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Neurofibromatosis

The Effect of Sleep Disorders on Neurofibromatosis

Lehar Marata

ABSTRACT

Neurofibromatosis, shortened NF, is a genetic condition in which tumors/neurofibromas grow on several nerves or under the skin. This condition most often affects the brain, nerves, spinal cord, and skin. To find the results, 95 (pediatric) patients with neurofibromatosis type 1 consummated the Bruni Sleep Disturbance Scale. 6.3% of patients had sleep disorders. patients that had neurofibromatosis type one (NF1) and attention deficit hyperactivity disorder (ADHD) had a higher amount of sleep and maintenance disorders (18%), sleep-wake transition disorders (12.5%), and daytime sleepiness (12.5%). The results showed that people who suffer from NF1 do not show a significantly high rate of sleep disorders. But, those who suffer from other cognitive disorders and sleep deprivation do end up having a higher chance of getting NF1.

INTRODUCTION

Neurofibromatosis can lead to several complications. NF1 is caused by the mutation of neurofibromin 1 (a type of protein). NF2 is caused by the mutation of neurofibromin 2. The gene mutation can happen due to unknown ("spontaneous") reasons or can be passed through genes. The diagnosis of NF can be found through a set of findings. Doctors use a special light to exam the skin for cafe au lait (light brown) spots, in the groin or underarm area. MRIs, CT scans, X-rays, and blood tests can also be used to examine for defects in the NF1 gene. To examine for defects in the NF2 gene, hearing and imagery tests are used to look for tumors around the spinal cord, brain, or auditory nerves. Because neurofibromatosis is a genetic condition, gene testing is also one of the main factors in diagnosing NF. Despite that, gene testing can *not* determine the severity of the condition. NF1 is often diagnosed in one's childhood, whereas NF2 and schwannomatosis are usually diagnosed in early adulthood.

Does sleep deprivation increase the risk of someone getting neurofibromatosis?

Neurofibromas grow in size during hormonal changes. Lack of sleep/ sleep deprivation causes a change in hormones. Thus, the goal of this research is to find whether or not lack of sleep increases the risk of neurofibromatosis. The research being performed will be based on inductive research, which will include a lot of research and statistics. Many teenagers and working adults are sleep deprived, due to the amount of work and tedious lifestyles they have. This is why it is important to raise awareness about this so teens and adults learn a little bit more about how their unhealthy sleep schedule can affect their health. If people have a healthy sleep schedule then they will have a decreased risk of suffering from Neurofibromatosis, because sleep deprivation affects the hormones which in turn affects the growth of neurofibromas.

ANALYZATION OF RESEARCH SOURCES

95 (pediatric) patients with neurofibromatosis type 1 consummated the Bruni Sleep Disturbance Scale. 6.3% of patients had sleep disorders. Whereas, patients that had neurofibromatosis type one (NF1) and attention deficit hyperactivity disorder (ADHD) had a higher amount of sleep and maintenance disorders (18%), sleep-wake transition disorders (12.5%), and daytime sleepiness (12.5%). Adding to that, patients with neurofibromatosis type one (NF1) and intelligent quotient (IQ) level lower than 85 have a higher rate of daytime sleepiness and sleep hyperhidrosis. Although these results may seem high these rates weren't significantly higher than the rates of the general population. Yet, these disorders are more common with cognitive disorders and/or attention deficit hyperactivity disorder (ADHD). Thus, the hypothesis was proved wrong since sleep disorders do not have a significant effect on the rate of risk of suffering from NF, unless if the patient is suffering from a cognitive disorder and sleep deprivation they do have an increased chance of suffering from NF.

DISCUSSION AND CONCLUSION

If people have a healthy sleep schedule then they will have a decreased risk of suffering from Neurofibromatosis, because sleep deprivation affects the hormones which in turn affects the growth of neurofibromas. The results showed that people who suffer from NF1 do not show a significantly high rate of sleep disorders. But, those who suffer from other cognitive disorders and sleep deprivation do end up having a higher chance of getting NF1. Thus, the hypothesis was proven wrong.

The reason behind this is, cognitive disorders themselves already promote sleep disorders. So sleep disorders and cognitive disorders both have a very strong effect together on the growth of Neurofibromas. If it is sleep disorders alone, it won't have as much of an effect. Ways this information can be applied is for frequent testing of NF to be done on those with cognitive disorders so it can be detected earlier.

Limitations in this research were that there was very little research done on this topic so it was hard to write a paper-based analysis. A future research question is if people have cognitive disorders only does that increase their risk of suffering from Neurofibromatosis?

In conclusion, although sleep disorders do not have a significant effect on the rate of risk of suffering from NF if the patient is suffering from a cognitive disorder and sleep deprivation they do have an increased chance of suffering from NF.

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The Rise of Rotator Cuff Tears In Older Athletes

Matilyn Wang

ABSTRACT

Throughout the years, the rate of rotator cuff injuries has increased as the tennis player population has expanded in the United States. At a closer look, it can be identified that a rotator cuff is a group of four muscles that stabilize and strengthen shoulder movement. These muscles are vulnerable to injury because of their repeated motions in daily activities, especially tennis. They weaken over time, causing tears and impingement. Tendons and muscles in elderly players have been proven to tear or fray naturally from aging, which makes them more susceptible to a rotator cuff injury. Utilizing an archival research technique, scientific journals were assessed and a conclusion on the findings was reported.

The results show that the prevalence of rotator cuff tears is higher in older-aged players than in younger players, as "approximately 25% of patients in their 60s and 45% of patients in their 70s suffer from rotator cuff tears. Patients 80 years and over have an even higher occurrence rate of 80%." Additionally, elderly players were shown to be three times more likely to have more serious tears, which can vary the treatment options depending on factors such as size, age, and pre-existing conditions. Older patients tend to favor non-operative management because there is less risk. Due to the high risk of injury, elderly players must be aware of the causes of rotator cuff injuries to try and prevent the likelihood of getting an injury.

INTRODUCTION

Although it is widely considered to be an enjoyable sport, tennis can often lead to unexpected injuries. As such, complex conditions, such as tears of the rotator cuff, have become increasingly prevalent amongst tennis players. The rotator cuff is formed by the supraspinatus superiorly, the subscapularis anteriorly, the teres minor and infraspinatus posteriorly muscles [Appendix A]. Then, these amalgamate the tendons into the humerus. Stabilization of the glenohumeral joint, a joint near these muscles, is very dependent on the force created by the tendons of the rotator cuff muscles. The rotator cuff muscles also stabilize the joint by controlling

the head of the humerus into the scapula (glenoid fossa of the shoulder). The larger external muscles near the humerus--such as the deltoid, pectoralis major, and latissimus dorsi--provide the shoulder with enough force and stability needed to swing with enough power on the ball. The deltoid helps with the abduction of the shoulders, and the pectoralis major produces internal rotation and extension of the arm at the glenohumeral joint. The latissimus dorsi works together with the pectoralis major to assist in upper extremity actions, helping with rotation and arm movement.

Musculoskeletal joints, specifically the shoulder and elbow, are used frequently to help create energy for the next move when playing, making it vital that the different joints work together during energy transfer so that the joints are exposed to equal pressure. A kinetic chain combines arranged joints to create coordinated movement. In tennis, players use a kinetic chain, coming from the lower body (feet, thighs, and legs) passing it to the upper body (shoulders and hands) creating maximized power onto the ball to hit inside the court. The rotator cuff muscles are a part of the kinetic chain, which is where the power needed comes from. The kinetic chain changes based on how much experience players have because every player uses different joints to hit the ball. A more competitive tennis player has more experience using the kinetic chain, making them more efficient and decreasing the force and pressure onto the shoulder region. However, recreational players often have less experience in efficiently using the proper technique. As it is exposed more to shoulder movement, the kinetic chain causes more shoulder injuries to the player, evident in long matches.

The complexity of the rotator cuff makes it significantly susceptible to a variety of injuries, such as tears. The location of the tears is commonly split into three types: superior supraspinatus tendon (affects the supraspinatus tendon), posterosuperior (affects both the supraspinatus and infraspinatus posteriorly tendons), and anterior superior tears (affects the supraspinatus and subscapularis tendon). The rotator cuff tendon is responsible for the movement and rotation of the glenohumeral joint. Tears can disrupt normal shoulder motions by changing the force balance between the subscapularis and infraspinatus tendons. When the tear progresses and involves the posterior area of the cuff, instability and a loss of function in the glenohumeral joint happen as a result. Rotator cuff injuries take place in many different forms, such as strains, tendinitis, and bursitis, which range in thickness and location. Damage to the rotator cuff causes

strong pain and pressure to the rotator cuff muscles, broken up into partial and full-thickness tears, primarily in older-aged athletes, caused by aging or traumatic injury. A partial rotator tear occurs when only a part of the tendon is damaged, whereas, a complete rotator cuff tear occurs when the tendon is completely damaged from the humerus. Full-thickness tears are rare in younger athletes under 35 years, while players older than 50 years are more inclined to getting full-thickness tears due to the shift from minor lesions to degenerative changes, which causes shoulder internal impingement. If the number of older-aged athletes increases, then the likelihood of rotator cuff injuries increases.

ANALYZATION OF RESEARCH SOURCES

Further knowledge on this topic can be developed through the examination of several research journals. The scholarly article, *Rotator Cuff Injuries in Tennis Players*, introduces the role of the rotator cuff, crucial for movements such as overhead strokes; specifically the serve, one of the most demanding strokes. Tennis players spend nearly half of the games starting the point off with the serve. The three most common serves are the flat, topspin, and slice serves, each ranging in the force acting upon the shoulders when hitting the serve [Appendix B]. Players must make a small, repetitive turn at the beginning of the service, requiring an immense amount of strength to push the service in the diagonal service box.

The top-spin (kick) serve is known as the second or backup serve, because it is the most consistent, targeting shorter and recreational players. The kick serve has the greatest amount of force on the shoulders, putting it at risk for injury. The slice serve has the lowest impact on the shoulders. It is commonly advised that new tennis players learn the slice serve first, then gradually learn the kick serve as they get more comfortable. This also puts recreational tennis players at higher risk of more serious injuries in the future due to improper technique and less experience than competitive players.

It is also crucial to dive deeper into the anatomical explanations that cause these injuries of the rotator cuff. Tears of the rotator cuff occur as a result of the repetition of the rotation of the the shoulder joint, which changes the arc of the shoulder and produces “an increased degree of external rotation at the expense of posterior capsule tightening.” Although this allows for a more powerful serve, an increased degree of external rotation causes posterior tightening, preventing

the degree to which the athlete's shoulder can rotate internally as a result. Thus, this can cause conditions such as GIRD (Glenohumeral Internal Rotation Deficit), characterized by a " >18° loss of internal rotation in the athlete's dominant shoulder compared with the non-dominant shoulder." GIRD is the tightening of the posterior muscles of the shoulder, causing shoulder stiffness and shoulder deceleration.

The Role of Age

Rotator cuff disease is multifactorial, both intrinsically and extrinsically. Rotator cuff disorders also contain many changes from impingement syndrome, resulting from the repeated squeezing of the rotator cuff tendons. This can lead to a test in the rotator cuff, causing disabilities. One of the main factors that play a role in rotator cuff injury is age. The research journal, *Exercise Rehabilitation In The Non-operative Management Of Rotator Cuff Tears: A Review Of The Literature*, examines the relationship between the development of rotator cuff injuries and factors associated with aging, such as degenerative tendon changes and repetitive overuse in the shoulder joint. Furthermore, Vidt et al. (2016) identify the prevalence of rotator cuff injuries as being present in 26% for individuals aged 60–69 years, 46% aged 70–79 years, and 50% aged 80+ years. Older players' shoulders are already weak due to natural degeneration of their muscles, so they are more easily negatively impacted by hitting some strokes which younger players are easily able to hit without injury. Older athletes are prone to placing repetitive stress on the shoulder, which continues to add pressure over time. In addition, sarcopenia, or muscle loss, leads to decreased strength in the muscles of the arm, making individuals in the age group more prone to injury.

The primary causes of tears in older athletes are acute and degenerative tears. Degenerative rotator cuff tears are from the tendons weakening over time as individuals start to age and decrease in blood supply, which doesn't allow the damage to naturally heal. Most degenerative rotator cuff tears come from an area near the infraspinatus and supraspinatus tendons. For example, in superior posterior and complete tears, an action involving the subscapularis tendon is more likely to produce symptoms, whereas superior rotator cuff tears are shown not to produce any symptoms. These upper extremity injuries are mostly caused by the overuse and dysfunction of the shoulder, leading to complications with the soft tissue. As such, the increase in recreational older athletes further increases the likelihood of a more damaged

tendon. Acute tears happen when there is a force applied to the rotator cuff and shoulder, such as improper or unnatural technique on a stroke; this type of tear is primarily seen in athletes. Finally, full rotator cuff tears are primarily caused by shoulder dysfunction, increasing functional demands in older individuals and becoming more widespread due to the aging population.

Nonoperative vs. Operative Treatment: Costs & Benefits

With the rise of injuries amongst older tennis players, researchers have diverted their attention towards finding the best form of treatment. Multiple factors should be reviewed, such as age, existing symptoms, conditions, and patient's activity level. In addition to the rotator cuff being easier to injure in older players, it is also much harder to heal. Additionally, if younger players get a rotator cuff injury, they are more prone to reinjury when they are older. Treatment options vary depending on age, the size of the tear, and the patient's desire to have surgery. It has been previously debated on whether it is more efficient to use non-operative or operative treatment on older patients. From age, older athletes are already vulnerable to age-related rotator cuff conditions, such as diabetes mellitus and osteoporosis. Physicians tend to use non-operative treatment more often to reduce symptoms and pain, as there are more risks involved in operative treatment in older-aged athletes. As such, exercise rehabilitation and physical therapy may be an alternative to repairing by surgery. These non-operative treatment options have shown high success rates, without surgery.

On the other hand, operative treatment is beneficial by repairing the rotator cuff tendon, further protecting tear progression and degeneration, and can alter the pathogenesis of rotator cuff injuries. Most patients with less severe tears (partial tears) heal without surgery; however, if the pain keeps escalating, surgery is necessary. Degenerative tears, associated with elderly individuals, have high retear rates "over 50% have been observed following fixation of RCTs in patients older than 70 years."

Common surgical procedures involve reattaching the tendon to the humerus and subacromial decompression. Arthroscopic decompression is a type of surgery that uses a small camera (arthroscope) to inspect the tissues near the shoulder joint. Arthroscopic rotator cuff repair is the preferred method because of the huge success rate in patients, allowing them to continue their daily functions and level of play.

RESULTS

Findings from previous literature on the topic at hand have shown that there has been an increase in recreational older athletes, which increases the likelihood of having a more damaged tear. Younger patients were shown to have a higher ratio of partial-thickness tears compared to complete tears. On the other hand, older patients were "three times more likely to experience massive rotator cuff tears." Therefore, this concludes that older athletes are more prone to more severe complete thickness tears, as "approximately 25% of patients in their 60 s and 45% of patients in their 70s suffer from rotator cuff tears. Patients 80 years and over have an even higher occurrence rate of 80%." The increase in recreational older athletes further increases the likelihood of a more damaged tendon. Given that full rotator cuff tears are primarily caused by shoulder dysfunction, tennis increases the functional demands in older individuals and makes rotator cuffs more widespread in the aging population.

Additional studies have found that out of 51 tennis players with rotator cuff tears, 32 patients were recreational tennis players, while 19 were competitive tennis players. From that sample, the full-thickness tears were most likely from older players and the partial-thickness tears were most likely from young players. This may be because aging causes weaker shoulders in older players, causing more damage to them. This result shows several factors to why recreational tennis players are injured more, such as not preparing enough before and after they play, unaware of what causes these tears to occur, like the kick serve, or using techniques that put the shoulder at risk. Less than half of the tennis players that had a rotator cuff tear were competitive, indicating that these players are at the level to practice more difficult techniques or swings and have experienced the force on the shoulders for a longer time.

It is also important to take into consideration findings of human anatomy to further understand the mechanisms underlying these injuries. The shoulder joint is a major factor in the ball's speed and contributes to "nearly 4-17% of all tennis injuries." It is the "most mobile joint in the body" and balances stabilization and rotation, so damage to this joint can be very painful and prevent players from playing for a couple of months. Most shoulder movements surround rotator cuff muscles that "attach to the scapula and other surrounding capsular structures." Players may experience weakness when the shoulder becomes damaged from "chronic overload" and develop a syndrome called scapular dyskinesis, which occurs in a change in the normal

position of the scapula as a result of shoulder movement. This ultimately produces pain and pressure when hitting the ground and overhead strokes.

To address this issue, several studies have been conducted to develop a successful treatment. Investigations have shown that mesenchymal stem cells generate a high level of growth factors and immunoregulatory molecules. As such, treatments using mesenchymal stem cells have been proposed to treat tissue damage in individuals and disorders of the immune system. Han et al. (2019) have demonstrated that data from previous investigations show mesenchymal stem cells as being effective in enhancing the repairing and regeneration of tendons and bones. Furthermore, there is a similar treatment to mesenchymal stem cells called platelet-rich plasma (PRP). PRP contains a variety of growth factors, which can promote angiogenesis and the regeneration of tissue regeneration. If these expected effects were to be held, PRP holds great potential as a treatment for treating tendon-bone injuries. In theory, if one were to combine these two treatments, the recovery of tissue could further be promoted to a greater extent. Once again, Han et al. (2019) have proved through the findings of the current investigation, as displayed in Appendix C, that the combination of these two treatments improves the results of tendon-bone repair and enhances the biochemical attributes of the regenerated tissue. This is relevant to the topic at hand as it can be utilized effectively in the treatment of rotator cuff injuries. This finding is especially of interest as it can be used as a treatment for the elderly population, as it is a non-invasive procedure with few to no risks.

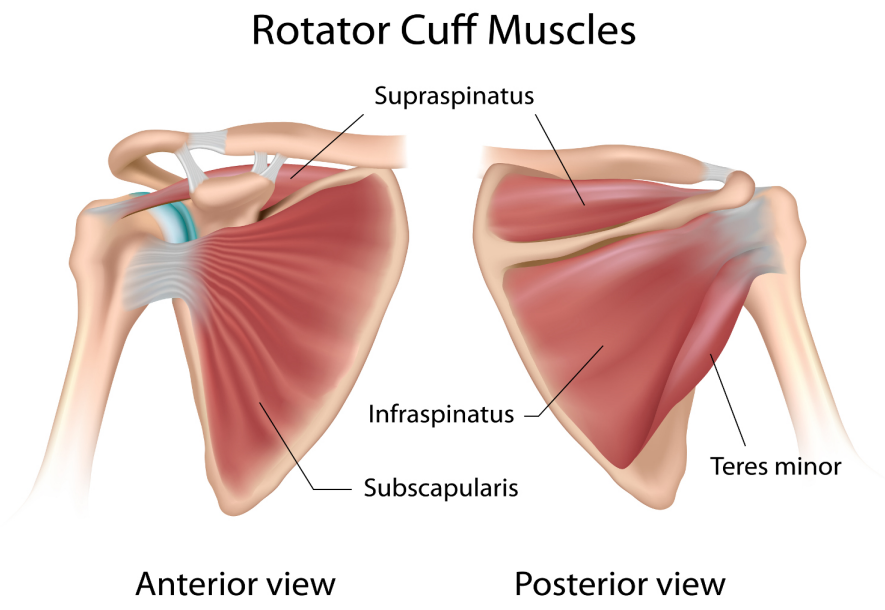
In the United States alone, tears of the rotator cuff affect at least 10% of those over the age of 60, equating to over 5.7 million people and resulting in an estimated 75,000–250,000 rotator cuff surgeries performed per year. In Australia, this figure is approximately $14,000 annually, with direct medical expenses for rotator cuff repair estimated at $250 million per year. Therefore, it is important to investigate possible solutions to reduce the increasing social and economic burden that rotator cuff repair places on patients and health care systems around the world.

CONCLUSION

Overall, older-aged athletes are different from younger players because they start to develop conditions from aging, not often seen in younger players. Recreational players are more

prone to rotator cuff injuries because they are not informed or educated on the different types of strokes they should be using. They also tend to try to copy the technique of professional athletes, which puts the shoulder at risk. Professional and competitive athletes are used to repetitive training and their muscles can handle all of the pressure. In addition to this, older players need to understand how their pre-existing conditions can increase their risk of injury. Therefore, as the number of older-aged athletes playing tennis rises, the number of rotator cuff tears also rises. There are ways to minimize the likelihood of getting these injuries, but not fix it to the full extent. Even though there is no guarantee to prevent rotator cuff injuries from occurring, tennis players need to be aware of what causes these injuries and look for ways to decrease the likelihood of getting an injury. As a whole, all players need to gain awareness of proper technique and strengthening exercises for the muscles that are most at risk and prone to injury. Athletes can do this by joining organizations that spread awareness on these types of injuries, learning about the causes and effects of these injuries, talking to their doctors, or reading books about it.

In the future, researching how this information can be applied to other fields of study and how it can be generalized to the population will have a significant impact on future research. Furthermore, conducting experiments or analyzing research on studies on the efficacy of non-operative vs. operative treatment in older tennis players, taking into consideration Gender differences, and breaking down the demographics of older tennis players would be very beneficial.

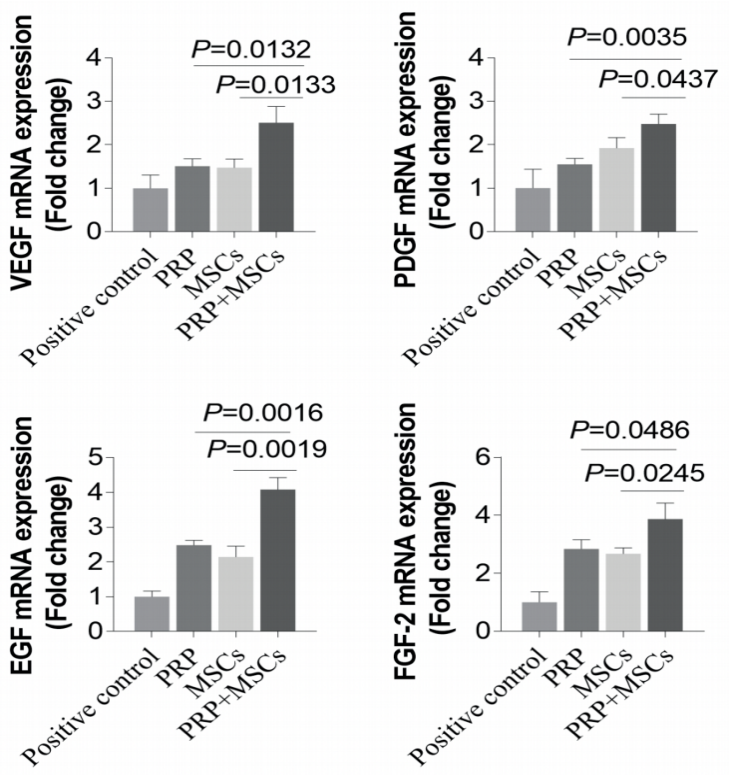


Appendix A

Figure: Overview of the four muscles that come together to form the rotator cuff.

Appendix B

Figure: Differences in the three most common types of serves players hit, all of which are prone to different rotations.



Appendix C

Figure: Statistics displaying the difference of mRNA expression under four different physiological conditions.

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Accessibility of Brain-Computer Interface Technology

Peach Paraiso

ABSTRACT

This research was conducted to know if brain-computer interface technology will be accessible for underserved communities when the time comes that they will need it. Information was gathered by asking the participants about the family's financial situation, questions on how much the family is willing to pay, and how much money the family has in case of emergencies. Questions were compiled in a google form and the survey was distributed through different online communities and other social media platforms. Several participants willingly filled out the survey so pie charts and bar graphs were generated to help in organizing the data to make the data understandable. Results have shown that even if a family belongs to underserved communities, they still have insurance or savings to help them get through medical expenses. It also shows that most people have access and a small percentage lack access. Based on studies conducted, the families that lack the means of affording brain-computer interface technology can be supported and funded through fundraising events which will lower the number of families who can not afford brain-computer interface technology.

INTRODUCTION

Brain-computer interface is a new kind of technology that is currently being developed. The user's brain is used to control external devices. This kind of technology will be life-changing for physically disabled patients especially half-paralyzed patients. The development of brain-computer interface technology has been progressive throughout the years and it will soon be fully functional. However, the accessibility of the new technology for middle-class families and underserved communities is an expected problem.

The experiment was conducted through the participation of the community through online platforms. The purpose of the experiment is to gather data and analyze whether a brain-computer interface will be accessible for underserved communities through an observational study. Experimenting was imperative because, through the experiment, people from different parts of the world from different backgrounds were able to share important data

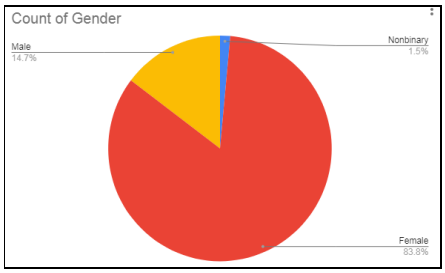
for the research, such as the estimated amount their families are willing to pay in case brain-computer interface technology will be needed for a family member. An observational research study couldn't be conducted without the participation of humans. This study was conducted with the consent of human participants who willingly shared their data with the researcher.

If a brain-computer interface is highly accessible, then it should ease the lives of disabled people even if they belong to underserved communities because unprivileged people should be able to have access to this kind of technology and not be exclusive to the ones who can pay a high price. The study focuses on the accessibility of the technology for underserved communities because people have witnessed in previous big technologies created, families were not able to afford these. Willingness to spend money on the new technology will be determined especially for low-income families.

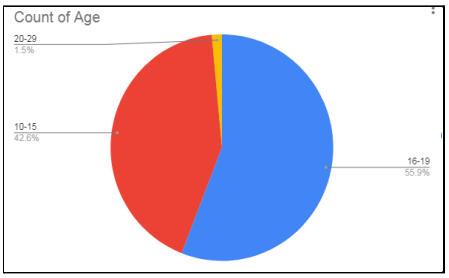
METHODS

This research was conducted entirely online and because of that, methods of experimenting were limited. A survey form was used to gather data for the research. To release an engaging survey, questions had to be brainstormed. The survey contains mostly YES/NO questions so that the participants will not be required to type in long answers but will still be required to properly analyze the question. Revisions to several questions had to be made and the number of questions to be asked were limited to keep it short, simple, and understandable for the participants. When the questions were finalized, the online survey form was released to several online platforms in hopes of attracting prospective respondents to participate in the study. A spreadsheet was made to track responses and for easy checking from time to time. The respondents or the participants who filled out the survey form were the dependent variables and the questions that were asked are the independent variables. The variables that were controlled were the independent variables or the questions. The questions needed to be controlled because at the beginning, questions were constantly being changed.

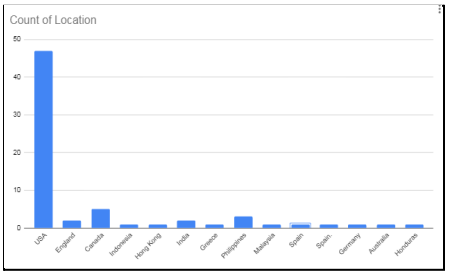
RESULTS



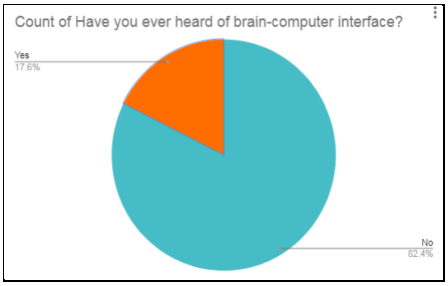
This pie chart shows that most of the respondents were female. 83.8% were female, 14.7% were male, and 1.5% were non-binary. This shows the gender of the respondents that is a member of a family in a community where a brain-computer interface is expected to be used.



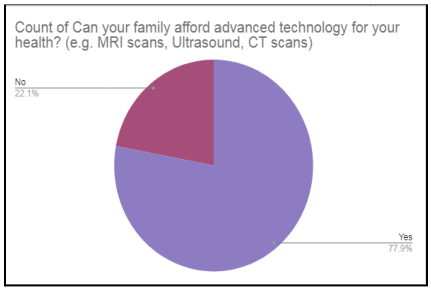
The pie chart on the left shows the age of respondents of the brain-computer interface accessibility survey. 55.9% were in the 16-19 range, 42.6% were in the 10-15 range, and 1.5% were in the 20-29 range.



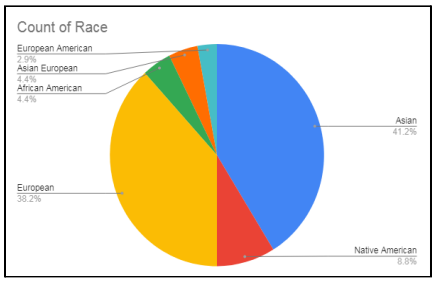
This bar graph shows 14 different locations of the participants and it indicates how diverse the respondents in the survey are. This is a great way to have a glimpse at the accessibility of brain-computer interfaces in different parts of the world, not just from one place.



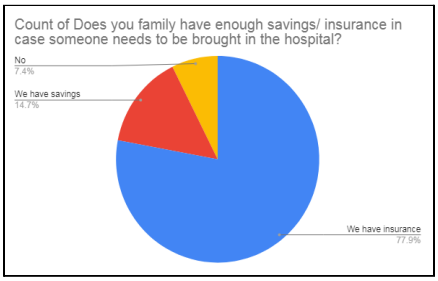
82.4% of the respondents said they haven't heard of the brain-computer interface before. This was understandable and a brief explanation of what the brain-computer interface was is provided at the beginning of the survey form to give initial knowledge to respondents.



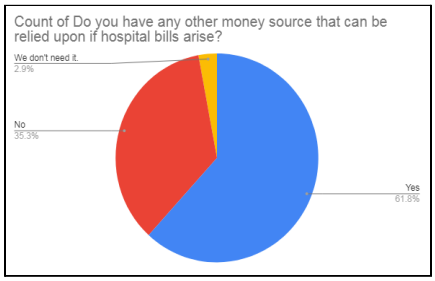
77.9% of the respondents said that their families can afford advanced healthcare technology, while 22.1% said that their families cannot pay for advanced healthcare technology. This partially indicates that 77.9% can also afford brain-computer interfaces since they have the means to pay for advanced healthcare technology.



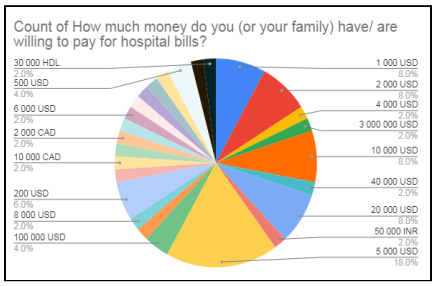
The majority of the respondents came from the Asian community. A big portion also came from Europeans, and a small portion of the respondents came from European Americans, Asian Europeans, African Americans, and Native Americans.



77.9% of the respondents have insurance to cover their healthcare expenses which is great news because there is a big chance that they can access the brain-computer interface if needed. The 7.4% however can hopefully be provided for by fundraisers and donation drives if they will need access to the brain-computer interface.



61.8% said that they have other sources that they can go to in case insurance or savings aren't enough. The 35.3% however, do not have any other money source in case insurance or saving will not be enough.



The amount of money each family has allotted for hospital bills was diverse and in the pie chart, it can be inferred that 5000 USD is the most common amount of money available for healthcare bills.

DISCUSSION AND CONCLUSION

Brain-computer interface is being developed quickly and it will become fully functional soon. However, its price and accessibility to middle-class families and underserved communities are undetermined. Some may be willing to spend a huge amount of money on the new technology for disabled persons but some may not have enough, though willing. If a brain-computer interface is highly accessible, then it should ease the lives of disabled people even if they belong to underserved communities because unprivileged people should be able to have access to this kind of technology and not be exclusive to the ones who can pay a high price. Research has shown that most of the families in communities will be able to afford brain-computer interfaces. In a pie chart with the responses to the question "Can your family afford advanced technology for your health?", 77.9% of the respondents said that their families can afford advanced healthcare technology, while 22.1% said that their families cannot pay for advanced healthcare technology. This partially indicates that 77.9% can also afford brain-computer interfaces since they have the means to pay for advanced healthcare technology.

The information that has been gathered will be very useful especially for scientists who are developing the brain-computer interfaces. It will give them an idea about what people can afford and how much money they have for these kinds of advancements. Releasing this information to the public will give the people an idea of what is this brain-computer interface, how it will be useful, how important it will be, and will give them an idea that they need to save up to secure finances for hospital bills because when the time comes, you will want to have access to this kind of advanced technology. A problem that was encountered when data analysis is being performed is the very diverse amount of responses when asked for a specific amount of money. Researchers should have given the participants choices regarding the range of money so responses will be uniform. If this mistake was corrected from the beginning, the responses about the amount of money a family has will be narrowed down.

The experiment that was conducted was valuable, yet it needs further action. Surveys can be launched in different communities and data can be analyzed within a specific community in a very specific place so that the data that will be gathered will be more specific. It would be great if the question, “How accessible will brain-computer interface be for the families in X village compared to the families situated in Y village?” was asked in another study. Knowing this will, furthermore, be helpful as the study is conducted in a specific place.

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Inside the Mind of Alzheimer's

Saniya Chethan

ABSTRACT

The brain is arguably the most important aspect of the human body. It holds memories and identities among many other vital components. Therefore, research based on the effects of Alzheimer's, a disease that deals with the decrease in cognitive skills and memories through the brain, is crucial. By focusing on the key elements of the brain, neurons, one can further understand the dealing of Alzheimer's disease. By thoroughly analyzing research papers, the following statement about the effects of Alzheimer's on patients' brains was determined. An abnormal buildup of proteins such as tau and amyloid plaques in the brain causes the neurons of an Alzheimer's patient to degenerate.

INTRODUCTION

Alzheimer's is in the top ten leading causes of mortality in the United States and is a growing concern. This disease is thought to originate from the unusual accumulation of proteins in and around brain cells. As these proteins affect the brain cells, a decline in neurotransmitters (chemical messengers) is observed. These neurotransmitters are responsible for important roles such as sending messages or signals between brain cells. Over time, due to these decreased levels, different areas of the brain shrink. The first areas generally to be affected are responsible for memories, thus, shown by the drastic memory loss symptoms.

Unfortunately, Alzheimer's currently has no cure, however, research continues and treatments for symptoms are available. These treatments can temporarily slow the worsening of dementia symptoms and improve the quality of life for patients. A couple of symptoms are severe memory loss, confusion, difficulty remembering newly learned information, disorientation, mood changes, and behavior changes, difficulty speaking, trouble swallowing, and problems with walking. Since all of these changes drastically alter the lives of these patients, Alzheimer's is a cause to be concerned about.

To get to the core of the disease, one must further explore the effects that Alzheimer's has on the brain specifically. The utmost core of the brain includes features like neurons, nerve cells within the brain. These neurons are messengers for information as they use electrical impulses and chemical signals to transfer information between different areas of the brain. An adult brain holds around 100 billion nerve cells and branches connect these nerve cells at more than 100 trillion points. Thus, making neurons the key player in brain activity. By researching neurons, brain activity, and the effects that Alzheimer's can have on these factors, one can further understand the basis behind this disease. This research can help further Alzheimer's research studies in understanding this disease and eventually finding a cure. If Alzheimer's disease is present in a patient, then the neurons in the patient's brain will undergo significant damage because Alzheimer's disease reduces the amount of brain activity in a patient and neurons are one of the key components of brain activity.

ANALYZATION OF RESEARCH SOURCES

The first source of information, *What Is Alzheimer's Disease?,* touches on the basics, the known effects, and the symptoms of Alzheimer's. First off, it goes over the age at which Alzheimer's would usually start (around sixty years old), a brief history about the disease, and which parts of the brain Alzheimer's affects. According to the article, there are plaques and tangles in the brain that are considered some of the main features of Alzheimer's that were the initial cause for deterioration in the brain's neurons. More specifically, amyloid plaques and neurofibrillary (tau tangles) are considered to be the reason for the deterioration (NIA scientists and other experts, 2017). Lastly, it goes on to explain what the disease looks like, how long a person can live with Alzheimer's, and other general information about the disease.

The second article, *The Progression of Alzheimer's Disease*, goes over amyloid plaques, neurofibrillary tangles, Alzheimer's symptom progression, and the stages of the disease. One of the key characteristics of Alzheimer's is the accumulation of amyloid plaques as they are protein fragments that were never broken down and eventually formed hard insoluble plaques. The second key characteristic, neurofibrillary tangles, are insoluble twisted fibers containing tau that are found inside the brain's nerve cells. The buildup of tau protein from the tangles is abnormal and causes structures within the brain to collapse (BrightFocus Foundation, 2020). In the early

stages of the disease, short-term memory begins to decline as the cells in the hippocampus degenerate. In the intermediate stages, judgment worsens, emotional outbursts may occur and language is impaired. In the final stages, people may lose the ability to feed themselves, speak, recognize people and control bodily functions.

The third article, *What Happens to the Brain in Alzheimer's Disease?*, outlines the effects of Alzheimer's disease on the brain. The article goes further on to explain key topics such as the key biological process of the brain and the main characteristics of the brain with Alzheimer's. The first section labeled, "key biological process of the brain" entails the parts of a neuron, the cell body, dendrites, and the axon. Each part of the neuron has a specific job that allows them to complete their duties such as communication, metabolism, repair, remodeling, and regeneration. However, in the brain of an Alzheimer's patient, these functions do not occur and there are many negative outcomes. In Alzheimer's, there is mass damage to neurons, resulting in loss of function for neurons, decreased communication with other neurons, and eventual death of neurons. The disease usually destroys neurons and their connections in parts of the brain that is involved in memory, language, reasoning, and social behavior (NIA scientists and other experts, 2017). Furthermore, the article discusses the characteristics of the brain with Alzheimer's such as amyloid plaques, neurofibrillary tangles, chronic inflammation, vascular contributions to Alzheimer's disease, the loss of neuronal connections, and cell death. All in all, this article covers all of the components of the brain during Alzheimer's.

The last article, *Alzheimer's Disease Destroys Neurons that Keep Us Awake*, uses research to deduce the effects of Alzheimer's on sleep. It also introduces how Alzheimer's directly attacks the brain regions responsible for wakefulness during the day. The deterioration in such brain regions allows for brain degeneration that drives Alzheimer's symptoms. Furthermore, the article discusses tau buildup and how specifically the buildup leads to brain degeneration. Since the whole wakefulness-promoting network is degenerating, not just a single brain nucleus, the brain has no way of compensating because all of the functionally related cell types are being demolished at the same time (Weiler, 2019). Therefore, concluding that the brain has no way to compensate and starts deteriorating at a serious rate.

DISCUSSION AND CONCLUSION

The topic of Alzheimer's disease is a vast topic that still has a lot of potential for research and learning as not much is known about this disease. Specifically, the effects of Alzheimer's on neurons are important because neurons are the key components to the affected area, the brain. Therefore, the following hypothesis was developed. If Alzheimer's disease is present in a patient, then the neurons in the patient's brain will undergo significant damage because Alzheimer's disease reduces the amount of brain activity in a patient and neurons are one of the key components of brain activity. After conducting research, it was determined that the hypothesis was proven to be true. The researched articles discussed the negative effects of the abnormal buildup of tau from microtubules that eventually block the neuron's transport system and harm the communication between neurons. Moreover, the articles covered the malicious effects of an accumulation of amyloid plaques, protein fragments that were never broken down, that eventually formed hard insoluble plaques. These results can give a better overall understanding of what occurs in the brain of an Alzheimer's patient. They can also further the research on Alzheimer's to provide more treatments and devices to aid such patients. Therefore, eventually finding a cure for this disease. However, there are several limitations to this research. Since this research is on a disease that needs data on humans with the disease, certain ethical limitations can lead to the research being a prolonged study. Moreover, this specific research paper collects and expands on other studies, so this paper is unable to supply new experiments. The results of this research additionally act as a new platform to base new future research questions. The following are examples of such research questions. What are the main contributing factors to tau buildup and/or amyloid plaques? How can the buildup of tau and/or amyloid plaques be prevented or slowed? Why does the buildup of tau and/or amyloid plaques occur? How do the two factors, the buildup of tau and amyloid plaques, affected each other? All in all, this research deeply expanded on the effects of Alzheimer's disease as it discussed the factors that lead to degenerative neurons and how others can use this information to further research on the topic of Alzheimer's.

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Impact of COVID-19 on the Development of Cognitive Skills, Perspectives and Experiences of Individuals with Developmental Brain Disorders

Shristi Jain

ABSTRACT:

COVID-19 has affected millions of lives in unexpected ways. Virtual learning and work from home culture force one to extensively use electronic gadgets that have proven to impact the functioning of our brain and ultimately cause disorders. Neurologists noticed a spike in such cases during the lockdown, and we surveyed google forms to test the relationship between usage of gadgets and symptoms of Developmental Brain Disorders (DBD). With a P-Value less than 0.05, our hypothesis was significant that Developmental Brain Disorders can be caused due to the increase in screen time.

INTRODUCTION

Kokilaben Dhirubhai Ambani Hospital and Medical Research Institute researches various topics that are medically relevant. Dr. Pradnya Gadgil is a Paediatric Neurologist and Epileptologist at Kokilaben Dhirubhai Ambani Hospital and is actively involved in researching their Neurology Lab. Her specialization is in Epilepsy which is a common clinical entity in neurology clinics. The prevalence rates of epilepsy in India are similar to those of developed nations. Dr. Gadgil's Lab is actively involved in studying the large treatment gap and why it is a major challenge to India's public health system. They have discussed a few common etiologies such as neurocysticercosis, newer genetic epilepsy syndromes and touched upon the Indian experience in pediatric epilepsy surgery.

The lab is also very focused on a bunch of interesting pharmacological projects. Recently they proposed a letter to the editors of Neurology India where they discuss how a first-line drug used in the management of ISs, Vigabatrin (VGB), induced reversible changes on magnetic resonance imaging (MRI) of a 7-year-old girl who was presented with seizures at the age of 3 months.

Dr. Gadgil's guidance, and tie up with Dr. Kunal Jadhav's Neuro Hub, Dr. Sandeep Borse's Axon Neuro Centre in Pune, allowed our experiment to focus on the impact of COVID-19 on the development of Cognitive skills, perspectives, and experiences of People/Children with Developmental Brain Disorders (DBD). Developmental Brain Disorders (DBD) can be caused before or after birth due to multiple reasons like maternal stress, environmental factors, usage of gadgets, extracurricular activities, etc. With the COVID-19 pandemic, this situation has only worsened and impacted millions of lives in different ways. With virtual learning and work-from-home culture being very popular these days, one would agree that the screen time consumption of individuals has also gone up. Naturally, symptoms of DBD like Epilepsy, motor impairment, seizures, and prescriptions of their respective medications might have also gone up indicating an impairment of neurological components of our brain. We hypothesize that if the usage of electronics increases in response to virtual learning, then the symptoms and prescriptions of developmental brain disorders (DBD) medications will increase rapidly because the usage of electronics directly affects the brain development of individuals and causes various brain disorders.

METHODS

To understand the relationship between usage of electronics and developmental brain disorders (DBD) a survey was conducted with individuals who visited Neurologists in Maharashtra, India. The survey was conducted in the Neurologists' clinic via Google Forms and had to be narrated in the patient's local language i.e., Hindi or Marathi to gather information effectively. The purpose of our survey was to better understand the experiences and perspectives of patients from India with neurological disorders, specifically before and after the Quarantine/Lockdown period due to the COVID-19 pandemic.

The COVID-19 Pandemic took a hit on the educational, professional structure everyone was accustomed to. People from various corners of the world had to switch to a completely virtual environment during the quarantine/lockdown period. This increased usage of electronics in response to the pandemic was the independent variable of our experiment. Neurologists had noticed a shift in behavior and symptoms post lockdown in patients, and we wanted to see if the usage of electronics directly affects the brain development of individuals and causes symptoms

of various brain disorders. This dependent variable of increased symptoms could be backed up with an increase in medications provided to patients for developmental brain disorders (DBD).

It was necessary to identify individuals who had increased their screen time during the lockdown period. Initially, our target was children and youth since the virtual environment had directly impacted individuals that fall in these age ranges. However, it was observed that a lot of adults and senior citizens were hooked to their screen for hours as they had nothing else to do once the pandemic hit. Hence, the experiment was governed by patients from various age ranges who saw an increase in the gadgets they used. This was necessary to check if new behavioral symptoms arrived during the lockdown period that weren't evident before the lockdown period. Another variable that played a key in controlling our experiment was the pre-existing records of patients who weren't visiting the clinic for the first time. This helped us gather evidence of the prescriptions with various symptoms and medications that were provided to the patients before lockdown to analyze if there were changes in the medications provided to treat patients.

RESULTS

The sample size for this experiment needed to be restricted to 18 patients (n=18) due to the increasing Covid Cases in Maharashtra. It included patients from the age of 3.5 to 73 years. 5 patients were from Mumbai, and the remaining 13 were from Pune. This division was solely due to the fact that Mumbai went under a total lockdown during this experiment, and it became difficult to access the Neurologist.

FIGURE 1.1 Electronic Gadget Usage

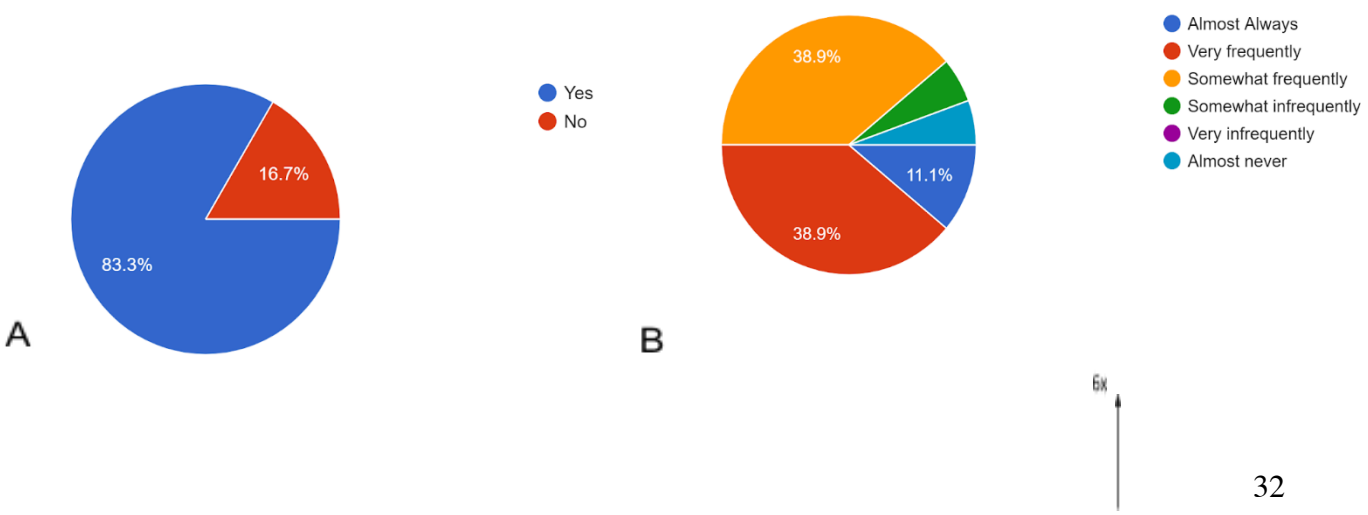

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Fig 1.1 represents the usage of Electronic Gadgets by the sample (n=18). Pie chart "A" shows the increase in patient's use of an electronic gadget in response to the pandemic. Pie chart "B" shows exactly how much the patient resorted to an electronic gadget during the lockdown period (March 2020 onwards) as compared to before the lockdown.

Based on the survey, in Fig 1.1A we found out that 83.3% of the sample had seen increased usage of electronic gadgets due to the pandemic. Fig 1.1B depicts the exact division of the 83.3% sample that said "Yes" in response to the usage of electronic gadgets. The sample had an option to choose from different categories which have respective points assigned on a scale of 1 to 6. 50% of the sample size in Fig 1.1B said that they "Almost Always – 6 points" or "Very Frequently – 5 points" used their electronic gadget as compared to the pre-lockdown period.

Fig. 1.2 Comparison between the Usage of Electronic Gadgets before and during/after lockdown

Patient #	Patients Age (Yrs.)	How much did the patient resort to an electronic gadget **before** lockdown?	Points	How much did the patient resort to an electronic gadget **during/after** lockdown?	Points
1	3.5	Somewhat infrequently	3	Somewhat infrequently	3
2	5	Somewhat infrequently	3	Very frequently	5
3	9	Somewhat infrequently	3	Very frequently	5
4	10	Somewhat infrequently	3	Somewhat frequently	4
5	14	Somewhat infrequently	3	Somewhat frequently	4
6	18	Somewhat frequently	4	Very frequently	5
7	24	Somewhat frequently	4	Somewhat frequently	4
8	26	Somewhat frequently	4	Almost Always	6
9	28	Somewhat frequently	4	Somewhat frequently	4
10	29	Somewhat infrequently	3	Somewhat frequently	4
11	31	Almost never	1	Almost never	1
12	32	Somewhat frequently	4	Very frequently	5
13	42	Somewhat infrequently	3	Somewhat frequently	4
14	50	Somewhat infrequently	3	Very frequently	5
15	52	Somewhat frequently	4	Almost Always	6
16	59	Somewhat infrequently	3	Somewhat frequently	4
17	61	Somewhat infrequently	3	Very frequently	5
18	73	Somewhat infrequently	3	Very frequently	5

Electronic Gadget usage before lockdown		**Electronic Gadget usage during/after lockdown**	
AVERAGE	**3.222222222**	**AVERAGE**	**4.388888889**
SD	**0.7320844981**	**SD**	**1.144752164**
SAMPLE SIZE	**18**	**SAMPLE SIZE**	**18**
95% CONFIDENCE INTERVAL	**0.3640570561**	**95% CONFIDENCE INTERVAL**	**0.5692718582**
P-VALUE	**0.0008898344743**		

Fig. 1.2 is a chart that represents the comparison between the usage of electronic gadgets before and during/after lockdown. The P-Value is less than 0.05 which shows that our hypothesis is significant with a 95% CI of 0.569.

Our results prove that the average usage of electronic gadgets increased to 4.389 points (95% CI = 0.569) during/after lockdown as compared to 3.23 points (95% CI = 0.364) which were observed before lockdown (Fig 1.3). The P-Value is 0.000889 < 0.05 which indicates that our hypothesis is significant and hence proves that the usage of electronic gadgets increases during/after lockdown as compared to before lockdown.

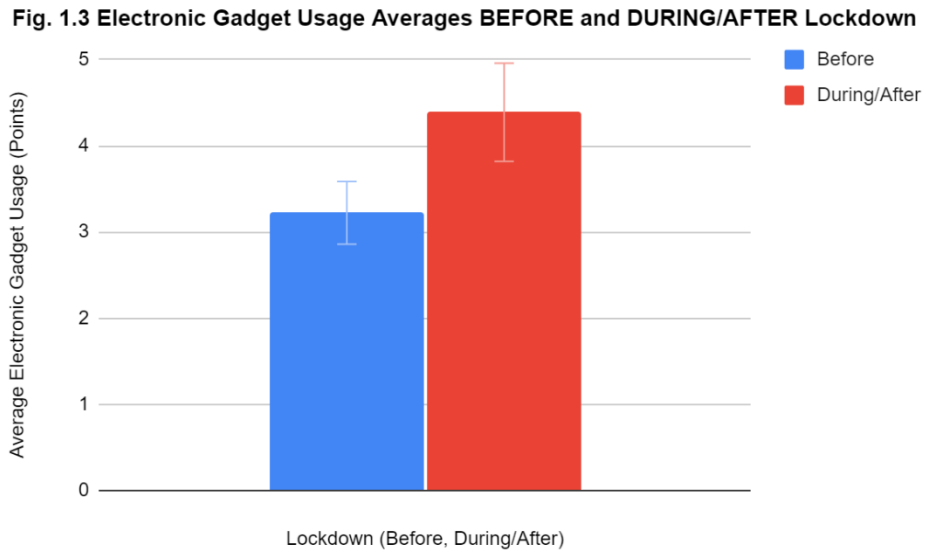

Fig 1.3 depicts the average usage of electronic gadgets before (blue) with an error bar of constant value 0.364 and during/after (red) lockdown with an error bar of constant value 0.569.

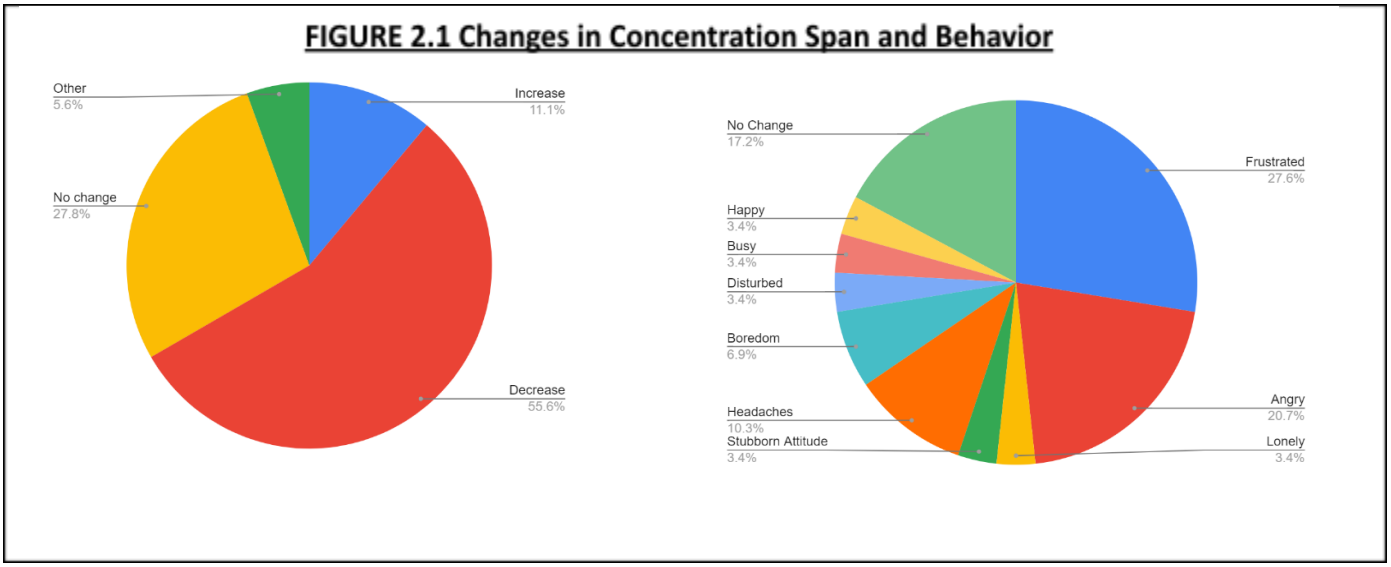

Fig 2.1 represents the changes observed in concentration span (pie chart A) and behavior (pie chart B) DURING/AFTER lockdown that wasn't prevalent before in the sample (n=18).

From Figure 2.1A, a 55.6% decrease in concentration span was seen. The top two differences in behavioral patterns observed in Figure 2.1B were Frustration (27.6%) and Anger (20.7% which further led to an increase in DBD's like Epilepsy, Paralysis, Migraines, Depression, etc. in the sample patient spectrum. Due to unavoidable circumstances, the exact

concentration and medications provided to the patients couldn't be recorded and hence, no conclusions can be made about that.

CONCLUSIONS

The experiment to investigate the impact of COVID-19 on the development of Cognitive skills, perspectives, and experiences of People with Brain Disorders was conducted to understand if the usage of electronics increases in response to virtual learning. We hypothesized that If so happens, then the symptoms and prescriptions of developmental brain disorders (DBD) medications will increase rapidly because the usage of electronics directly affects the brain development of individuals and causes various brain disorders. A significant increase in gadget usage was seen amongst the sample size (P-Value = 0.000889 < 0.05), however, there wasn't a significant increase in a special medication provided due to unavoidable circumstances that interrupted the study. The majority of the people with different brain disorders were frustrated, angry, or were suffering through migraines which could be directly correlated with the increase in usage of gadgets. One of the major limitations of this experiment was that there was a very small sample size (n=18), and in the future, this experiment should be reconducted with a larger sample size to account for differences like sex, hormones, body mass composition, etc. There should also be a distinction in the age intervals, as the brain development of children is different as compared to the youth, adults, or seniors. This experiment should be repeated with pregnant women who use electronic gadgets prior to and during/post-delivery to check if there could be an impact on the brain of newborn babies or the mother during gestation.

Overall, the impact of gadgets has caused severe implications on the brain during the pandemic and is a valuable piece of information that could be used in a clinical setting to predict Developmental Brain Disorders based on the specific experiences and symptoms of patients. It should also be used to educate parents, and children so that they are aware of the implications that could be caused simply by the excessive usage of easily accessible gadgets.

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Exploring Workaholism - Its Causes and Effects

Vivian Ha

ABSTRACT

An individual's overall health and mental wellbeing can be impacted by many factors seen throughout daily life. For teens and young adults, it may be the school environment, relationships, or extracurriculars. For the working adult, work environment, hours in the office, or interpersonal relationship may be the cause of unnecessary stress. After working or studying hard in a certain environment, many individuals are recommended to allocate time for themselves, whether it be doing meditation, exercise, or a self-care routine. In this experiment, the relationship between time spent "working" and time spent "relaxing" is tested against a person's overall happiness and wellbeing. Surveys are conducted daily over a two-week time period that records individuals' number of hours working and relaxing and their overall happiness levels. From these surveys, there is an ongoing trend showing that the more relaxing time in comparison to working time in a day, the person will more likely be happier. From graphs, we can conclude from our findings that there is a positive relationship between free time and happiness, and a negative relationship between happiness and the time allocated for work and school.

INTRODUCTION

With the growing job industry and countless career paths, many adults are investing more and more time into finding and working a job, and students are putting even more time into their education than ever before. This behavior in society has led to many people claiming to have burnout and even a case of workaholism, better known as an addiction to working. The purpose of the lab is to take workaholism and take it apart. When doing so, we find correlations between

working and relaxing time to the happiness levels of an individual. This brings about the question: What is the connection between time spent working, whether it be going to school or working a job, and the time spent relaxing, be it self-care or meditation, to one's happiness and overall mental wellbeing? This question leads to the hypothesis: If an individual works a maximum of 8 hours a day for 5 days a week and supplements their week with at least 1 hour for themselves, mental wellbeing and happiness will improve. This is because the mind can relax after working hard and being stressed in a school or work environment. Without time for the mind and body to relax, there is a higher chance an individual will become overwhelmed and feel taken over by stress. This hypothesis will be tested and be proven true or false by the end of the experiment. Through surveys done on individuals who have both school and working lives, there will be a more conclusive result at the end. Though the lab lacks many resources, the utilization of surveys and strong data analysis will help gage a better understanding of the connections between workaholism and happiness.

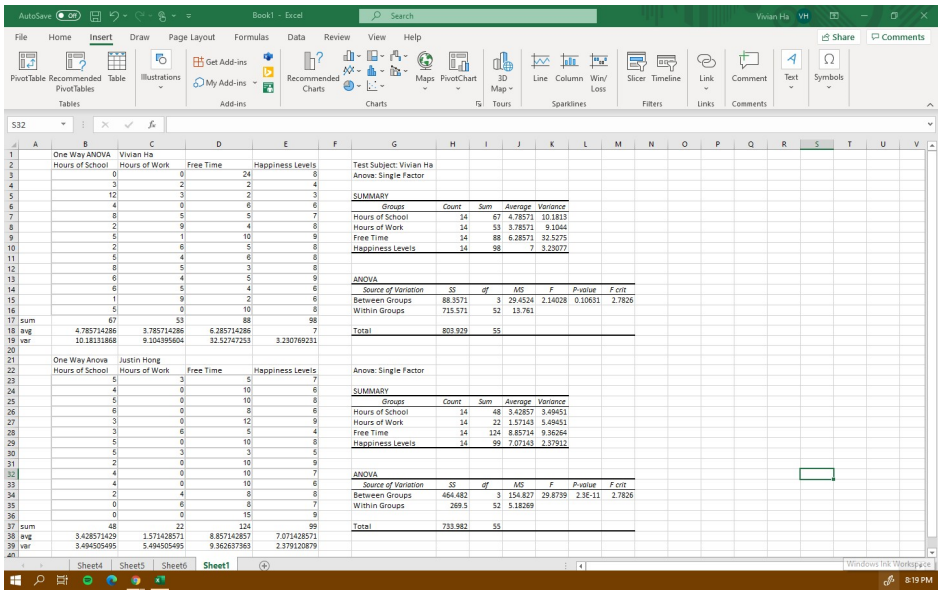
METHODS

In this experiment, the utilization of surveys in combination with data analysis through bar graphs and linear graphs was necessary. The independent variables were set to be the time spent working and time spent relaxing. The dependent variable was set to be individuals' happiness levels rated on a scale of 1 to 10, with 1 being related to depressed, angry, stressed feelings and 10 being related to relaxed, happy, energetic feelings. These times were recorded in hourly form and happiness levels were recorded via scale. Individuals were selected to be in this research and these individuals are both students and have jobs, which helps to have a better overall, general interpretation within the experiment. Surveys were given to each individual and filled out every day, at the end of the day for two weeks. In the survey, there was an additional space at the end of the survey to describe the individual's personal feelings or day-to-day activity that may have occurred and have contributed to overall happiness or sadness. After the survey is conducted for two weeks, this data from the google form is translated over to a google sheet which records the individual's form responses. These responses are then translated into graphs that are later interpreted. From this data set, the individuals will be examined and compared side to side of one another and links will be found in the data set and compared against one another.

From this data analysis, a conclusion will be drawn about the correlation between happiness and working behaviors.

RESULTS

From the surveys, an ANOVA test is produced from each individuals' combination of hours of school, work, and free time and compared to happiness levels. From these numbers, a sum, average, and variance is produced from each category and an ANOVA value is produced.



	One Way ANOVA	Vivian Ha		
	Hours of School	Hours of Work	Free Time	Happiness Levels
	0	0	24	8
	3	2	2	4
	12	3	2	3
	4	0	6	6
	8	5	5	7
	2	9	4	8
	5	1	10	9
	2	6	5	8
	5	4	6	8
	8	5	3	8
	6	4	5	9
	6	5	4	6
	1	9	2	6
	5	0	10	8
sum	67	53	88	98
avg	4.785714286	3.785714286	6.285714286	7
var	10.18131868	9.104395604	32.52747253	3.230769231

Test Subject: Vivian Ha
Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Hours of School	14	67	4.78571	10.1813
Hours of Work	14	53	3.78571	9.1044
Free Time	14	88	6.28571	32.5275
Happiness Levels	14	98	7	3.23077

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	88.3571	3	29.4524	2.14028	0.10631	2.7826
Within Groups	715.571	52	13.761			
Total	803.929	55				

	One Way Anova	Justin Hong		
	Hours of School	Hours of Work	Free Time	Happiness Levels
	5	3	5	7
	4	0	10	6
	5	0	10	8
	6	0	8	6
	3	0	12	9
	3	6	5	4
	5	0	10	8
	5	3	3	5
	2	0	10	9
	4	0	10	7
	4	0	10	6
	2	4	8	8
	0	6	8	7
	0	0	15	9
sum	48	22	124	99
avg	3.428571429	1.571428571	8.857142857	7.071428571
var	3.494505495	5.494505495	9.362637363	2.379120879

Anova: Single Factor

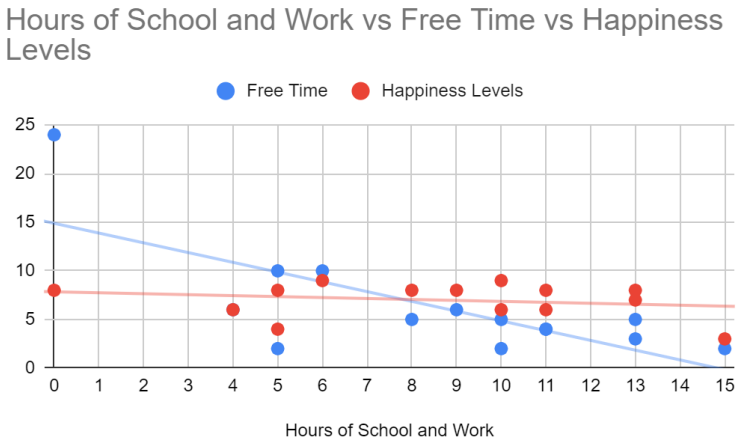
SUMMARY

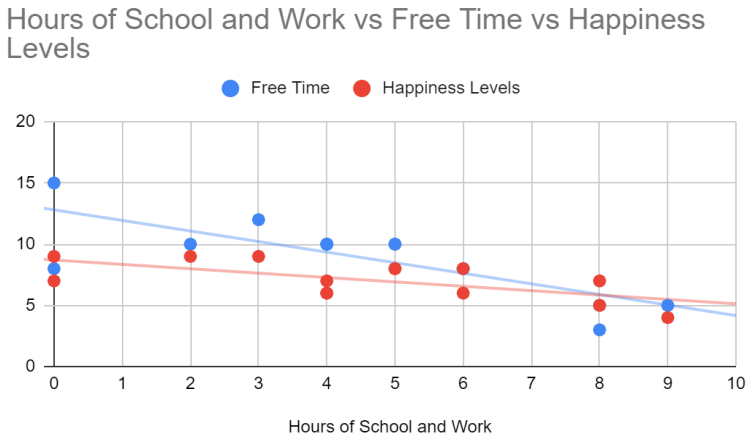
Groups	Count	Sum	Average	Variance
Hours of School	14	48	3.42857	3.49451
Hours of Work	14	22	1.57143	5.49451
Free Time	14	124	8.85714	9.36264
Happiness Levels	14	99	7.07143	2.37912

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	464.482	3	154.827	29.8739	2.3E-11	2.7826
Within Groups	269.5	52	5.18269			
Total	733.982	55				

Additionally, graphs are produced for each individual comparing hours of school and work vs free time vs happiness levels. The graphs are shown below.





DISCUSSION/CONCLUSION

The original problem of today's society is the spreading and growing disease of workaholism that is further detrimental to individuals' wellbeing. Initially, the hypothesis states that if an individual works eight hours a week, five days a week, and supplements each working day with at least an hour of work, mental wellbeing and happiness will improve. This hypothesis can neither be supported nor unsupported due to the environment that this experiment was set in. Due to COVID-19, many people are stationed at home to do work or school, which allows more "free-time" and unallocated rest time to account for in this experiment. However, based on the experiment, those who allocate free time for themselves throughout the day tend to be happier than those who do not. As work, school, and other stress factors increase, free time is reduced, which lowers the happiness levels of an individual. There are more factors outside of school and work that may impact an individual's wellbeing, such as family, friends, and home environment. Based on the trends seen in the experiment, as free time decreases, happiness decreases, and as free time increases, happiness increases. There is a positive relationship between happiness and the amount of free time. There is a negative relationship between happiness and the amount of time allocated towards school and work. There is no way to get an accurate number statistic on happiness. It is also hard to properly research an individual's life and understand everything that may be influencing their happiness. There is also no method to test for certain mental illnesses or behaviors that may be caused as an effect. I think there is more to be said and done with this

experiment. With the lack of resources and supplies, it is hard to get a grasp on what is happening.

REFERENCES

Balducci, Cristian, et al. "Exploring the Relationship between Workaholism and Workplace Aggressive Behaviour: The Role of Job-Related Emotion." *Personality and Individual Differences*, Pergamon, 4 June 2012, www.sciencedirect.com/science/article/abs/pii/S0191886912002267.

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