed that the compound annual growth rate (CAGR) was 3.3.% for people with mild AD and 3.1% for people with both moderate and severe AD. These CAGRs were derived from population forecasts taken from an Alzheimer's Association report.

Total Population (millions)	Year 1	Year 2	Year 3	Year 4	Year 5
Mild Stage	1.75	1.80	1.86	1.93	1.99
Moderate Stage	1.93	1.99	2.06	2.12	2.19
Severe Stage	2.56	2.64	2.72	2.81	2.89
Total Population	6.24	6.44	6.64	6.85	7.07

Total Population Data



MUSIC ENGAGEMENT ADOPTION SCENARIOS

KPMG assumed three scenarios with varying rates of music engagement adoption across the AD population in the US. The scenarios are as follows:

- **Scenario A:** 30% adoption rate.
- **Scenario B:** 50% adoption rate.
- **Scenario C:** 70% adoption rate.

KPMG chose to run three scenarios with different adoption rates to allow for a deeper understanding of how the economic impact may vary with different population samples. We chose 30% as our most conservative adoption rate and 70% as our highest adoption rate, because in our view it would be unrealistic to adopt music engagement as a form of treatment for the entire US population with Alzheimer's disease. We chose 30% and 70% because we wanted to develop a reasonable range around 50%, with a low ratio and a high ratio to avoid extremes in either direction.

In addition, KPMG assumed that not all people with AD who participate in music engagement would respond positively. By stage of disease, it was assumed that approximately 52% of people with mild AD would respond positively, while approximately 28% of people with moderate AD and approximately 14% of people with severe

AD would respond positively. KPMG also assumed that it would take five years to ramp up the music engagement adoption rate to achieve steady state. In other words, adoption rates of 30%, 50%, and 70% would be reached in Year 5. For Scenario A, this assumes a 6% increase in the adoption rate year over year. For Scenario B, this assumes a 10% increase in the adoption rate year over year. For Scenario C, this assumes a 14% increase in the adoption rate year over year.

The following table summarizes the total AD population by each scenario. Note that the figures for each year represent running cumulative totals.

Scenario A (30%): Population Participating in Music Engagement¹⁹ (millions)	Year 1	Year 2	Year 3	Year 4	Year 5
Mild Stage	0.10	0.22	0.34	0.46	0.60
Moderate Stage	0.12	0.24	0.37	0.51	0.66
Severe Stage	0.15	0.32	0.49	0.67	0.87
Total Population	0.37	0.77	1.20	1.65	2.12
Scenario B (50%): Population Participating in Music Engagement²⁰ (millions)	Year 1	Year 2	Year 3	Year 4	Year 5
Mild Stage	0.17	0.18	0.56	0.77	0.99
Moderate Stage	0.19	0.40	0.62	0.85	1.09
Severe Stage	0.26	0.53	0.82	1.12	1.45
Total Population	0.62	1.11	1.99	2.74	3.54
Scenario C (70%): Population Participating in Music Engagement²¹ (millions)	Year 1	Year 2	Year 3	Year 4	Year 5
Mild Stage	0.24	0.51	0.78	1.08	1.39
Moderate Stage	0.27	0.56	0.86	1.19	1.53

¹⁹ As noted earlier, only a portion of those who participate in music engagement would respond positively.

²⁰ As noted earlier, only a portion of those who participate in music engagement would respond positively.

²¹ As noted earlier, only a portion of those who participate in music engagement would respond positively.

Severe Stage	0.36	0.74	1.14	1.57	2.03
Total Population	0.87	1.80	2.79	3.84	4.95

CALCULATING THE COSTS ASSOCIATED WITH EACH EVENT

For each scenario, we calculated the negative and positive costs associated with each of the seven events or shocks, based on our assumptions about the frequency and costs of music engagement, as well as reduced healthcare costs and the ability of caregivers to work more paid hours. In this context, negative costs refer to decreased spending, and positive costs refer to increased spending.

AGGREGATE COSTS ASSOCIATED WITH THE ADOPTION OF MUSIC ENGAGEMENT

The following table summarizes the anticipated negative and positive costs associated with each event, by scenario.

Event	Nature of Activity	Scenario A (30%) (US\$, 2020 dollars)	Scenario B (50%) (US\$, 2020 dollars)	Scenario C (70%) (US\$, 2020 dollars)
Music Engagement	Increased spending	\$1,400,560,693	\$2,334,267,821	\$3,267,974,949
BPSD Prescription Medication	Decreased spending	(\$25,152,920)	(\$41,921,533)	(\$58,690,146)
Outpatient Care	Increased spending	\$33,405,262	\$55,675,436	\$77,945,611
Inpatient Hospital Stays	Decreased spending	(\$601,764,032)	(\$1,002,940,053)	(\$1,404,116,075)
Skilled Nursing Facility Stays	Decreased spending	(\$373,423,503)	(\$622,372,504)	(\$871,321,506)
Home Healthcare Services	Decreased spending	(\$94,267,792)	(\$157,112,987)	(\$219,958,182)
Unpaid Caregiver Reentering Workforce	Increased employee income	\$502,945,182	\$838,241,970	\$1,173,538,757

PER-PERSON TREATMENT COSTS AND SAVINGS ASSOCIATED WITH THE ADOPTION OF MUSIC ENGAGEMENT

Under the model's assumptions, the average annual treatment costs are \$34,158 for people with mild AD, \$43,381 for people with moderate AD, and \$67,674 for people with severe AD (all in 2020 dollars).

Based on these assumptions, the use of music as a health intervention could result in treatment cost savings for those who respond positively as follows:

Alzheimer's Disease Stage of People Who Respond Positively to Music Engagement	Estimated Annual Medical Treatment Cost Savings (2020 dollars)
Mild Stage AD	\$2,102
Moderate Stage AD	\$1,636
Severe Stage AD	\$1,324

Note that the costs in the table above were determined by subtracting the reduced total medical treatment costs from the original total medical treatment costs for people with AD who respond positively to music engagement.

Note that under the model's assumptions, the average annual music engagement costs per person are approximately \$802 (2020 dollars), regardless of the level of disease severity.

ECONOMIC IMPACT ANALYSIS—STEADY STATE

IMPLAN

KPMG then inputted the aggregate negative and positive expenditure and income figures into IMPLAN, a third-party database and software application (IMPLAN 2020). Through IMPLAN's proprietary software, users can access its input-output model, which combines a set of extensive databases, economic factors, multipliers, and demographic statistics. IMPLAN's databases carry out economic analyses within the US and can help economists gain insight into an industry's contributions to a region, quantify the impact of a shock to an economy, or study any other event specific to the economy of a particular region and how it would be impacted. The model identifies direct impacts by sector, and then develops a set of indirect and induced impacts by sector.

INDUSTRY CODES, MULTIPLIERS, AND ECONOMIC ACTIVITIES

The analysis was performed using the IMPLAN input-output model of the US economy. IMPLAN relies on a 546-sector scheme that is mapped to North American Industry Classification Systems (NAICS) industry codes. These 546 sectors group together firms that share similar spending patterns. Sector-specific multipliers are developed based on these common spending patterns. These sector-specific multipliers are applied against the change in economic activity (e.g., industry spending change, industry sales change, employment change, etc.) to estimate the total economic effects of these changes. Thus, it is critical to select the correct sector code in IMPLAN to accurately capture the multiplier effects.

The table below summarizes KPMG's mapping of each of the seven events to a specific IMPLAN sector and specifies the nature of the economic activity associated with each event.

IMPLAN Sector Code	Event	Economic Activity
485 – Offices of Other Health Practitioners	Increased expenditure on music engagement (Event 1)	Increase in industry output
172 – Pharmaceuticals	Decreased expenditure on BPSD prescription medication (Event 2)	Decrease in industry output
486 – Outpatient Care Centers	Increased expenditure on outpatient care (Event 3)	Increase in industry output
490 – Hospitals	Decreased expenditure on inpatient hospital stays (Event 4)	Decrease in industry output
491 – Nursing and Community Care Facilities	Decreased expenditure on skilled nursing facility stays (Event 5)	Decrease in industry output
488 – Home Healthcare Services	Decreased expenditure on home healthcare services (Event 6)	Decrease in industry output
N/A	Increased labor income earned by caregivers (Event 7)	Increase in employee compensation

SUMMARY OF ECONOMIC IMPACT

KPMG estimated the total potential economic impacts for each of the seven events under each of the three scenarios in Year 5, when steady-state adoption rates would be achieved. These results are summarized in the table below; all economic impact figures are in 2021 dollars.

Potential Economic Impact (2021 dollars)	Scenario A (30%)	Scenario B (50%)	Scenario C (70%)
Output	\$996M	\$1.7B	\$2.3B
GDP	\$830M	\$1.4B	\$1.9B
Employment	7,784 jobs	13,509 jobs	19,234 jobs
Labor Income	\$369M	\$615M	\$861M
Tax Revenues	\$126M	\$210M	\$294M

Scenario A: With a 30% adoption rate, the participation of people with AD in music engagement could generate **total output of \$996 million**, contribute a **total of \$830 million in GDP**, sustain a **total of 7,784 jobs** across the

US, generate a **total of \$369 million in labor income**, and generate a **total of \$126 million in government tax revenues**.

Scenario B: With a 50% adoption rate, the participation of people with AD in music engagement could generate **total output of \$1.7 billion**, contribute a **total of \$1.4 billion in GDP**, sustain a **total of 13,509 jobs** across the US, generate a **total of \$615 million in labor income**, and generate a **total of \$210 million in government tax revenues**.

Scenario C: With a 70% adoption rate, the participation of people with AD in music engagement could generate **total output of \$2.3 billion**, contribute a **total of \$1.9 billion in GDP**, sustain a **total of 19,234 jobs** across the US, generate a **total of \$861 million in labor income**, and generate a **total of \$294 million in government tax revenues**.

The sections that follow discuss in detail the economic impacts generated from (1) the increase in spending on music engagement services, (2) the overall decrease in spending on healthcare services and prescription medication, and (3) the increase in labor income earned by unpaid caregivers.

DETAILED ANALYSIS

ECONOMIC IMPACTS FROM INCREASED EXPENDITURE ON MUSIC ENGAGEMENT SERVICES

Event 1 models the potential economic impact generated due to additional output by the music engagement sector, representing an expansion of the economy. Under all three scenarios, Event 1 generates positive direct effects including additional GDP, supporting more jobs directly in the sector, increasing labor income, and increasing federal, state, county, and incremental tax revenues being earned by federal, state, and county governments. Event 1 also generated positive indirect effects through business-to-business transactions resulting from input purchases. Finally, positive induced effects are generated when employees working in the music engagement sector and the supplier sectors spend their money throughout the economy.

Scenario A (30%)	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output	\$1.4B	\$544M	\$1.3B	\$3.3B
GDP	\$1.1B	\$281M	\$731M	\$2.1B
Employment	13,744 jobs	2,507 jobs	7,102 jobs	23,354 jobs
Labor Income	\$718M	\$163M	\$411M	\$1.3B
Tax Revenues	\$189M	\$55M	\$162M	\$407M

Scenario B (50%)	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output	\$2.4B	\$906M	\$2.2B	\$5.5B
GDP	\$1.8B	\$468M	\$1.2B	\$2.5B
Employment	23,443 jobs	4,179 jobs	11,837 jobs	39,460 jobs
Labor Income	\$1.2B	\$273M	\$687M	\$2.2B
Tax Revenues	\$315M	\$92M	\$270M	\$678M

Scenario C (70%)	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output	\$3.3B	\$1.3B	\$3.0B	\$7.6B
GDP	\$2.5B	\$656M	\$1.7B	\$4.9B
Employment	33,142 jobs	5,850 jobs	16,572 jobs	55,566 jobs
Labor Income	\$1.7B	\$382M	\$961M	\$3.0B
Tax Revenues	\$441M	\$129M	\$379M	\$949M

ECONOMIC IMPACTS FROM DECREASED EXPENDITURES ON HEALTHCARE SERVICES AND MEDICATION

In combination, Events 2 to 6 model the potential economic impact generated due to less overall output by the pharmaceutical sector and other components of the healthcare sector. Together, Events 2 to 6 represent a contraction of the economy; under all three scenarios, there are negative direct effects. These include less GDP; fewer jobs supported directly in the sector (i.e., loss of jobs); a decrease in labor income; and reduced federal, state, county, and local tax revenues. Events 2 to 6 also generate negative indirect effects because lower output means decreased demand for intermediate inputs and consequently fewer business-to-business transactions resulting from input purchases. Finally, negative induced effects are generated when the number of jobs decreases within the healthcare and supplier sectors, because unemployed individuals spend less money throughout the economy.

Scenario A (30%)	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output	(\$1.1B)	(\$783M)	(\$1.2B)	(\$3.0B)
GDP	(\$609M)	(\$409M)	(\$663M)	(\$1.7B)
Employment	(9,208 jobs)	(4,067 jobs)	(6,437 jobs)	(19,712 jobs)
Labor Income	(\$533M)	(\$258M)	(\$373M)	(\$1.2B)
Tax Revenues	(\$144M)	(\$84M)	(\$147M)	(\$376M)

Scenario B (50%)	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output	(\$1.8B)	(\$1.3B)	(\$2.0B)	(\$5.1B)
GDP	(\$1.0B)	(\$682M)	(\$1.1B)	(\$2.8B)
Employment	(15,347 jobs)	(6,778 jobs)	(10,728 jobs)	(32,854 jobs)
Labor Income	(\$889M)	(\$430M)	(\$622M)	(\$1.9B)
Tax Revenues	(\$240M)	(\$140M)	(\$245M)	(\$626M)

Scenario C (70%)	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output	(\$2.5B)	(\$1.8B)	(\$2.7B)	(\$7.1B)
GDP	(\$1.4B)	(\$955M)	(\$1.5B)	(\$3.9B)
Employment	(21,486 jobs)	(9,489 jobs)	(15,019 jobs)	(45,995 jobs)
Labor Income	(\$1.2B)	(\$602M)	(\$871M)	(\$2.7B)
Tax Revenues	(\$336M)	(\$197M)	(\$343M)	(\$876M)

It should be noted that the potential **negative indirect effects** generated from Events 2 to 6, taken together, outweigh the potential positive indirect effects generated from Event 1 in which the output produced by the music engagement sector increases. This is so despite the fact that the increase in output experienced directly by the music engagement sector in Event 1 is greater than the decrease in output experienced directly by the pharmaceutical and healthcare sectors in Events 2 to 6. The explanation is that a lot more supplies are needed to produce pharmaceuticals and to run hospitals and nursing and community care facilities than to provide music engagement services.

Note also that the I/O model is a partial equilibrium model. As such, it is unable to factor into its estimation the economic impact of demand for healthcare services in the US, which generally outpaces the supply. It is therefore rational to assume that the workforce capacity freed up in hospitals and nursing and community care facilities, as well as in home healthcare services (Events 4 to 6), may be redirected to other individuals in need of care, rather than resulting in an economic contraction. If this assumption holds true, then the negative economic impacts resulting from reduced spending on healthcare services (e.g., fewer hospital and skilled nursing facility stays, fewer home healthcare services) by people with AD should be zeroed out and possibly lead to further gains. However, the I/O model does not adjust to this potential new equilibrium.

ECONOMIC IMPACTS FROM INCREASED LABOR INCOME EARNED BY UNPAID CAREGIVERS

Event 7 models the potential induced economic impacts generated due to increased labor income earned by unpaid caregivers representing an expansion of the economy. Under all three scenarios, positive induced effects—in terms of increases in output and GDP, more jobs, additional income, and greater government tax revenues—are generated when these caregivers spend their additional income throughout the economy.

Scenario A (30%)	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output	\$0	\$0	\$761M	\$761M
GDP	\$0	\$0	\$427M	\$427M
Employment	0 jobs	0 jobs	4,147 jobs	4,147 jobs
Labor Income	\$0	\$0	\$240M	\$240M
Tax Revenues	\$0	\$0	\$95M	\$95M

Scenario B (30%)	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output	\$0	\$0	\$1.3B	\$1.3B
GDP	\$0	\$0	\$711M	\$711M
Employment	0 jobs	0 jobs	6,902 jobs	6,902 jobs
Labor Income	\$0	\$0	\$400M	\$400M
Tax Revenues	\$0	\$0	\$158M	\$158M

Scenario C (30%)	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Output	\$0	\$0	\$1.8B	\$1.8B
GDP	\$0	\$0	\$996M	\$996M
Employment	0 jobs	0 jobs	9,663 jobs	9,663 jobs
Labor Income	\$0	\$0	\$561M	\$561M
Tax Revenues	\$0	\$0	\$221M	\$221M

OVERALL DIRECT, INDIRECT, AND INDUCED EFFECTS BY SCENARIO

The figures below provide a breakdown of the potential direct, indirect, and induced effects generated by the seven events in aggregate, under each of the three scenarios. While the aggregate direct and aggregate induced effects are positive, the aggregate indirect effects are negative. Nonetheless, in each scenario, **the total impact (direct + indirect + induced) is positive, meaning under the assumptions in this report the provision of music engagement as a treatment for older US individuals diagnosed with AD is estimated to have a positive impact on the US economy.**

SCENARIO A (30%)

	Direct Impact		Indirect Impact		Induced Impact		Total Impact
Output	352M	+	-240M	+	883M	=	996M
GDP	463M	+	-128M	+	495M	=	830M
Employment	4,536	+	-1,560	+	4,807		7,784
Labor Income	185M	+	-95M	+	279M	=	369M
Tax Revenues	45M	+	-29M	+	110M	=	126M
	Impacts generated directly within the subsectors		Impacts within suppliers to the subsectors		Impacts from the spending of Labor Income earned through direct and indirect impacts		

SCENARIO B (50%)

	Direct Impact		Indirect Impact		Induced Impact		Total Impact
Output	587M	+	-399M	+	1.47B	=	1.66B
GDP	772M	+	-214M	+	825M	=	1.38B
Employment	8,096	+	-2,599	+	8,012		13,509
Labor Income	308M	+	-158M	+	465M	=	615M
Tax Revenues	75M	+	48M	+	183M	=	210M
	Impacts generated directly within the subsectors		Impacts within suppliers to the subsectors		Impacts from the spending of Labor Income earned through direct and indirect impacts		

SCENARIO C (70%)

	Direct Impact		Indirect Impact		Induced Impact		Total Impact
Output	822M	+	-559M	+	2.06B	=	2.32B
GDP	1.08B	+	-299M	+	1.15B	=	1.94B
Employment	11,656	+	-3,639	+	11,217	=	19,234
Labor Income	431M	+	-221M	+	651M	=	861M
Tax Revenues	105M	+	-68M	+	256M	=	294M
	Impacts generated <u>directly</u> within the subsectors		Impacts within <u>suppliers</u> to the subsectors		Impacts from the spending of <u>Labor Income</u> earned through direct and indirect impacts		

Recommended Next Steps

Based on this analysis, KPMG recommends the following next steps for future understanding of the economic impact of music engagement and other art modalities as interventions to advance health and wellbeing for all:

FURTHER SCIENTIFIC RESEARCH ON THE EFFICACY OF MUSIC ENGAGEMENT AS AN INTERVENTION

While there is some literature on the efficacy of music engagement on Alzheimer's disease, more robust scientific research is needed. Current limitations are primarily due to a lack of consistency in the methodology across studies, such as variances in number of participants, participant age, disease severity, cognitive level, outcome measures, type of intervention (active versus passive), and length of intervention. Further, many of the existing studies have very small sample sizes and are not RCTs. Larger sample sizes increase the likelihood of statistically significant results; RCTs would provide the most reliable evidence of the effectiveness of the music interventions because they minimize the risk of confounding factors.

Given the potential benefits of music engagement on people with AD, their caregivers, and the community in terms of improved health, wellbeing, and quality of life, the next step is to pursue further scientific research in this area.

CONDUCT A MORE COMPREHENSIVE ANALYSIS TO EXAMINE IMPACT ON QUALITY OF LIFE

The scientific studies we reviewed provide evidence that quality of life for individuals with AD can be positively impacted by music engagement. Music can also positively impact the QoL of caregivers and families. QoL encompasses life satisfaction, including physical health, emotional wellbeing, social relationships, quality of environment, work, financial and material wellbeing, personal safety, and a sense of belonging. This economic analysis has not measured those impacts.

Given the potential importance of this measure of health and wellbeing, KPMG recommends that the analysis be expanded to consider QoL benefits of music engagement for people with AD, their families, and other caregivers.

CONDUCT ANALYSES IN OTHER COUNTRIES

The increasing prevalence of Alzheimer’s disease is a global concern; indeed, the World Health Organization has called it a public health priority (World Health Organization 2021). Given this, and the ease and low cost associated with providing art-based treatments, it would be valuable to conduct similar economic (and social) analyses in other countries to further assess and potentially establish neuroarts as a viable and cost-effective intervention for people with AD.

CONDUCT ANALYSES OF THE ECONOMIC IMPACTS OF OTHER ART-BASED INTERVENTIONS ON ALZHEIMER’S DISEASE

Music engagement is one of several potential art modalities that could be used to enhance the health and wellbeing of people with AD. Other potential art modalities include dance and movement, theatre, visual arts, and more (NeuroArts Blueprint 2021). This analysis could be advanced by performing a multimodal analysis that evaluates economic impacts under a scenario where people with AD experience more than one type of art intervention.

CONDUCT ANALYSES OF THE ECONOMIC IMPACTS OF MUSIC AND OTHER ART MODALITIES ON OTHER HEALTH CONDITIONS

The model developed for this economic analysis could be applied to evaluate the economic impact of other types of art-based interventions on other populations with a range of mental and physical health conditions. Expanding such work to include QoL analyses would also lead to a more comprehensive understanding of the economic, social, and health impacts of various art modalities on different populations.

The potential contribution of these analyses depends on the availability of quality research measuring the impact of art-based interventions on health and wellbeing—that is, the power of the economic assessments is directly correlated with the strength of the underlying research. As neuroarts research progresses, so too will the value of economic analyses in furthering the goals of the *NeuroArts Blueprint*.

Appendix 1

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