Exercise as Medicine in the Treatment of Parkinson's Disease: Survey Assessment of Non-Contact Boxing Participants with Supportive Brain Anatomy Analysis

by

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Submitted in partial fulfillment of the requirements for graduation as an Honors Scholar at Point Loma Nazarene University, San Diego, California, May 7, 2018.

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Date APRIL 6, 2018

Abstract:

This study was intended to quantify the benefits group exercise therapy has on the motor functions and psychological aspects of a person living with Parkinson's disease (PD) and the neuromuscular structures effecting PD. This research was necessary to assess the efficacy of group pugilistic exercise for PD patients in different disease stages. After receiving informed consent, forty-one volunteers diagnosed with PD were given surveys to assess their physiological, medical, and psychological reactions to bouts of punching in a program known as "Rock Steady" (RS) in order to quantify the perceived benefits of this exercise. A cadaveric dissection of the brain was utilized to better understand the neuromuscular gross anatomy and pathophysiology of structures etiological to and effected by Parkinson's disease. Data analysis for each parameter was done via descriptive and inferential statistical procedures. It was found that those who are a part of RS see an improvement overall and therefore continue to attend RS. Statistical significance was found in the improvement of spiritual health, but no statistical significance found that RS improves the overall quality of life of these people (including physical, social, emotional, environmental, intellectual and spiritual aspects of life), although more research is needed to conclude this. The research problems relate to the pathogenesis and quality of life in a patient suffering from PD who perform high intensity RS.

Introduction:

Studies show that people with more than nine years of education (specifically doctors) are more likely to develop Parkinson's disease (PD). PD is a disease that inhibits the production of Dopamine in the substantia nigra and ventral tegmental area of the brain. Since Dopamine is essential for movement, progressive deficiencies result in neuromuscular extremes. Patients with PD often have tremors, rigid muscles, dyskinesia (involuntary muscle movements), and gait problems.

Every individual with PD is at their unique, complex stage of pathology. PD is progressive and affects a small, yet important part of the brain. There is no known cure, though rigorous and voluminous research continues. Medications are used to improve the quality of life, but often have significant side effects.

Relatively recent research on the benefits exercise has on PD includes systematic scientific quantification and interpretation of the following exercise variables: the type of exercise that is most beneficial, the stage of PD in which it is most beneficial, and whether or not it has a long-term impact on patients who continue their program.

The objective of this research study was to examine how guided exercise programs such as Rock Steady (RS) can improve the quality of life in a group with PD. The survey study examined the participants' opinions on the influence that pugilistic stimulation has on each life domain of their Health and Wellness. The model used to create the survey questions was the *7 Domains of Health*, the parameters of which include: Spiritual wellness, Physical wellness, Social wellness, Emotional wellness, Intellectual wellness, Financial Wellness and Environmental wellness. See Figure 1 below.

In the basal ganglia and substantia nigra—found in the low brain—the neurotransmitter Dopamine is synthesized and released. To access the basal ganglia and substantia nigra, a cadaveric dissection was performed. The dissection included a craniotomy, and an endoscopic location and harvesting of the 24 Cranial nerves and the 2 carotid arteries. The brain was sectioned sagittally and the basal ganglia and substantia nigra were identified. This is discussed in more detail in Dissection section below.

Epidemiology:

As more research is conducted, the epidemiology of PD has become better understood and is second in age-related neurodegenerative disorders to Alzheimer's disease.[1] The prevalence of PD is divided into 3 subcategories: age distribution, gender distribution, and ethnic/geographic distribution found throughout research. (See table 1)[1,2]

Table 1: Epidemiology of PD

Age Distribution	Gender Distribution	Ethnic/Geographic Distribution
• 41 per 100,000 inhabitants between 40 and 49 years and 1903 per 100,000 inhabitants older than 80. 70–79-year-old population, PD is less frequent in Asia than in North America, Europe and Australia. • 37.6 cases per 100,000 person-years in women older than 40 years and 61.2 in men older than 40 years.	Men are more affected than women, especially in the 50–59-year-old group where the prevalence is 134 men and 41 women per 100,000 individuals.	• Europe and North America have a higher prevalence, around 100 to 350 per 100,000. • Asians in Japan and China and black Africans have lower rates, around one-fifth to one-tenth of those in whites. • Prevalence is 15 per 100,000 in China, 328 per 100,000 in India, 131 per 100,000 in Mississippi, USA, and 657 per 100,000 in Argentina

Parkinson's disease is found to be much more prevalent in age groups above 70 years old. According to the statistics above, men are 3.3 times more likely to be diagnosed with PD than women. The geographic distribution of PD shows that PD Is less prevalent in Asia and more prevalent in North America, Europe and Australia.

Pathogenesis:

Parkinson's disease is a chronic and progressive neurodegenerative disease that originates in the basal ganglia and substantia nigra in the brain. PD is not officially diagnosed until post-mortem, but is recognized by its symptoms. Post-mortem diagnosis of PD is found by observing Lewy bodies (abnormal aggregates of the protein α-synuclein that develop inside nerve cells) and the loss of sufficient dopaminergic neurons in the substantia nigra (see figure 1).

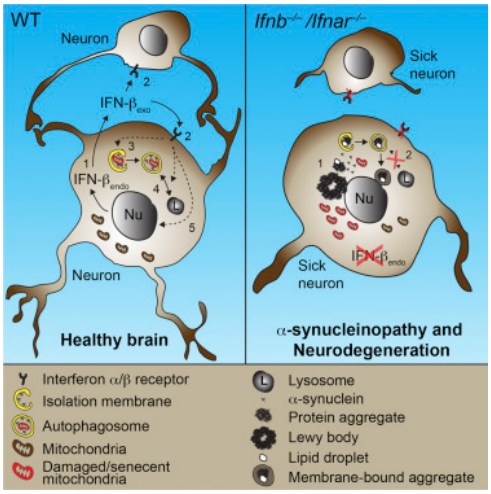


Figure 1: Lewy Body formation with α-synuclein protein
http://www.cell.com/cell/fulltext/S0092-8674(15)01185-X

These neurons give rise to the nigrostriatal pathway. Due to the neuronal loss, there is a depletion in striatal dopamine that results in the clinical phenotype. Since Lewy bodies occur due to aberrant buildup of protein α-synuclein, the first genetic evidence to early-onset familial PD was linked to the α-synuclein gene (SYNCA-PARK1 locus) and is found as an autosomal dominant missense mutation.[2] IFN-β is found in a healthy brain and promotes neuronal autophagy and α-synuclein clearance. However, in a brain where PD is present, the brain lacks this interferon, and causes a buildup of the protein leading to what we call a Lewy Body. Further research is being done to confirm this pathogenesis.

Current research suggests that there are numerous inter-related factors contributing to the pathogenesis of PD, one being genetic mutations. They are assigned to one of two categories, each with subcategories. (See Table 2).[3]

Table 2: Categories of Genetic Mutations that May Lead to PD

Cell Autonomous	**Non-Cell Autonomous**
Autophagy	Trans-synaptic transmission of abnormal proteins
Lysosomal dysfunction	Neuro-inflammation
Mitochondrial dysfunction	Loss of Trophic support

In a healthy brain, the dopamine neurons in the substantia nigra project onto the striatum. This “highway” of neurons is called the nigrostriatal pathway. With PD, these neurons have little clumps of proteins (Lewy Bodies). The role of these Lewy bodies is unknown. A person with PD begins to lose these neurons, and at about 80% loss patients manifest bradykinesia, rigidity, and the other physical signs of PD listed in Table 1. Two pathways found in the basal ganglia account for these symptoms and signs: the direct and indirect pathways. The direct pathway works to increase movement and the indirect pathway works to decrease movement. Together, these pathways “adjust” the activation of the Thalamus.

Normally, dopamine is produced by cells in the pars compacta of the substantia nigra. The Nigrostriatal axon terminals release dopamine into the striatum. Dopamine has an

excitatory effect on cells in the striatum that are part of the direct pathway and has an inhibitory effect on striatal cells associated with the indirect pathway. In other words, the direct pathway is excited by dopamine while the indirect pathway is inhibited by dopamine. Both of these effects, lead to increased motor activity or can be said to be synergistic. There are also cholinergic (ACh) neurons in the striatum whose axons do not leave the striatum and synapse on the GABAergic striatal neurons that project to the globus pallidus portion of the basal ganglia. The cholinergic actions inhibit striatal cells of the direct pathway and excite the striatal cells of the Indirect Pathway. In other words, the direct pathway is inhibited by Ach and the indirect pathway is excited by ACh. ACh turns down motor activity through these two pathways.

In a person with PD, dopamine is suppressed. This makes the direct pathway's activity decrease, reducing motor activity. Concomitant to that, ACh interneurons are still inhibiting the striatal cells in the Direct Pathway, adding to the decrease in motor activity. The end result is more inhibition, making the motor thalamus and cortex less active, and turning down motor activity. Absent the necessary inhibition that dopamine would normally produce in the indirect pathway, there is an increase in activity. The loss of dopaminergic inhibition to the indirect pathway is compounded by the now un-opposed excitatory actions of the cholinergic interneurons that drive the indirect pathway. The end result is increased activity in the indirect pathway, which turns down motor activity.

Diagnosis:

Symptoms of PD may manifest across the entire disease process in all patients, but symptoms often vary during the disease progression. There is no standard diagnostic test for Parkinson's, but researchers are working to develop an accurate test, such as a blood test or an imaging scan. To date, the best objective testing for PD consists of specialized brain scanning techniques that can measure the dopamine system and brain metabolism.[4] These tests are performed only in specialized imaging centers and can be very expensive, so they are not available to all who might benefit from them. Most of the time, tests are done for differential diagnosis to eliminate the possibility of other diseases that imitate PD, such as a stroke or hydrocephalus.

Treatment/Medications:

Individuals suffering from PD are often given a medication that can help ease the symptoms that are presented with PD. The drug Levodopa is synthesized in the brain into dopamine and is the most important first-line drug for the management of PD symptoms. Symptoms moderated by Levodopa include nausea, vomiting, loss of appetite, lightheadedness, lowered blood pressure, and confusion. It was developed in the late 1960s as the first medication proven effective in managing PD symptoms. Today, it remains the single most effective drug in treating PD.[5] It is almost always administered with the drug Carbidopa, which prevents the nausea that can be caused by levodopa alone but is also a levodopa enhancer. Due to it being a Levodopa enhancer, it allows for a much lower dose of levodopa. In pill form, Levodopa is absorbed in the blood from the small intestines and travels through the blood to

the brain, where it is converted into dopamine and stored in the neurons until the body needs it for movement. The blood brain barrier normally prevents dopamine from entering into the brain, but since Levodopa is a precursor to dopamine, it can enter. Because Levodopa pills go through the small intestines and throughout the body before entering the blood and the brain, there are unwanted effects that come with it. Our bodies contain proteins that break down levodopa. One of these proteins is called DOPA decarboxylase and turns Levodopa into dopamine. Inside the brain, this protein is vital for activating the drug, but when it is turned into dopamine outside of the brain, it causes nausea.[6] Carbidopa stops that break down, allowing more levodopa to get into the brain and reducing the side effects.

Carbidopa/Levodopa is now available via a dopamine intestinal infusion pump (DUOPA), which provides 16 continuous hours of carbidopa and levodopa to modulate motor symptoms. The small, portable infusion pump delivers carbidopa and levodopa directly into the small intestine. In a clinical trial, the amount of "on" time without troublesome dyskinesia was better in the pump group when compared to the placebo group (4.1 vs. 2.2 hours).[5]

However, there are many drawbacks in the use of Levodopa/Carbidopa for the patient. Common side effects that include nausea, vomiting, loss of appetite, lightheadedness, lowered blood pressure, and confusion. Patients who take Levodopa can sometimes develop Levodopa induced Dyskinesia characterized by involuntary, erratic, movements of the face, arms, legs, and/or trunk. Dyskinesia usually occurs one to two hours after a dose of levodopa has been absorbed into the bloodstream and is having its peak clinical effect. Patients who suffer from PD often develop anxiety, depression, or other mental disorders that can result in having to take medication. A pharmacopeia complication is that most Levodopa/Carbidopa medications cannot be taken with antidepressants. Another drawback found in the DUOPA approach is that there is a need for a percutaneous gastrojejunostomy (a small feeding tube), which can result in infections and other complications.[5]

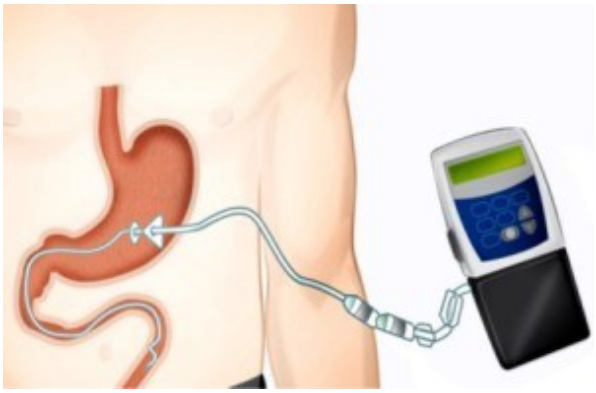


Figure 2: DUOPA
https://www.perkyparkie.com/2016/02/2394/

Therapies

Approximately 42% of people with PD report depressive symptoms. Research suggests that depression in PD adversely impacts both health-related quality of life and the capacity to complete activities of daily living.[7] Depression accompanying PD is linked to a faster progression of physical symptoms, greater cognitive decline, and poorer quality of life.[8] The current approach in treating depression in PD is to prescribe Antidepressants, however, the results from studies pertaining to the effects of Antidepressants on PD yields mixed results and has other side effects such as insomnia, fatigue, and dependance.[8]

Cognitive Behavioral Theory (CBT) is currently being researched, and involves using self-monitoring, stress management, managing negative thoughts, and appropriate use of social supports. Although the exact cause of depression in PD is not pinpointed, the high incidence of depressive symptoms in this population likely result from the interaction of neurodegeneration, and how patients and families think, feel, and react to living with this medical condition.[8] This approach looks promising and will help us better understand if CBT modulated depression in PD clients.

Research regarding Nutritional Therapy is increasing in popularity because PD shows sensitivity to environmental factors. Preliminary research shows that individuals who consume large amounts of dairy products may often have low serum uric acid levels. Serum urate and uric acid are inversely correlated with the risk of PD and disease duration, although research has shown that the neuroprotective effects of serum urate seems to be limited to men. In addition, the possible presence of dopaminergic neurotoxins, including pesticides and polychlorinated biphenyls in dairy products, may increase the risk of PD.[9] On the other hand, epidemiological studies found that high intake of fruits, vegetables, and fish were inversely associated with PD risk and studies have shown that the levels of vitamins A, B (riboflavin), C, and E, which are present in low levels in some PD patients correlates to the disease manifestation. There is hope that with nutritional balance, PD prevention or forestalling of the disease may be possible.

The most common therapy for PD is Physical Therapy (PT). When a patient is diagnosed with PD, one of the first steps is the commencement of PT. PT with a patient with PD has 3 key elements. The first element, known as strategy training, is teaching the patient how to move more easily and maintain postural stability by using cognitive strategies. Such training targets the primary motor control deficit in the basal ganglia, brain stem, and motor cortex. The 2 forms of strategy training include: (1) compensatory strategies to bypass the defective basal ganglia and (2) learning strategies to improve performance through practice. The second element of PT is the management of secondary sequelae affecting the musculoskeletal and cardiorespiratory systems that occur as a result of the ravages of deconditioning and reduced physical activity. The third element is the promotion of physical activities that empower the patient to make lifelong changes in exercise and physical activity habits that enhance life quality as well as preventing falls. Researchers who have provided the evidence for the efficacy for these approaches have grounded their studies on different theoretical paradigms and have studied targeted questions based on those paradigms.[10] PT has proven to have benefits for PD, and this study sought to quantify the benefits of pugilistic group exercise.

Exercise Therapy:

It is important to note the difference between exercise and physical activity. Exercise refers to specific regimens meant to improve specific underlying problems, such as balance, gait, and flexibility and is often supervised. Physical activity is referred to any movement of the body that uses energy. Examples of this include, but are not limited to, walking, hiking and gardening. In a person with PD, exercise is important in correcting specific underlying problems that interfere with daily function and can lead to falls. Physical activity is critical after supervised exercise to keep the person going.[11] Exercise and physical activity are also known to promote positivity in a person's life. Group exercise also allows the patient to have a community of people who are dealing with the same issues and can support each other through the various stages of PD.

Rock Steady is a non-contact boxing program designed for people with PD to modulate the effects PD. The "fighters" have the opportunity to meet up to three times a week to fight the battle of PD. Fighters are assigned to one of two classes deepening upon their diagnosed stage of PD. There is a class for stage one and two patients, and another for stage three and four patients. Tremors have been shown to decrease within hours after a session and have also been shown to improve the mental state of these people.

Prognosis:

There are 5 stages of motor function in PD known as the Hoen and Yahr stages (see figure 3). Applying the stages using manifested signs and symptoms allows medical professionals to decide what treatment is appropriate to each PD patient. Stage one is the hardest stage to diagnose due to the many other neurological diseases that can sometimes show similar symptoms. In the first stage, the patient has mild symptoms that generally do not interfere with daily activities including tremors and other movement symptoms that occur unilaterally. The second stage is characterized by bilateral tremor and rigidity. During this stage, completing day-to-day tasks becomes more difficult and may take longer to complete. Stage three is considered mid-stage in the progression of the disease. In this stage, loss of balance and slowness of movements are evident, with falls being more common. Though the individual is still fully independent, symptoms significantly impair activities of daily living such as dressing and eating. In stage four, symptoms are severe and very limiting. Movement may require a walker, and they may need help with activities of daily living. Living alone is not possible. Stage five is the most advanced and debilitating stage of Parkinson's disease. Stiffness in the legs may make it impossible to stand or walk and the person requires a wheelchair or is sometimes bedridden. A caretaker is required for all activities, and the person may experience hallucinations and delusions.

PD is not a fatal disease, but due to the symptoms, can lead to life-threatening complications such as trauma from bad falls, pneumonia, choking resulting from obstructed airway, and septicemia from urinary tract infection, all of which may a shorten their life. Because every person's brain is so unique, the progression of PD is unique to that person and it makes it difficult for a medical professional to estimate the rate of progression.

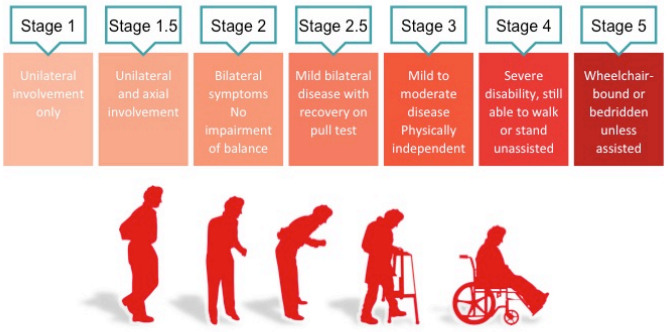


Figure 3: Hoen and Yahr Stages
https://www.apo-go.com/hcp/clinical-updates

Research Design:

Survey research and Gross Anatomy dissections were the 2 prongs of this study. After granting informed consent forty-one subjects in varying stages of PD from Rock Steady completed a 3-page survey designed to assess their beliefs, attitudes, and self-perceptions on the benefits of RS therapy on the domains of their personal health (see figure 4). We refrained from including financial health to prevent adverse reaction to potentially sensitive topics which would create a negative response. The data was analyzed using a multivariate analysis generalized linear regression on all total Domains of Health. We chose to use Wilks Lambda's test of significance.

Figure 4: Seven Domains of Health
http://healthyhappyhumanbeings.com/events/oct-24-an-integrative-health-conversation-and-case-study/

The domains were separated into sections that contained their own questions. The answers to the questions used the following scale: 1 agree, 2 somewhat agree, 3 somewhat disagree and 4 disagree.

The physical health section focused on the person's physical wellness as they saw it. They were divided into P1 (Rock Steady has resulted in improved walking), P2 (While being a part of RS, I have seen an improvement with tremors), P3 (While being a part of RS, I have seen an improvement in balance), and P4 (My overall level of fatigue has decreased since I started going to RS). The mean of these added responses was calculated to give a PTOTAL which would act as the overall total physical health.

The social health section focused on how they viewed themselves in society. They were divided into S1 (RS has helped me find good friends), S2 (After my PD diagnosis I felt that my identity was negatively affected) and S3 (Rock Steady gives me an enhanced identity).

The emotional health section focused on the mental stability/instability that these people faced and how RS played a role in that. They were divided into E1 (RS has decreased depression/anxiety in my life), E2 (Since beginning RS, my relationships have improved), and E3 (I feel that PD has decreased my ability to do my part in society).

The environmental health section was focused on how they see their environment change due to PD. They were divided into EN1 (There are obstacles where I live that are threats to me), EN2 (There are places in my community that I do not frequent due to hazards), EN3 (I take active steps to bolster my immune system to avoid illness) and EN4 (My exercise at RS is part of my health regimen).

The intellectual health section focused on how RS has improved their memory and ability to learn. They were divided into I1 (Thanks to RS, I have more drive to go out and learn or do something new), I2 (My memory has improved since I began RS), and I3 (My ability to concentrate has improved thanks to RS).

The last domain of health, spiritual health, focused on questions pertaining to their overall spirituality (both religiously and non-religiously) and how RS has influenced it post-diagnosis. They were divided into SP1 (I consider myself a spiritual person), SP2 (I am religious), SP3 (Since I have started RS, my relationship with God has improved), SP4 (Thanks to RS, I have established peace and harmony in my life that wasn't there before), SP5 (My spiritual health has shifted in a positive way since I began attending RS).

Dissection

The dissection began with a full craniotomy of a 72-year-old male. The purpose of the dissection was to better understand the anatomy of the brain and the structures involved in PD. After removal of the scalp, we used a bone saw to cut through the skin, muscle and dura mater. We carefully removed the superior portion of the cranium and, when the brain was exposed, we were able to perform an encephalectomy. We kept the 24 cranial nerves intact and removed the brain with the brain stem. When the brain was removed, we noticed plaque build-up on the frontal lobe. The cranial nerves were studied, and we began the further dissection of the structures of the brain. Upon removal of the brain we identified the dura mater, arachnoid mater, pia mater, and the Falx cerebri. The Falx cerebri, found in the longitudinal fissure, was removed prior to encephalotomy. We transected the brain into left and right hemispheres in order to clearly identify the internal structures. The basal ganglia and substantia nigra were identified. The substantia nigra is the midbrain gray matter portion of the basal ganglia.

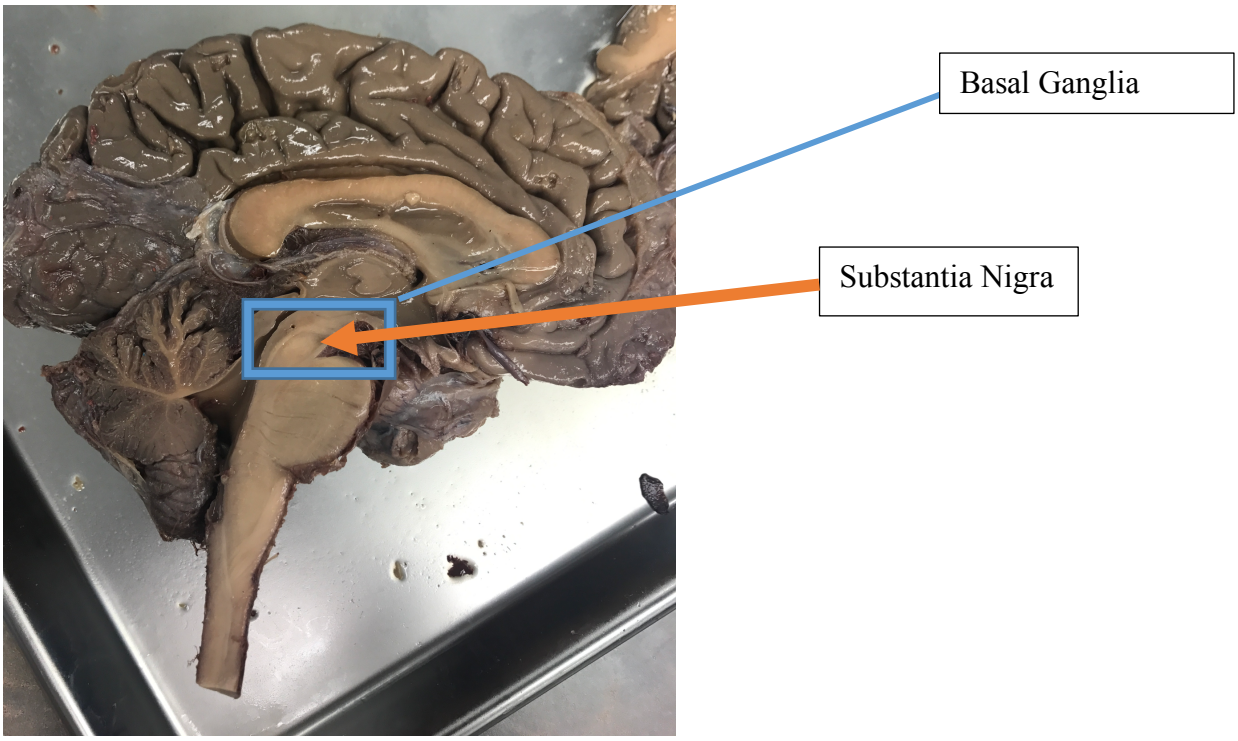


Figure 5: Hemisphere of Brain with Basal Ganglia and Substantia Nigra

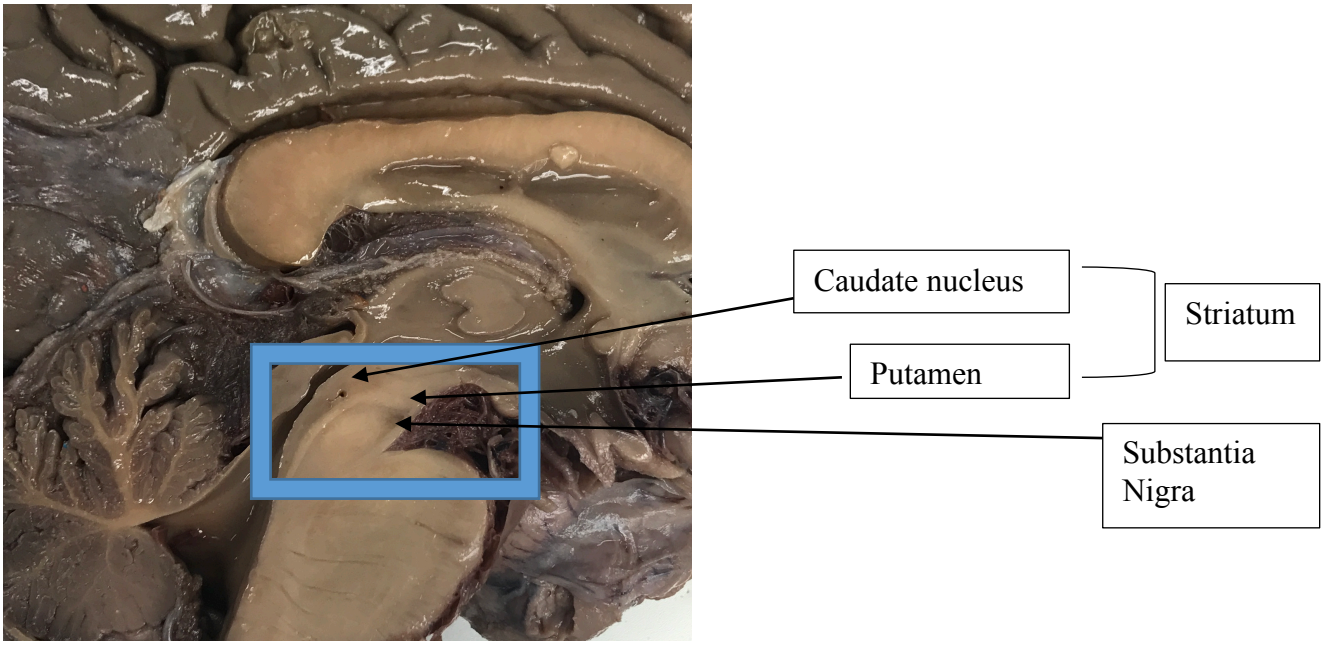


Figure 6: Zoomed in Depiction of Striatum and Substantia Nigra

Results

Data Analysis

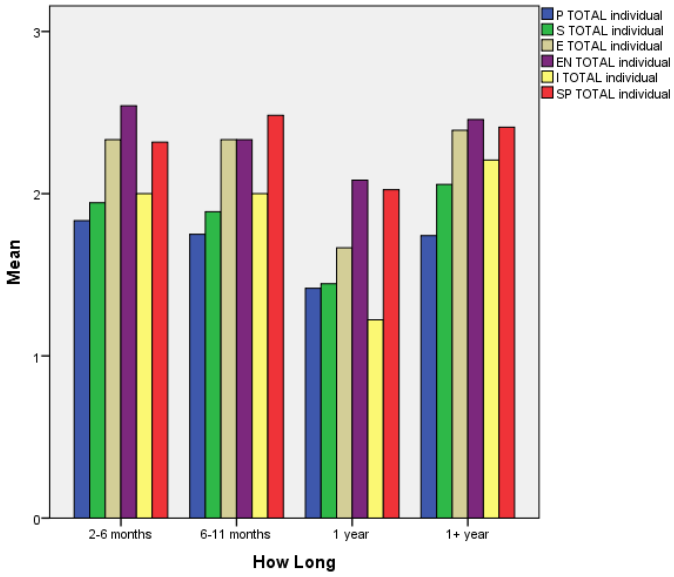


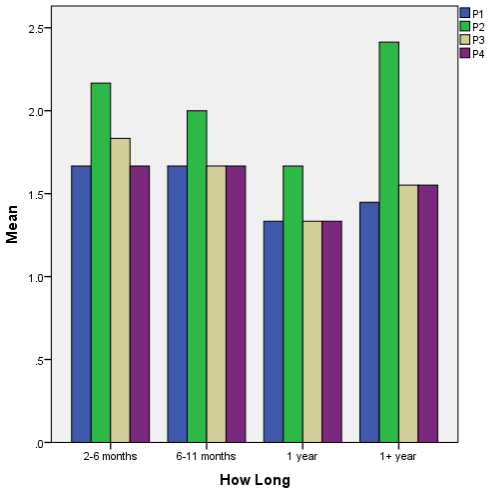
Figure 7: The above graph shows the 6 Domains of Health (Physical, Social, Emotional, Environmental, Intellectual, and Spiritual) and if the fighters saw an improvement in each of them compared to how long they have attended RS. (1=agree, 2=somewhat agree, 3=somewhat disagree, 4=disagree)

A one-way multivariate analysis of variance (MANOVA) was conducted to test the hypothesis that there would be one or more mean differences between symptoms (physical, social, emotional, environmental, intellectual, and spiritual) and how long they attended RS. There was no statistically significant MANOVA effect obtained, Wilk's $\lambda = 0.720$, $F(18, 91) = 0.623$, $p = 0.873$. The multivariate effect size was $\eta^2 = 0.873$ (See table 4).

Table 3: Descriptive Statistics

	N	Mean	Std. Deviation
P1	41	1.49	.637
P2	41	2.27	1.205
P3	41	1.59	.805
P4	41	1.56	.838
P TOTAL individual	41	1.73	.628
S1	41	1.68	.907
S2	41	2.51	1.052
S3	41	1.73	.895
S TOTAL individual	41	1.98	.658
E1	41	2.02	1.129
E2	41	2.20	1.077
E3	41	2.76	1.220
E TOTAL individual	41	2.33	.769
EN1	41	3.24	1.135
EN2	41	3.46	.840
EN3	41	1.83	.998
EN4	41	1.20	.679
EN TOTAL individual	41	2.43	.545
I1	41	1.63	.888
I2	41	2.41	1.072
I3	41	2.22	.962
I TOTAL individual	41	2.09	.817
SP1	41	1.73	1.096
SP2	41	2.05	1.224
SP3	41	2.63	1.356
SP4	41	2.46	1.120
SP5	41	2.46	1.164
SP TOTAL individual	41	2.37	.240

Table 3 contains the descriptive statistics for each question within each domain of health as well as the total mean of each domain of health. The standard deviations are noted here.



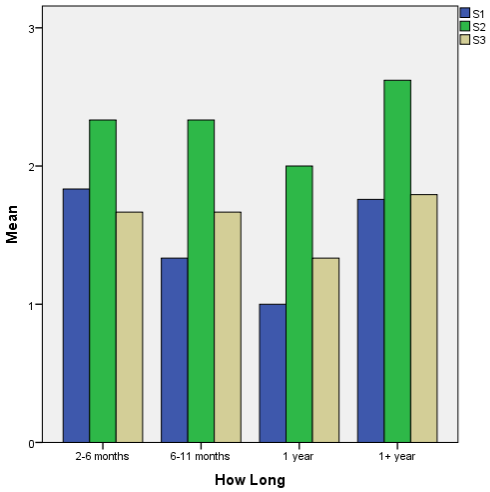
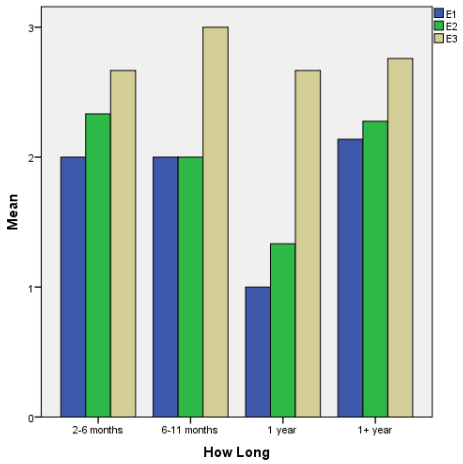


Figure 8 (left) & Figure 9 (right): The above graphs show physical health (left) and social health (right) broken down into its subsections and if the fighters saw an improvement in each of them compared to how long they have attended RS. (1=agree, 2=somewhat agree, 3=somewhat disagree, 4=disagree)

We considered physical health and ran ANOVA to identify a significant difference between physical health symptoms and time in Rock Steady and found no significant difference, $F(3,38) = 0.121$, $p = 0.832$, $\eta^2 = 0.023$. Additionally we ran ANOVA to identify significant differences between time of participation in Rock Steady and social health symptoms and found no significant difference, $F(3,38) = 0.355$, $p= 0.497$, $\eta^2= 0.062$ (See table 5).



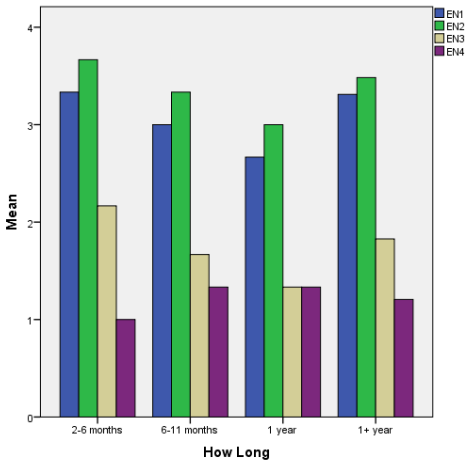
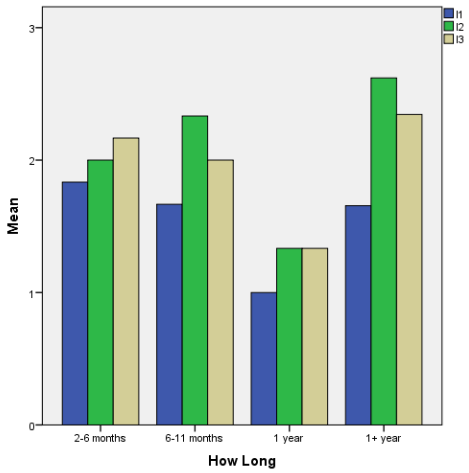


Figure 10 (left) & Figure 11 (right): The above graphs show emotional health (left) and environmental health (right) broken down into its subsections and if the fighters saw an improvement in each of them compared to how long they have attended RS. (1=agree, 2=somewhat agree, 3=somewhat disagree, 4=disagree)

We considered emotional health and ran ANOVA to identify significant difference, we found the difference to be not significant. F((3,38)= .475, p= 0.507, $\eta^2 = 0.060$. We considered environmental health and ran ANOVA to identify significant difference, we found the difference to be not significant. F(3,38)= .161, p = 0.669, $\eta^2 = 0.041$ (See table 5).



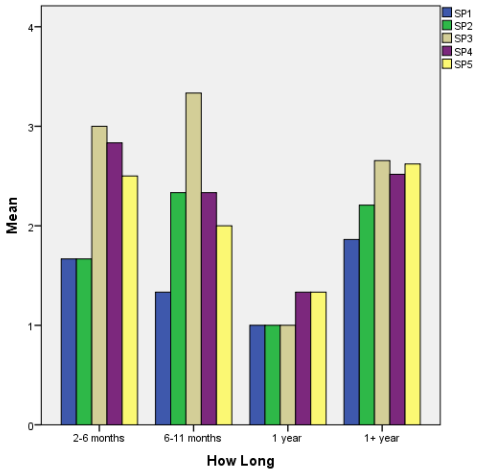


Figure 12(left) & Figure 13 (right): The above graphs show intellectual health (right) and spiritual health (right) broken down into its subsections and if the fighters saw an improvement in each of them compared to how long they have attended RS. (1=agree, 2=somewhat agree, 3=somewhat disagree, 4=disagree)

We considered intellectual health and ran ANOVA to identify significant difference, we found the difference to be not significant. $F(3,38)= .909$, $p= 0.257$, $\eta^2=0.102$. We considered spiritual health and ran ANOVA to identify significant difference, we found the difference to be significant. $F(3,38)= 0.153$, $p = 0.040$, $\eta^2= 0.199$ (See table 5).

Table 4: Statistical Testing for Domains of Health and How Long

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.984	321.166[b]	6.000	32.000	.000	.984
	Wilks' Lambda	.016	321.166[b]	6.000	32.000	.000	.984
	Hotelling's Trace	60.219	321.166[b]	6.000	32.000	.000	.984
	Roy's Largest Root	60.219	321.166[b]	6.000	32.000	.000	.984
HowLong	Pillai's Trace	.291	.609	18.000	102.000	.885	.097
	Wilks' Lambda	.720	.623	18.000	90.995	.873	.104
	Hotelling's Trace	.374	.637	18.000	92.000	.862	.111
	Roy's Largest Root	.329	1.863[c]	6.000	34.000	.116	.247

Table 5: Univariate Tests for each Domain of Health

	df	**F**	**Sig**	**Partial Eta Squared**
P TOTAL	3,38	.121	.832	.023
S TOTAL	3,38	.355	.497	.062
E TOTAL	3,38	.475	.507	.060
EN TOTAL	3,38	.161	.669	.041
I TOTAL	3,38	.909	.257	.102
SP TOTAL	3,38	.153	.040	.199

Discussion

The gender demographics of the sample size (n=41) was 26 males (63.41%) and 15 females (36.59%). The 61-70 age range was most prevalent by 39.02% and the second most prevalent age range was 71-80 with 36.59%. The least prevalent age range was 30-40. The ethnic group most represented at Rock Steady in Escondido was the white population having 85.37%. A majority of the participants have attended rock steady for over 1 year (70.73%) and only 1 participant is new and has only attended Rock Steady for a few weeks. In terms of frequency of attendance, there were 70.73% of participants who attend Rock Steady 2 times/week and 29.27% attend 3 times/week. We found 51.22% of participants take Carbidopa/Levodopa combination medication, 2.44% take antidepressants alone, 36.59% take both carbidopa/levodopa and antidepressants, 4.88% have Rock Steady as their only medication, and 4.88% take other medication for their symptoms. Thirty-nine of the participants reported that they did not come in needing a walking aid, but 2 participants claimed they did. Both of those participants also reported an improvement in walking throughout their Rock Steady experience. Figure 21 and 22 show that there were 60.98% of fighters who experienced anxiety since being diagnosed, and 58.54% who experienced depression since their diagnosis. See Appendix A.

There were limitations with this project which include a small sample size, the inability to determine how their disease process progressed as they continued the program, and the largely unequal amount of people in each "group" for how long they have attended Rock Steady. The responses to the questionnaire were categorized by 1 being agree, 2 being somewhat agree, 3 being somewhat disagree and 4 being disagree. The way the questions were organized could have played a role in not finding statistical significance. In the future, the organization of questions should be reordered so that they can provide better information for statistical significance.

There is a decrease in numbers (meaning an improvement) in all of the health domains minus spiritual health from 2-6 months to 1 year of attending Rock Steady (see Figure 7). There needs to be further research done to evaluate why there was an increase in numbers and therefore a decrease in improvement from 1 year to over 1 year. A possible answer may be that we did not take into account the disease progression. Although they were attending Rock Steady and their symptoms decreased, their disease continued to progress and therefore the symptoms may have also progressed. It is determined that the improvement seen is not statistically significant. Many reasons may attribute to these results. One reason may be that we did not take into account the disease progression. Another reason may be the way the questions were organized and the scale that was used. Further research would need to be done with a larger sample size and better organization of survey questions.

Physical Health

The individual physical health domain divided by each question is seen in figure 8. All of the physical health questions decreased over time showing there was an improvement. Each individual question showed an improvement through 1 year of RS attendance. Even though it goes back up at 1+ years of attendance, all except P2 are still lower than they are at 2-6 months of attendance.

Social Health

We also see an overall improvement from 2-6 months to 1 year in each of the social health questions (see figure 9). Each individual question showed an improvement through 1 year of RS attendance.

Emotional Health

An improvement is also seen in all of the individual emotional health questions (see figure 10). E3 goes up which is expected because the question asked if the person felt that PD decreased their ability to do their part in society. Because the mean was closer to 4, this means that they did not think that PD decreased this ability. This is an example of where the statistical significance could have gone wrong because of the difference in what number we wanted/expected to see.

Environmental Health

There is an improvement seen in all of the environmental health questions minus E4, which asks if their exercise at RS is a part of their health regimen (see figure 11). The reason this question might have been answered differently is uncertain and would need further consideration. This graph shows the biggest downwards trend and although they all go up from 1 year to 1+ years of attendance at RS, there is still an improvement compared to those who attended RS for 2-6 months.

Intellectual Health

There is an overall improvement from 2-6 months to 1 year in intellectual health, with the exception of question I2 which increases at 6-11 months then decreases again at 1 year (see figure 12). I2 addressed an improvement in memory and the reason for this would need further consideration. There is a downwards trend found, with the biggest trend seen between 6-11 months and 1 year of attendance at RS.

Spiritual Health

Spiritual health is divided by each individual question and it is seen that there is an overall seemingly large improvement from 2-6 months to 1 year (see figure 13). This domain of health was the only one where there is a statistical significance of .040. This graph shows a downward trend throughout time, until 1+ years.

Conclusion

Exercise Therapy continues to be a vital topic of research for PD. This study showed that there is an overall improvement in all of the domains of health considered (physical, social, emotional, environmental, intellectual and spiritual), despite the lack of statistical significance. This having been the first step in researching group exercise classes such as RS, it needs improvement in many aspects, including better structure of questions/answers and bigger sample size. It would also be important to somehow incorporate each individual's disease progression. Further steps also include quantitative analysis and using some sort of measurement that includes measuring tremor rates before and after a RS class. This would also be interesting to measure before starting the classes, and after a certain amount of time in the program. It was seen through these surveys that people were generally happy with the way RS has shifted their lives post PD diagnosis. Furthering this research, I would be curious to compare non-contact boxing to a different form of group exercise such as dancing. As research

progresses, there is hope that exercise could be a new form of medication for people suffering from PD.

Appendix A:

Demographics:

Figure 14: Sample Size by Gender

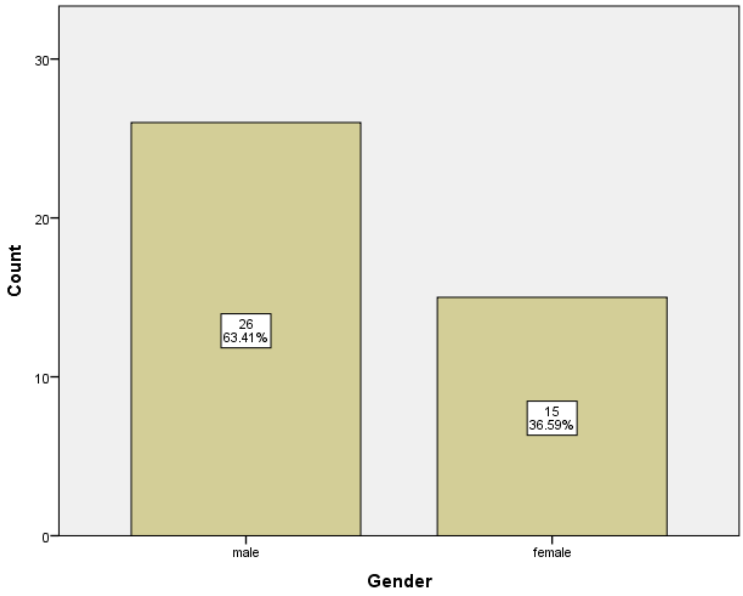


Figure 15: Age of Sample Size

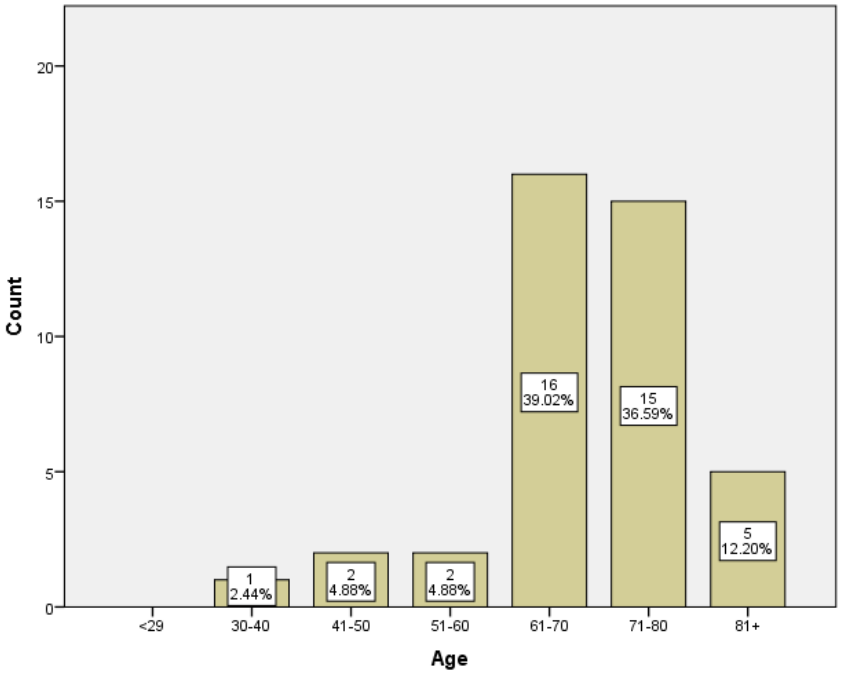


Figure 16: Ethnicity of Sample Size

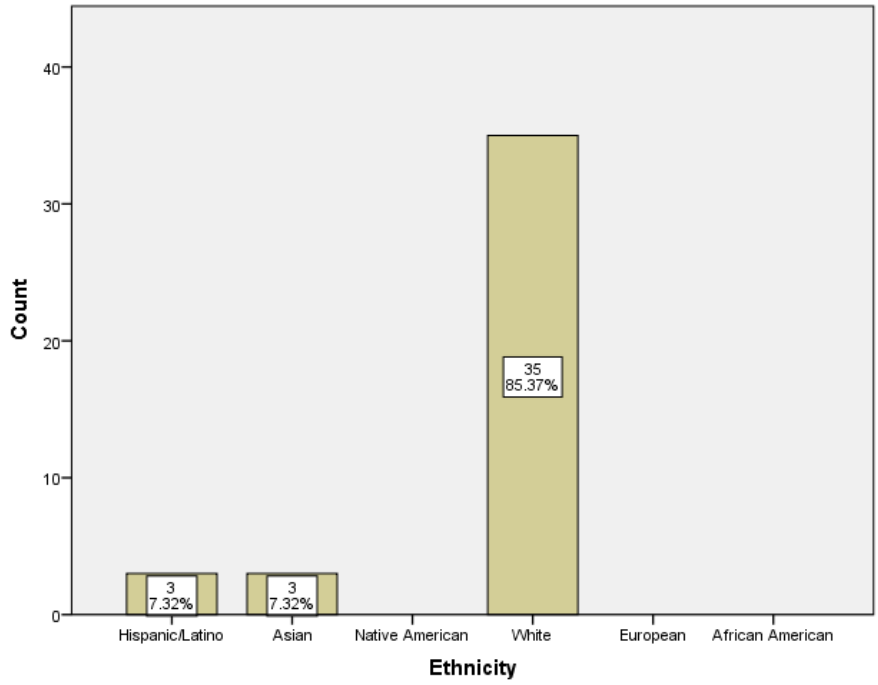


Figure 17: Rock Steady Class of Sample Size

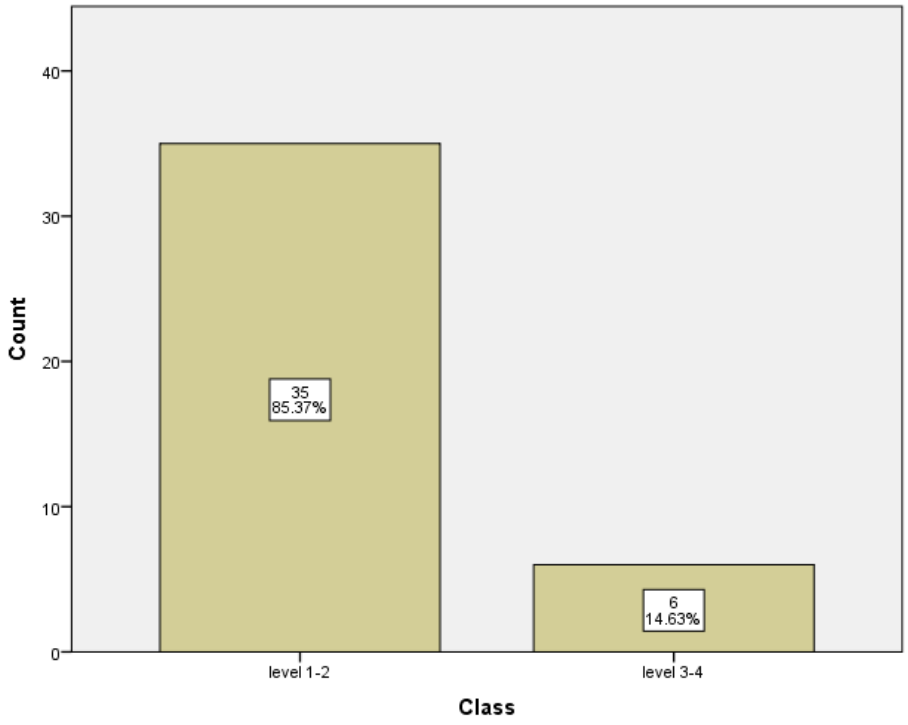


Figure 18: How Long Sample Size Has Attended Rock Steady

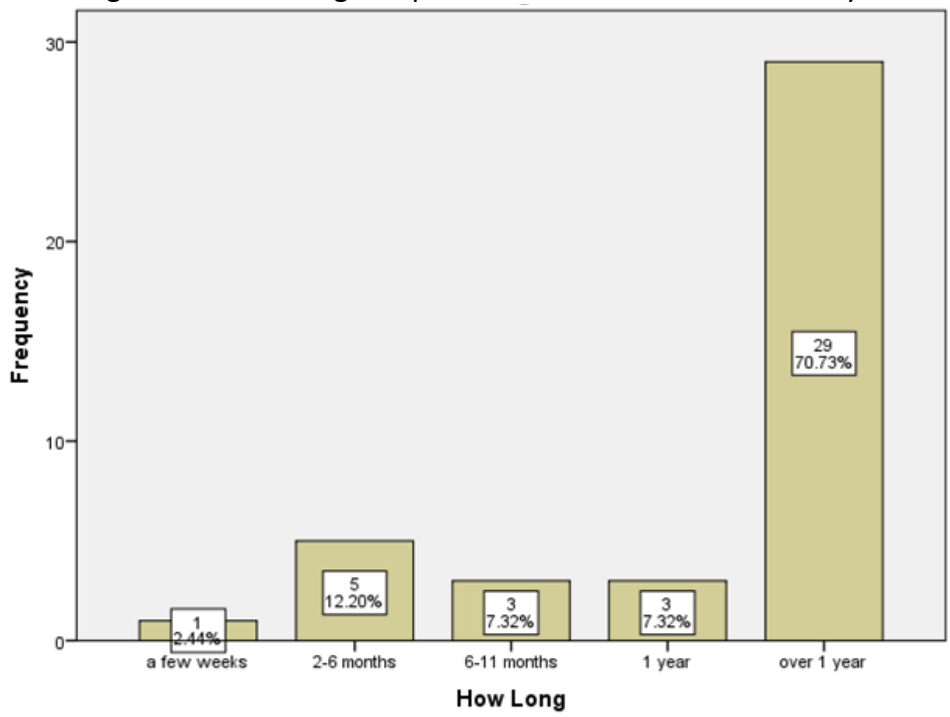


Figure 19: Frequency of Attendance

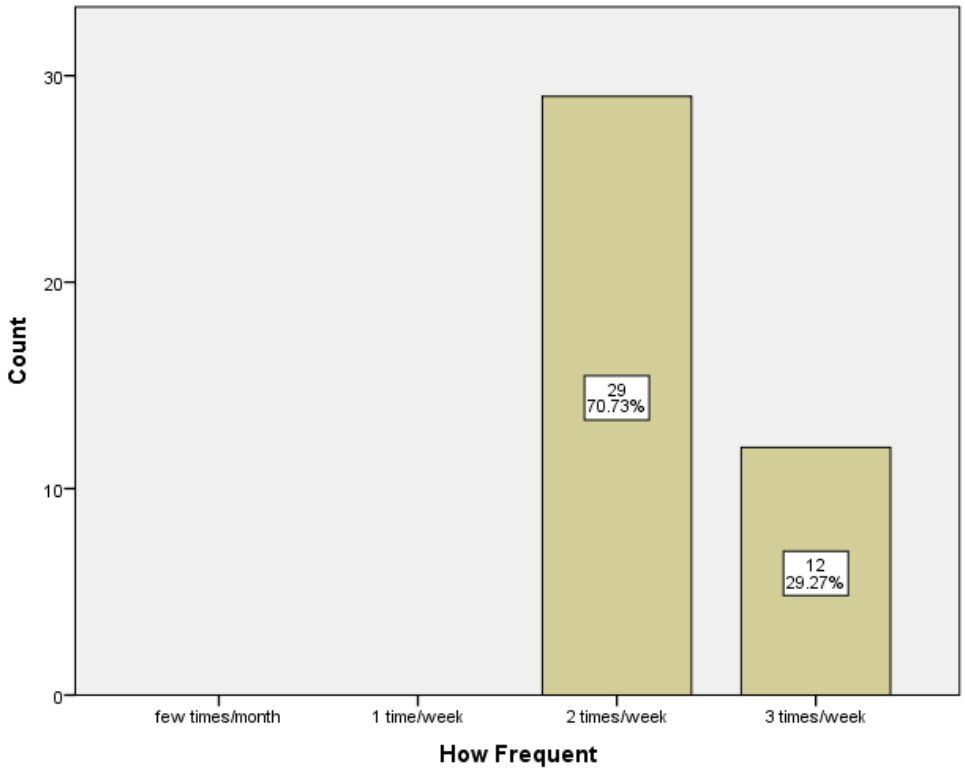


Figure 20: Medications Taken

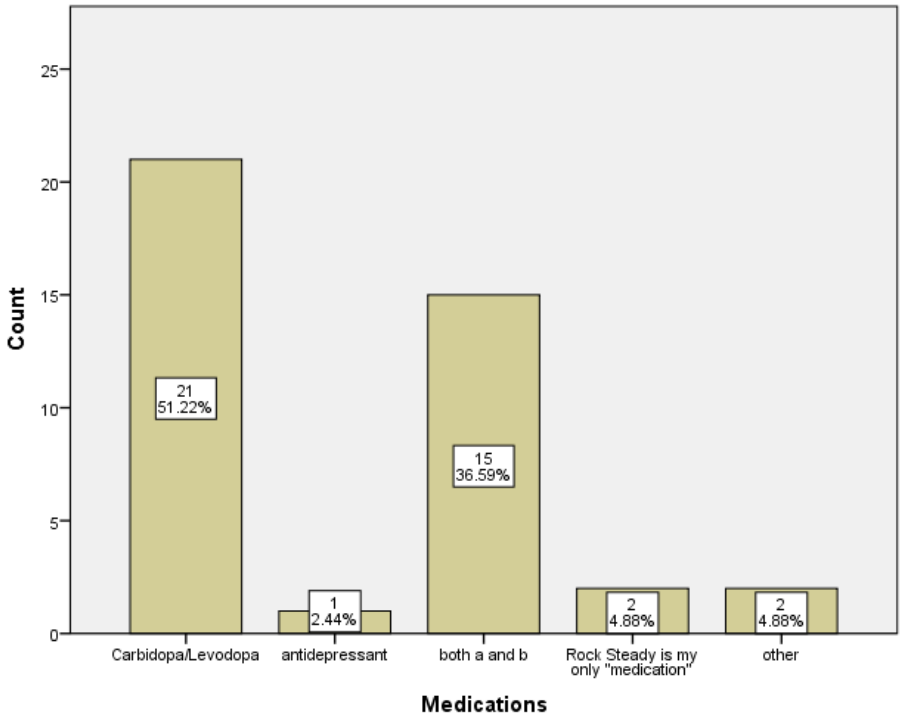


Figure 21: Anxiety Associated with PD Diagnosis

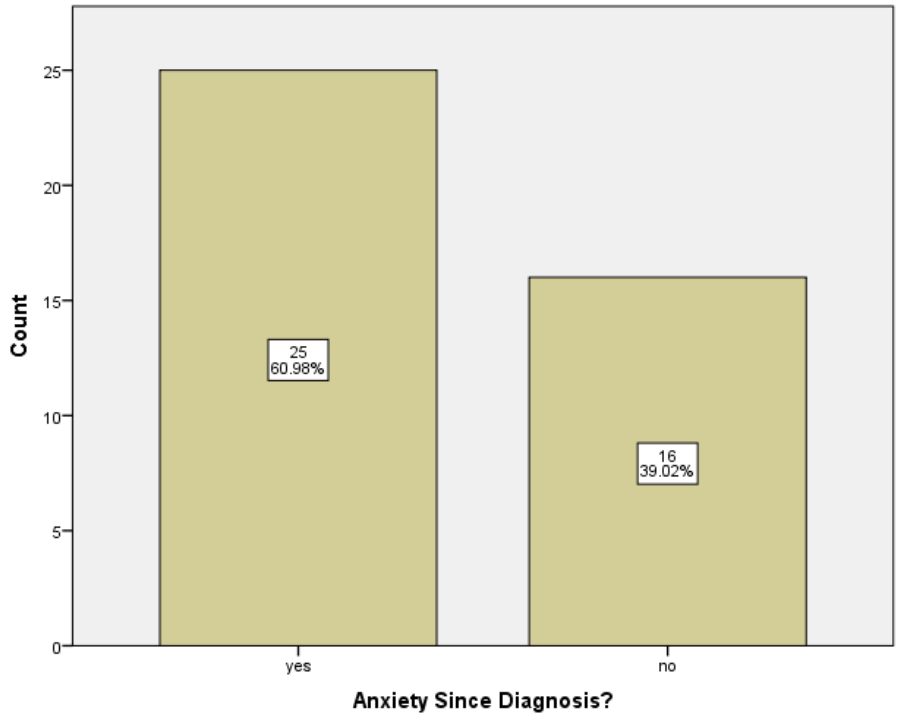
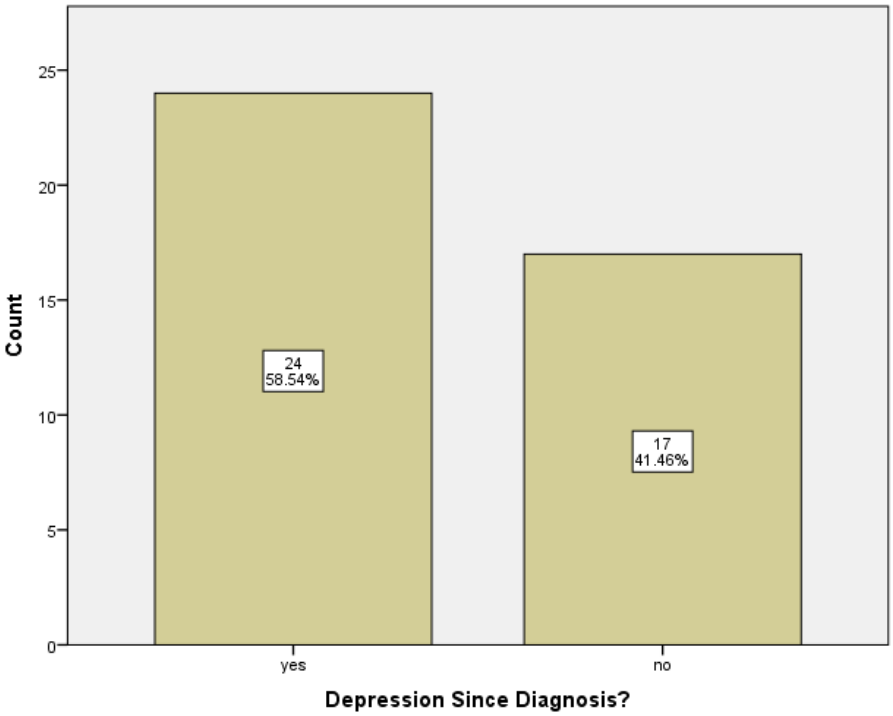


Figure 22: Depression Associated with PD Diagnosis



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