EVALUATING PHYSICAL ACTIVITY AND KETOGENIC DIET TO TREAT AND CONTROL EPILEPSY

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2016
The purpose of this literature review is to evaluate the role of physical activity and diet in treating and controlling seizures for individuals who have epilepsy. This research will examine the effects of exercise on epilepsy, as well as the impact of the ketogenic diet in patients with epilepsy, and finding specific ways to prevent or/and reduce epileptic seizures by using ketogenic diet and exercise.
• Physical activity is an important step to help the body grow, especially for patients with epilepsy and for most chronic diseases. Studies have shown that physical activity has an effectiveness that can reduce the rate of seizures, and reduce depression, and increase blood flow to the brain, and other positive factors whether in terms of physical, psychological or mental. Neurologist should recommend patients for performing sporting activities on a regular basis, on condition that fits with the health status of the patient.

• Ketogenic Diet is one of the innovative and effective treatments for patients with epilepsy. KD is a special diet containing a high percentage of fat and low in carbohydrates. Most studies have proven that this diet is considered an effective treatment dramatically for patients with epilepsy, and the percentage of the effectiveness of this diet for children greater than adults. Also, KD can reduce the rate of seizures in a positive way.
Overview

• Epilepsy
• Physical Activity and Epilepsy
• Ketogenic Diet and Epilepsy
Epilepsy (defined by John Jackson)

- **Epilepsy** is a chronic disease that is related to the neurological situation of the patients, which results in changing the electrical function of the brain during the period of time during which the seizure occurs.

- **Seizure** is an imbalance of an abnormal, excessive, hypersynchronous discharges of the electrical neurons activity in the brain.
Statistics

• According to the Center for Disease Control and Prevention (CDC) in 2014
  Approximately 2.8% of population in the U.S.

• Each year, nearly 200,000 new condition of epilepsy are recorded.
The treatments of Epilepsy

- Drugs
  (Tegretol, Depakote, Zantoin, Topamax, Keppra, Mysoline, and Vimpat)
- Surgery
- Special diet
- Implantation of vagus nerve stimulator (VNS)
Causes of Epilepsy

• 70-80% of the causes are unknown
• Examples of Epilepsy causes which have been identified:
  1. Insufficient oxygen to the brain
  2. Gunshot wound
  3. Alcoholism
  4. Brain abscess or inflammation of membranes covering the brain or spinal cord
  5. Infectious diseases like measles, mumps, and diphtheria
  6. Degenerative disease
  7. Lead poisoning
  8. Traumatic brain injury (TBI)
  9. Arteriovenous malformation aneurysm (AVM)
Physical Activity and Epilepsy

• Physical activity is any body movement that works skeletal muscles and requires more energy than resting.
The benefits of physical activity

1. Improving body composition.
2. Enhancing lipoprotein profiles.
3. Improving glucose homeostasis and insulin sensitivity.
4. Reducing blood pressure.
5. Reducing systemic inflammation.
6. Decreasing blood coagulation.
7. Enhancing endothelial function.
8. Prevent and manage some chronic disease such as cancer, obesity, diabetes mellitus, hypertension, depression, and osteoporosis.
• Usually Epileptic seizure desires to attack individual when they are at sleep, or/and rest.

  Means;

  1- Increased mental alertness and attention suppress the electrical activity
  2- Lowered blood PH, and beta-endorphin
• According to Steinhoff, et al, for Patients with Epilepsy to see how the epilepsy could be controlled seizure by physical fitness. This study used 145 questions and a clinical evaluation selected 136 outpatients and compared their habits and views about exercise with controls.

• The study showed:
  1- The existence of a lack of physical activity in patients.
  2- Groups thought that sports were positive and acceptable for Positive Working Environment.
  3- 25% of the patients was control by doing PA.

(Steinhoff, Neusiiss, Thegeder, and Reimers, 1996).
The benefits of physical activity for individuals with epilepsy through research and clinical studies. These benefits are limited to three points in general which are:

1. The role in epilepsy prevention
2. The influence in seizure induction and control
3. The effect in epilepsy comorbidities
The role in epilepsy prevention

• The results of Pimentela et al study, physical activity in epilepsy patients have been shown that is positive on the body, which can be reduced brain cell loss or neuronal damage secondary to brain insults in animal studies by physical activity.

• One of the important factors that play an important influence of physical exercise is Neurotransmitters.

• Nyberg, et al study that suggested physical activity from an early age might have a protective effect on the subsequent development of epilepsy through the construction of neurological reserves, but this hypothesis needs more epidemiologic and prospective studies for confirmation.

The influence in seizure induction and control

- It was confirmed that the program was applied to the sports physical on mice, it works
  1. to reduce the number of frequency seizures rate of the patient more than the control,
  2. a high probability of non-occurrence of sudden death during sports,
  3. and strength training improved frequency of seizures.

According to Eriksen et al, 15 women with pharmacologically were selected who have epilepsy, were required to participate in aerobic dance with strength and stretching exercises twice a week for 60 minutes for 15 weeks. All reports registered the frequency of seizure by patients for 3-7 months before, after and during participation.

Result showed:

- Reduced the proportion the frequency of the seizure
- Reduced the proportion plasma cholesterol and increased the maximum absorption of O2
- Decreased level of health problems, such as muscle pain, sleep problems, and fatigue.

The effect in epilepsy comorbidities

- Mental health disorders play an important role in epileptic seizures include personal problems and mood, behavioral, and psychological problems such as depression, anxiety and a desire to commit suicide.

- According to McAuley, et al study for 12 weeks on epilepsy patients to figure out if there is a positive effect to improve in behavioral outcomes with no adverse clinical outcomes by doing physical activity program. They selected a 28 patients in random way, then divided by two group which are; to involve in a supervised physical activity exercise program, and to stay on their current level of activity with no planned exercise. The first group was exercised under exercise physiologist for three times per week, that program designed for behavioral and clinical outcomes were measured.

  The results showed that:

  have approved that physical exercise group improve their mood, quality of life, and increase the self-concept

Others Benefits for People who have epilepsy

• Increases blood flow to the brain.

(Ottley, 2015)
Recommendation of Physical Activity

- Examples of exercise to practice in physical activity for individuals with epilepsy

GOOD Examples

Walking, running, tennis, lifting weights, aerobic, fencing, and basketball.

BAD Examples

Football, rugby, soccer, 4 wheelers, motorcycle, auto racing, and sports fighting

(Ottley, 2015).
There are four categories of specific exercise that explain the recommendations of each type of specific sports:

- **Aerobic sports**; (e.g.: running, walking, lifting weight, aerobics, gymnastics): There is no certain controls, with taking into account all safety of precautions.

- **Shooting sports**: for people with controlled seizures must be assessed type of seizures and the kind of firearms, and not recommended for uncontrolled seizures.

- **Swimming and water sports**: For people with controlled seizures must performed with a sports coach, with a life jacket, no diving, no Swimming in open waters, and not recommended for uncontrolled seizures.

- **Motorsports**: For people with controlled seizures no certain controls, with taking into account all safety of precautions, and according to the driving regulations of each country

(Pimentela, et al, 2015)
Ketogenic Diet and Epilepsy

- The ketogenic diet is a treatment for epileptic seizures. This type of diet uses a low percentage of carbohydrates, low in protein, and high in fat.
- The diet calculates the production of the ketogenic ratio 4:1:1, which is 4 grams of fat, and 1 gram of protein, as well as 1 gram of carbohydrates.
- If the diet is effective, patients are traditionally kept on KD for at least 2 years, and then, depending on the results, physician might recommend that the patient may stop the diet.

(Williams, 2010).
The process to using KD

- The patient's medical condition is evaluated by a medical team composed of a neurologist, dietitian, and nurse’s staff, all of which are experienced with the use of KD.
- The diet is developed and determined daily calories recommendation for each patient, which will be followed during the treatment period.
- The patient is invited to enter the hospital for four days to complete the diet, and neurologists’ advice and oversee the process.
Why should the patient be at hospital in the beginning of KD?

1. Effectiveness and safety
2. Observation and control of possible side effects
3. Prevention of hypoglycemia
4. Supervision by the dietitian
5. Providing personal education to the patient and family to help them understand the diet.

(Schwartzkroin, & Rho, 2009)
The physiology of Ketosis

- A commonly known fact is that the human body needs to have three main resources for energy which are carbohydrate, protein, and fat. The carbohydrates are the main source of fuel energy to supply the body.

- When removing a carbohydrate from the diet (low carbohydrate) or after 3-4 days of fasting, it affects change in hormone levels specifically glucagon and insulin, which leads to a decrease in the level of insulin, and an increase in the level of glucagon (Table 1).

- **Insulin** is a vital hormone produced by cells in the pancreas. Insulin works to transport glucose from the blood to cells and to obtain energy or to store energy at a later time.

- **Glucagon** is a hormone that is produced in the pancreas. Glucagon prompts the liver and muscles to break down glycogen to glucose and release glucose again to the bloodstream.
**Table 1. Blood levels during a normal diet and ketogenic diet.**

<table>
<thead>
<tr>
<th>Blood levels</th>
<th>normal diet</th>
<th>ketogenic diet</th>
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<tbody>
<tr>
<td>Glucose (mg/dL)</td>
<td>80–120</td>
<td>65–80</td>
</tr>
<tr>
<td>Insulin (µU/L)</td>
<td>6–23</td>
<td>6.6–9.4</td>
</tr>
<tr>
<td>pH</td>
<td>7.4</td>
<td>7.4</td>
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</tbody>
</table>
It is necessary to find an alternative fuel in a minor way to produce energy for the body.

- Glucose becomes inadequate to provide power to the central nervous system and for the production of oxaloacetate which aids in natural fat oxidation.
- When there are not enough carbs, triglycerides transform to ketone bodies and fatty acids.
- Free fatty acids (FFA) provide ways that the production of energy can be used for most body tissues this excludes the brain and the central nervous system.
• As a result, the brain and the central nervous system need to receive an alternative source, which is derived from the excessive production of Acetyl-CoA, resulting in the production of ketone bodies acetoacetate, β-hydroxy acid, and acetone (Figure 1).

• Metabolic ketosis occurs during the production ketone bodies at an accelerated pace, and this situation leads to a decrease in the breakdown of protein to be used for energy, and a reduction in the use and production of glucose (Figure 2).
Figure 1. Pathway of ketone bodies.
Figure 2 Ketone Bodies Metabolism
**Why KD works**

There are several research showing several hypotheses about why KD responding. The most important of these assumptions are:

1- A high-fat, low-carbohydrate diet favors production of 3-OH-butyric acid and acetoacetic acid, the “ketone bodies,” perhaps acidifying the brain parenchyma and inhibiting neuronal H+-sensitive ion channels. However, there is no cogent evidence that such acidification occurs.

2- Glucose, even in physiological concentration, may increase neuronal excitability, and hyperglycemia lowers the seizure threshold. Conversely, a diminution of blood glucose, which ought to occur with a low-carbohydrate diet, might lower neuronal excitability and thereby attenuate an epileptic diathesis. However, it should be noted that a ketogenic diet enhances brain glucose transport, thereby maintaining central nervous system glucose concentrations even though blood levels are diminished.
Cont.

• 3- Ketosis may hyperpolarize neuronal membranes through an effect of ketone bodies or long-chain fatty acids on adenosine triphosphate (ATP)-sensitive K+ channels.

• 4- Fatty acids may directly inhibit neuronal function;

• 5- Acetone, which quickly enters brain, diminishes seizure threshold and severity;

• 6- Increased concentrations of fatty acids enhance both the levels and the activity of mitochondrial uncoupling protein, a phenomenon that might explain the protective effect of the diet against disorders such as glutamate toxicity, traumatic brain injury, and Parkinsonism."
Analysis of the effectiveness of the Ketogenic Diet

Many of the studies have shown that Ketogenic diet can reduce or prevent seizures in many patients, this type of study continues to increase in terms of the positive results, who cannot be controlled by medications or surgery seizures especially in children.
• In 1999, according to Sirven et al study by using the Ketogenic Diet as a treatment for adults with epilepsy who failed using medications and/or surgery, and their seizure uncontrolled. Authors applied the KD on 11 patients from ages 19 to 45 years for 8 months’ diet program, which were two men and nine women, without stopped their medications during the period.

The results;

1. seven patients had beneficial of the diet, and four patients had unbeneﬁcial of the diet because they stopped the diet.

2. The beneﬁts of the seven patients were divided in, 3 patients had 90% decrease in seizure frequency, 3 patients had 50-49% decrease in seizure frequency, and one patient had 40% seizure decrease
• According to Nordli, et al, that how KD effects in infant with refractory epilepsy. There were 32 infants who treated with the KD.

• The results showed that the majority of infants (71%) were fit to keep a powerful ketosis, which were 19.4% became seizure-free, and 35.5% had a greater than 50% reduction in seizure frequency.

Also, the infants showed improvements in behavior and function, alertness, activity level, and socialization
The benefits and Side-Effects of using KD

The benefits

1. Epilepsy seizure reduction in children and adults, and even after discontinuing diet
2. Cognitive and behavioral Improvements
3. Weight loss
4. Autism improvements
5. Improvements in Alzheimer’s, and Parkinson’s
6. Traumatic brain injury protection
7. Improved bipolar symptoms
8. Appetite suppression
9. Increased fat mass loss
10. Decreased tumor size
11. Athletic performance
12. Improved glycemic control or diabetes
13. Improved blood lipids

Side-Effects

1. Inflammation risk
2. Hypoglycemia
3. Poor growth in children
4. Skeletal fracture
5. Pneumonia
6. Heart arrhythmia
7. Myocardial infarction
8. Kidney stones
9. Osteoporosis
## Comparison between a normal diet and ketogenic diet

<table>
<thead>
<tr>
<th></th>
<th>Cals</th>
<th>Chol</th>
<th>Sodium</th>
<th>Fiber</th>
<th>Sugar</th>
<th>Carbs</th>
<th>Fat</th>
<th>Prot</th>
</tr>
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<tbody>
<tr>
<td><strong>Normal Diet</strong></td>
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<td></td>
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<tr>
<td></td>
<td>1911</td>
<td>665mg</td>
<td>2403mg</td>
<td>25g</td>
<td>73g</td>
<td>215g</td>
<td>66g</td>
<td>123g</td>
</tr>
<tr>
<td><strong>Ketogenic Diet</strong></td>
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<td></td>
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<tr>
<td></td>
<td>1693</td>
<td>209mg</td>
<td>1035mg</td>
<td>7g</td>
<td>4g</td>
<td>22g</td>
<td>160g</td>
<td>49g</td>
</tr>
</tbody>
</table>
normal diet

The total % of Carbs, Fat, and Protein for this normal diet

ketogenic diet

The total % of Carbs, Fat, and Protein for this KD
Summary the % of carbs, protein, and fat in between Normal Diet and Ketogenic Diet by daily recommendation.

<table>
<thead>
<tr>
<th></th>
<th>Normal Diet</th>
<th>Ketogenic Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbs</td>
<td>40%</td>
<td>2–4%</td>
</tr>
<tr>
<td>Protein</td>
<td>30%</td>
<td>6–8%</td>
</tr>
<tr>
<td>Fat</td>
<td>30%</td>
<td>85–90%</td>
</tr>
</tbody>
</table>
Ketogenic Diet food Groups

- **PROTEIN**: Meat, fish, eggs, vegetables
- **CARBOHYDRATE**: Fruits and vegetables
- **FAT**: Butter, oil, margarine, mayonnaise, or 36% or 40% whipping cream
Foods that are not allowed on Ketogenic Diet

• Anything high in sugar:
  Sugar
  Candy bars
  Desserts
  Sodas

• Anything high in carbohydrates:
  Pastas
  Milk
Thank you for listening and being attention with me.
References

  
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