THE EFFECT OF AEROBIC EXERCISE ON THE FREQUENCY AND PAIN OF MIGRAINE HEADACHES

by

MARK LAFAVE

A Thesis
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE

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THE EFFECT OF AEROBIC EXERCISE ON THE FREQUENCY AND PAIN OF MIGRAINE HEADACHES

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ABSTRACT

Migraine headaches afflict approximately 20 percent of the population. They are characterized by extreme pain often of pulsating quality in the head, nausea, vomiting and may be accompanied by visual or other sensory disturbances. There has been a great deal of research performed, but the etiology of migraine headaches remains unknown. As a result, most migraine sufferers must take medications to alleviate the signs and symptoms of the headache. Some researchers have been interested in analyzing the effect of some non-pharmaceutical treatments for migraine headaches. Aerobic exercise is one of those non-pharmaceutical treatments suggested and the topic of this study.

Sixteen female subjects were randomly assigned to two groups. One group merely measured their headache pain and frequency using a daily headache diary and visual analogue scale while the other group also collected that information in addition to being given and aerobic exercise protocol to follow. The groups collected information for twelve weeks. Subjects' fitness levels were measured by submaximal bike tests to look at the changes in their fitness levels. Once the control group was done twelve weeks of headache pain and frequency data collection, they were introduced to the aerobic exercise program.

Statistical analyses were performed to compare the headache pain and frequency of the group that exercised compared to the group which did not exercise. The results showed that there was no significant difference in headache pain or frequency between the group that exercised as compared to the group that did not exercise. Subjects were instructed to exercise a minimum of three times per week but this was accomplished only forty four percent of the time. As a result there was no significant changes in fitness levels. Based on this data it can be suggested that people suffering from Migraine headaches demonstrate a poor compliance rate and consequently significant changes in aerobic fitness which may or may not have affected migraine pain or frequency was not achieved.

Personal comments made by subjects suggested that the exercise was helpful. In fact, only one person thought that the exercise program made their condition worse whereas nine of the sixteen subjects talked about having a positive experience. These comments show promise for future research with aerobic exercise and the migraine headache population.

ACKNOWLEDGMENTS

Without the assistance of many people, I would not have been able to complete this project. I would like to acknowledge those people. I am extremely grateful to my supervisor, Dr. Glen Bergeron, for his assistance throughout this project as well as his influential leadership throughout my Certification as an Athletic Therapist. Without his tireless work for Athletic Therapy graduate students, evolution of the profession would not be possible. I would like to thank Dr. Brian Anderson for the thesis topic, his continual input, assistance in the study and financial support offered to me. I think that various disciplines may benefit from collaboration on such projects as this one which was initiated by Dr. Anderson. I would also like to thank my other committee members, Dr. Wendy Dalhgren and Sue Boreski for their support and assistance throughout this entire process. I would also like to acknowledge Mary Cheung, the department of biostatistics at the University of Manitoba for her assistance in the statistical analysis.

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To my wonderful wife, Lynne, for all your love, support and assistance. Without you, I may not have been able to place my sights so high and ended up where I am today. I would also like to thank her for her relentless help with some of the technical problems of this thesis. I would like to dedicate this thesis to her and our child to be.

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CHAPTER ONE
INTRODUCTION

Rapoport and Sheftell (1990) speculated 8 to 10 per cent of all men and 18 to 20 per cent of all women have experienced a migraine at some point in their lives. With such a large percentage of the population being affected by migraine headaches, study of methods to reduce the frequency or severity of migraine headaches seems appropriate. However, one problem with studying migraine headaches is that the cause is unknown (Spierings, 1988). It is difficult to study methods to reduce headache pain and frequency when the cause is unknown.

As a result, most studies have focused on reducing the signs and symptoms of migraine headaches. Since pain is one of the most debilitating symptoms, most treatment has focused on its reduction. Pharmaceutical methods of pain reduction have been the modality of choice by most physicians (Rapoport & Sheftell, 1990). However, pharmaceutical methods have lead to numerous side effects which have lead researchers to explore non-pharmaceutical modes of pain relief (Graham, 1979; Mathew, 1990a; Rapoport & Sheftell, 1990). Aerobic exercise has been listed as one non-pharmaceutical mode of pain relief (Mathew, 1990a).

Use of Aerobic Exercise as Pain Relief

Migraine relief by using aerobic exercise has been evaluated by researchers and resulted in anecdotal support for its use (Rapoport & Sheftell, 1990; Atkinson, 1977; Kumar, 1988; Darling, 1991). However, in order to recommend exercise for treatment of migraine headaches, more scientific evidence is needed (Lockett and Campbell,

1992). To date, there have only been a few studies which have explored the effect of aerobic exercise on migraine headaches (Lockett and Campbell, 1992; Grimm, Douglas and Hanson, 1981; Fitterling, Martin, Gramling, Cole and Milan, 1988). Most studies either reported statistically significant changes or they reported positive trends in migraine pain and/or frequency relief.

Lockett and Campbell (1992) reported that exercise significantly reduced the severity of pain for migraine headache sufferers (i.e.; migraineurs). However, they also found that, although there were no significant changes in affective distress (mood) and headache frequency there appeared to be some positive clinical changes. However, these were not described (Lockett and Campbell, 1992). The lack of significant changes may have been due to the length of the study (six weeks) or the data analysis chosen (parametric statistics) for their specific measurement tool of headache frequency and pain (Lockett and Campbell, 1992).

Fitterling et al. (1988) claimed positive reduction in headache pain and frequency, however, the study only included five subjects. In addition, the subjects which took part in their study were on a medication which may have influenced the results. Careful consideration to study design is essential in order to accurately evaluate the effect of exercise on migraine headache pain and frequency.

Headache Classification

Not all headaches are the same, even though they have the common denominator of pain in the head. Transient headaches can have many causes such as diseases of the paranasal sinuses, teeth, eyes, ears, nose or throat (Anderson, 1982). However, chronic headaches which are of interest for this study do not have a specific etiology. Because there are so many types of chronic and transient headaches, the Headache Classification Committee of the International Headache Society (1988) has organized headaches into twelve categories (Table 1-1).

Table 1-1: Headache Classification. (Headache Classification Committee of the International Headache Society, 1988)

1.	Migraine
2.	Tension type headache
3.	Cluster headache and chronic paroxysmal hemicrania
4.	Miscellaneous headaches unassociated with structural lesions
5.	Headache associated with head trauma
6.	Headache associated with vascular disorders
7.	Headache associated with non-vascular intracranial disorders
8.	Headache associated with substances or their withdrawal
9.	Headache associated with noncephalic infection
10.	Headache associated with metabolic disorder
11.	Headache or facial pain associated with disorder of cranium, neck, eyes, ears, nose, sinuses, teeth, mouth or other facial or cranial structures
12.	Cranial Neuralgias, nerve trunk pain and deafferentation pain

The Headache Classification Committee has further subdivided the first four categories so as to specifically differentiate between migrainous type headaches (Ferrer-Brechner, 1990)(Table 1-2). The first two subcategorizes (migraine with an aura and migraine without an aura) will be the target population of the present study. An aura will be discussed in more detail later in Chapter Two, but briefly, it is

defined as the onset of signs and symptoms which precede the pain associated with the headache (Rapoport & Sheftell, 1990).

Table 1-2: Classification of Migraine. (Ferrer-Brechner, 1990)

Migraine without aura
Migraine with aura
Migraine with atypical aura
Migraine with prolonged aura
Familial hemiplegic migraine
Basilar migraine
Migraine aura without headache
Migraine with acute onset aura
Ophthalmoplegic migraine
Retinal migraine
Childhood periodic syndromes that may be precursors to or associated with migraine
Benign paroxysmal vertigo of childhood
Alternating hemiplegia of childhood
Complications of migraine
Status migrainous
Migrainous infarction
Migrainous disorder not fulfilling above criteria

What Do We Know About Migraine Headaches?

There has been a great deal of research completed on migraine headaches (Raskin, 1988). Most discoveries of what is known about migraine headaches revolves around the use of pharmaceutical methods for the reduction of the signs and symptoms of headaches. In fact, Graham and Wolff (1938) were the first to report a vascular dysfunction associated with migraine headaches. They made this discovery possible using ergotamine, an arterial vasoconstrictor.

Vascular induced headaches have since been reported by a number of other researchers (Wolff, Tunis and Goodell, 1953; Olesen, Larsen and Lauritzen, 1981; Spierings, 1988). Investigating the

vascular mechanism of migraine headaches has centered on structures such as intracranial and extracranial arteries, veins and sinuses (Lance, 1982). The major anatomical structures capable of sensing pain in the brain are, in fact, intracranial and extracranial vasculature (Lance, 1982). Therefore, the question, "why does a head ache" is not a simple, straight forward question, as it might first appear (Lance, 1982). In order to treat headache pain, it is essential to identify the source of pain. Since the specific target tissue causing migraine headaches has yet to be identified, clinicians have resorted to non-specific pharmaceutical treatments (Graham, 1979; Lance, 1982).

Rationale for this Study

Numerous adverse affects of pharmaceuticals have been noted which, as a result, have prompted researchers to seek alternative treatment modalities (Graham, 1979; Mathew, 1990a). For example, Mathew (1990a) suggested a troubleshoot, multimodality approach which included exercise as one of the intervening methods. A systematic approach to closely examine the benefits of exercise on migraine headaches is required to determine the relative effectiveness of exercise intervention (Kumar, 1988).

STATEMENT OF THE PROBLEM

The purpose of this study was to determine the impact of an aerobic exercise program on migraine headache pain and migraine headache frequency. Secondarily, the study attempted to determine the effect of an aerobic exercise program on a patient's aerobic fitness level.

HYPOTHESES

1. Migraine headache pain will decrease significantly in the group that exercised compared to the group that did not exercise.
2. The frequency of migraine headaches will be significantly less in the group that exercised compared to the group that did not exercise.
3. Aerobic fitness level will be greater in the group that exercised compared to the group that did not exercise.

IMPORTANCE AND RELEVANCE

It has been estimated that as many as twenty percent of the population have been afflicted with migraine headaches (Rapoport & Sheftell, 1991). Since the etiology has yet to be determined, the medical profession has relied on medication to deal with the symptoms of migraine headaches (Lance, 1982). If drugs could completely control the headaches without side effects, a search for non-pharmaceutical treatment protocols would not be necessary. However, drugs have not provided complete relief from pain, nor do they work without significant side effects (Mathews, 1990b). Based

on this premise, a logical step would be to investigate the effectiveness of a non-pharmaceutical approach (Mathews, 1990a).

Since medications are associated with disabling side effects, the role of aerobic exercise to control migraine headaches would have both theoretical and practical implications to the scientific and medical communities. If aerobic exercise could affect migraine headaches in a positive manner, the scientific community may be one step closer to understanding the cause of migraine headaches. In the practical sense, a clinician working with migraine headache patients may be able to offer a variety of treatment options rather than just a pharmaceutical approach.

LIMITATIONS

1. Extraneous variables such as diet or stress were not controlled by the researcher.
2. The duration of the exercise and non-exercise periods was limited to twelve weeks for each group.
3. Subject compliance to the exercise program was limited to weekly phone call reminders from the researcher or research assistant.

ASSUMPTIONS

1. It was assumed, as in a study by Andrasik and Holroyd (1980), that if all subjects continued with their normal activities of daily living, in addition to the prescribed treatment program, extraneous variables such as diet or other physical and/or psychological stressors would not change

2. It was assumed that subjects would answer truthfully when they filled out the visual analogue scale (VAS)
3. It was assumed that if subjects said they exercised, and documented it as such, that they were telling the truth.
4. It was assumed that if the subjects were prescribed a certain quantity of exercise for them to complete, they would comply with the prescribed exercise requirements.

CHAPTER TWO
REVIEW OF LITERATURE

Migraine Pathogenesis

The exact etiology of migraine headaches is unknown (Graham, 1979; Lance, 1982; Mathew, 1990a; Raskin, 1988; Spierings, 1988). Research of migraine headaches has evolved considerably since the initial study performed by Graham and Wolff (1938) which assessed the vascular mechanism of migraine headaches. Subsequently, research has focused on the vascular model of migraine pathogenesis (Raskin, 1988). Alternatively, Lashley (1941) and Leao (1944) developed what is classified as the neuronal model for migraine headaches. Until more recently, no logical link could be made between the vascular and neurological models (Spierings, 1988).

Olesen (1986) reviewed several studies completed out of Copenhagen which attempted to disprove the vascular model as the primary mechanism of migraine headaches. However, Raskin (1988) disagreed with the neuronal model and stated the search for a single causal factor for migraine headaches may be a mistake. Raskin (1988) offered a more inclusive approach and coined the term "epiphenomenon" to depict the various biological phenomena which occur during migraine attacks (Table 2-1). An epiphenomenon may be defined as "a secondary phenomenon accompanying another and caused by it" (Mish, 1983, pg. 419). Raskin (1988) speculated that each of the epiphenomena, associated with migraine headaches, listed in Table 2-1 are reliant on each other for their occurrence, creating a cascading effect which can eventually produce a migraine headache.

Table 2-1: Biological phenomenon occurring during classical migraine attacks. (Raskin, 1988, pg. 100).

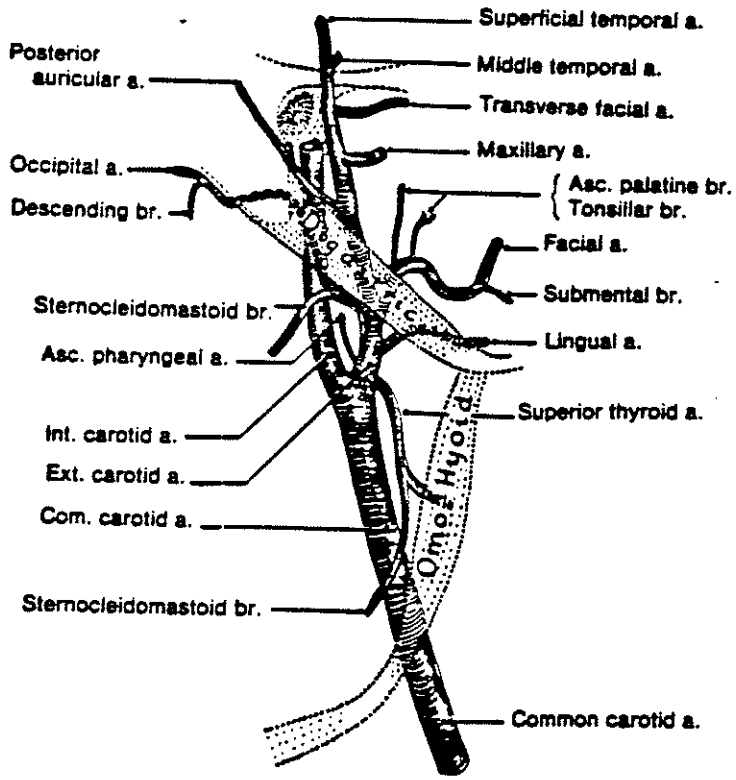
Intra and extracranial vasodilation
Spreading oligemia
Opening of cephalic arteriovenous shunts
Cerebral vasomotor dysautoregulation
Platelet activation
Release of platelet serotonin and B-thromboglobulin
Increased concentration of plasma-free fatty acids, histamine
Decreased concentration of plasma norepinephrine
Decreased platelet monoamine oxidase activity
Increased cerebrospinal fluid concentrations of
Y-aminobutyrate,
3', 5', - cyclic adenosine monophosphate

Each of these epiphenomenon is an important biological factor in migraine headaches, but as research has demonstrated, some may be more important than others (Raskin, 1988). To fully understand how each of these phenomena is known to affect migraine headaches, a thorough review of vascular and neurological anatomy is warranted.

Vascular and Neurological Anatomy

Extracranial arteries may be defined as arteries providing blood supply to the face and scalp (Saper, 1983). In general, these arteries include the external carotid arterial system and all of the branches which originate from it (Kandel, Jessel & Swartz, 1991)(Figure 2-1). The external carotid artery is a branch of the common carotid artery which gives rise to both the external carotid artery and its branches as well as the internal carotid artery which provides blood supply to the brain and intracranial structures (Moore, 1989) (Figure 2-1).

Figure 2-1: The carotid artery system and its branches. (Moore, 1985).



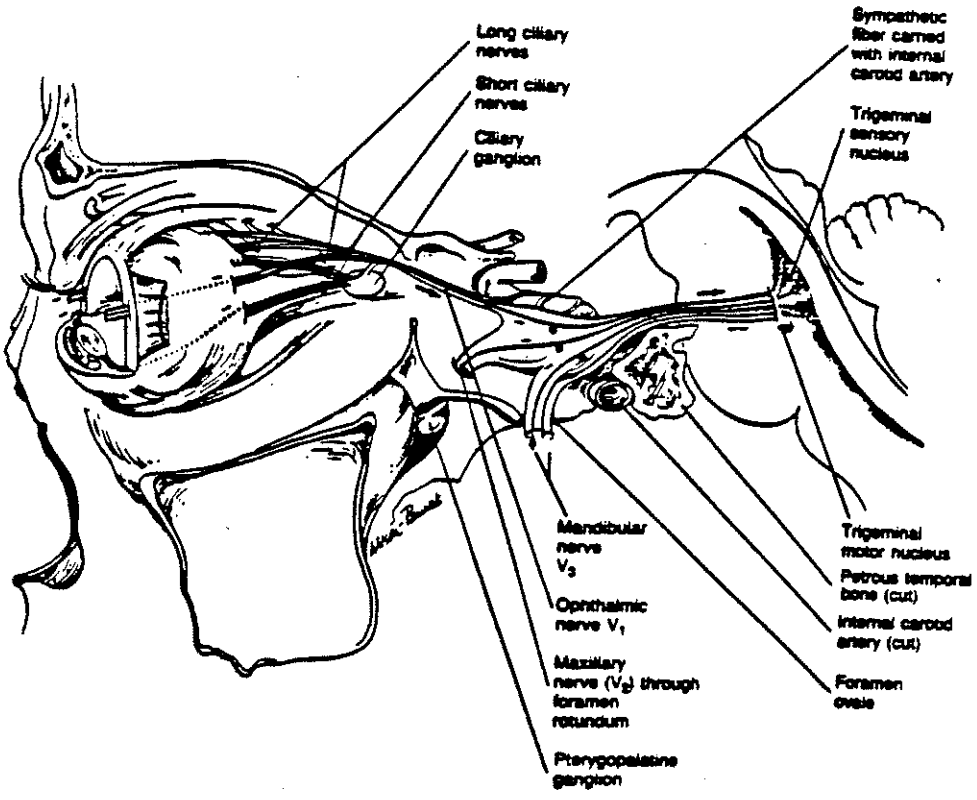
Trigeminal Nerve

Knowing what structures in the head are actually capable of sensing pain is not a simple endeavor (Lance, 1982). In fact, it is well documented that most of the brain is actually insensitive to pain

(Penfield, 1935; Ray and Wolff, 1940). Intracranial blood vessels are one of a few structures capable of sensing pain intracranially (Moskowitz, Beyerl and Henrikson, 1986).

The trigeminal nerve, also known as the fifth cranial nerve, is primarily responsible for the somatic sensations of the face (Kandel et al., 1991) except for portions of the ear and the angle of the jaw. This nerve also transmits sensory innervation for most of the oral mucosa, the anterior two thirds of the tongue, as well as the dura mater of the anterior and middle cranial fossae (Kandel et al., 1991). The trigeminal nerve is one of many cranial nerves to exit/enter the ventral aspect of the brainstem at the level of the pons (Kandel et al., 1991). The trigeminal nerve divides into its three major divisions which depart from the trigeminal ganglion: 1) the ophthalmic nerve (V1); 2) the maxillary nerve (V2); and the mandibular nerve (V3). (Figure 2-2).

Figure 2-2: Saggital view of the trigeminal nerve complex and its divisions. (Wilson-Pauwells, Akesson & Stewart, 1988).



Historical Perspective of Migraines

In a historical review of migraine headache research, Edmeads (1979) cited Thomas Willis, of the sixteen hundreds, as one of the first to attempt to explain the occurrence of headaches. Willis proposed that headache pain was the consequence of "sudden and vehement incursion" of blood into the head (Edmeads, 1979, pg. 230). Not until 1938 did Graham and Wolff study the effect of vasculature on migraines. Graham and Wolff studied the pulsation amplitude of the cranial non-cerebral arteries during migraine, before and after the administration of ergotamine. Ergotamine is commonly used as a medication to abort migraine headaches (Raskin, 1981), apparently for its vasoconstrictive action on blood vessels (Hardebo, Edvinson, Olman and Svendgaard, 1978).

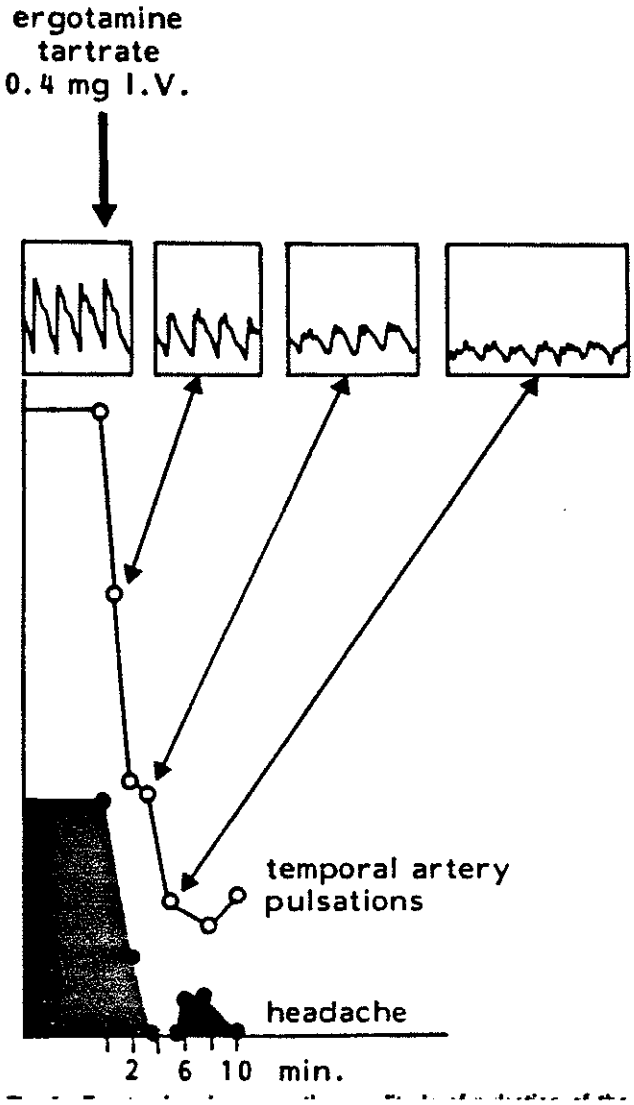
Since Graham and Wolff (1938) found a decrease in the pulse amplitude of the extracranial arteries as well as a decrease in pain with the administration of ergotamine, they proposed that the pathogenesis of migraine headaches must involve extracranial blood vessels. Tunis and Wolff (1953) also concluded that there was a direct correlation between an increase in pulse amplitude of the scalp arteries and the severity of a headache. It is now well accepted that there is, in fact, an elevation in extracranial blood flow correlated to the onset of migraine headaches (Sakai and Meyer, 1978). Graham and Wolff (1938) admitted that extracranial vasodilation, alone, could only produce headaches in migraineurs two thirds of the time. Changes in extracranial blood vessels can not be discounted because reactive vasodilation of the scalp and facial arteries does not occur in control subjects when compared to subjects

suffering from migraines (Dalessio, 1980). The exact role of the extracranial vessels has yet to be determined.

More recent work has suggested that the positive results reported by Graham and Wolff (1938) was not due to ergotamine tartrate's vasoconstrictive qualities (Lance, 1988; Dechant and Clissold, 1992). Rather, Lance (1988) and Dechant and Clissold (1992) speculated that the reduction of pain was purely coincidental, wherein the ergot bound itself to a serotonin receptor in the brain. The importance of serotonin and its receptors will be reviewed later in this chapter.

Ergotamine was found to decrease pain which, in turn, was correlated with a reduction in pulsation amplitude of the cranial non-cerebral arteries (Graham and Wolff, 1938)(Figure 2-3).

Figure 2-3: The Effect of Ergotamine on the Superficial Temporal Artery. Ergotamine decreases the amplitude of pulsation of the superficial temporal artery at the same time that it decreases the intensity of the migraine headache. (From Graham & Wolff, 1938).



In search for the pain mechanism of headache, Chapman, Ramos, Goodell, Silverman and Wolff (1960) discovered the presence of a polypeptide, which they termed neurokinin, in the extravascular space around the extracranial blood vessels which was speculated to be responsible for the pain. To date, the exact nature and function of neurokinin remains unknown, but researchers have speculated on its biochemical make-up. It has been speculated that inflammation

around the arterial walls is caused by substance P (a neurokinin), which has been shown to "dilate pial arteries, increase vascular permeability and activate cells that participate in the inflammatory response" (Raskin,1988, pg. 103). Substance P is said to be a peptide neurotransmitter released by the trigeminal nerve into the walls of the cerebral blood vessels to produce pain (Lance, 1982).

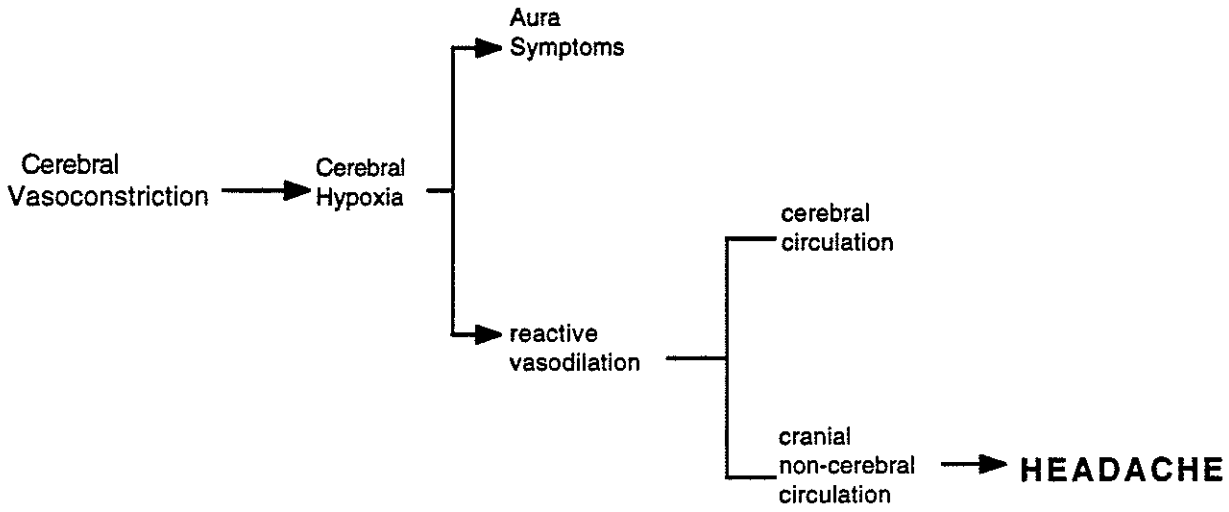
Raskin (1988) similarly describes a polypeptide substance, possibly neurokinin or substance P, which is released from the trigeminal nerve which may "lower tissue pain threshold, increase capillary permeability and increase tissue vulnerability to injury" (Raskin, 1988, pg. 103). The mechanism which releases these vasoreactive substances has not yet been determined (Saper, 1983). Raskin (1988) speculated that the involvement of the extracranial blood vessels may not be associated with migraines, but may only be a secondary phenomenon. Raskin (1988) also stated that head pain must also include intracranial mechanisms as well as involvement from serotonin.

Intracranial Phenomenon

Classical migraine headaches have associated symptoms known as an aura (Spierings, 1988). Aura symptoms may present in numerous forms, the most common being of a visual nature (Spierings, 1988). Marcussen and Wolff (1950) hypothesized that the aura symptoms were due to the transient vasoconstriction of intracerebral blood vessels leading to hypoxia, or lack of oxygen to the brain. Following this vasoconstriction, they speculated that there was a reactive hyperemia or increased blood flow to both the intracranial and extracranial blood vessels (Marcussen and Wolff,

1950). Vasodilation of the extracranial blood vessels was thought to cause the headache pain which is transmitted via the trigeminal nerve pathway (Spierings, 1988)(Figure 2-4).

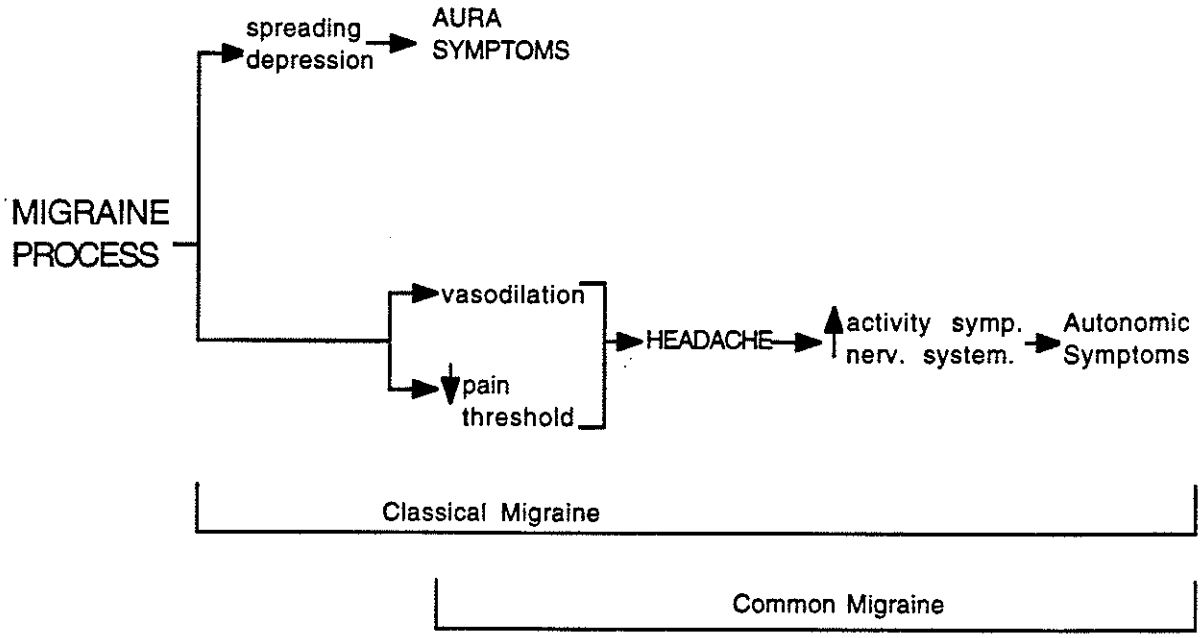
Figure 2-4: Wolff's Migraine Pathogenesis Model. (Spierings, 1988, pg. 656)



Wolff's model for migraine pathogenesis was disputed by Olesen et al. (1981) who studied the effect of intracranial blood flow of migraineurs. Intracranial blood flow was studied during all phases of migraine (onset of aura symptoms until pain subsided) using an intracarotid injection of a radioactive isotope, Xenon (Xe^{133}). Olesen et al. (1981) confirmed that intracranial blood flow increased during the headache free period. Marcussen and Wolff (1950) and Olesen et al. (1981) only differ in their use of terminology for the decrease in intracranial blood flow. The decrease in blood flow during a migraine was determined to be "about twenty five per cent which is generally considered not to be sufficient to cause neuronal dysfunction by hypoxia and, therefore, was referred to as Oligemia" (Spierings, 1988, pg. 657). Oligemia merely refers to a reduced amount of blood.

In addition to the circulatory aberrations described above, a cortical phenomenon known as spreading depression may also occur prior to headaches (Raskin, 1988). Intracranial blood flow and spreading depression have been linked together due to a similarity in velocity of onset (Raskin, 1988). Spreading depression has been described as a wave of neuronal inhibition moving slowly over the cerebral cortex, suppressing normal neuronal activity (Lance, 1982). Intracranial blood flow in migraine patients (oligemia) decreased at a velocity of two to five millimeters per minute (Lauritzen, Skyhoj, Hansen & Diemer, 1982). Spreading depression moved across the cerebral cortex suppressing normal activity at a similar velocity of two to three millimeters per minute (Lance, 1982). Milner (1958a) hypothesized that since the spread of neuronal inhibition is actually preceded by a short lasting period of excitation, aura symptoms could be a neurophysiological phenomenon, rather than a vasoconstriction induced hypoxia suggested by Marcussen and Wolff (1950). Rejection of the vascular hypothesis for migraine headaches was supported in that oligemia occurred in only one half the patients tested (Meyer, Zetusky, Jonsdottir & Mortel, 1986). These conclusions have lead Spierings (1988) to create a modified version (Figure 2-5) of Wolff's original model (Figure 2-4) of migraine pathogenesis.

Figure 2-5: Migraine Pathogenesis Model. Spierings, 1988, pg. 658).



This model includes spreading depression as part of the migraine sequence in support of Raskin's (1988) epiphenomenon hypothesis. The underlying cause leading to this cascade of events, termed the "migraine process" is yet to be fully understood (Spierings,1988, pg. 658) .

Intracranial Vasomotor Dysregulation

Raskin and Knittle (1976) have found that migraineurs experience frequent symptomatic transient cerebral ischemia caused by something as minor as a mere postural change. Raskin and Knittle (1976) speculated that this phenomenon was due to poor adaptation of intracranial blood vessels. Dysregulation may not only occur centrally (intracranially), but also peripherally (extracranially) (Appenzeller, Davison & Marshall, 1963; Appenzeller, 1969; Appenzeller, 1978). Peripheral vascular diseases, such as Raynaud's Disease and Prinzmetal's angina are frequently observed in the

migraine population (Zahavi, Chagnac & Hering, 1984; Miller, Waters & Warnica, 1981).

There is some contradiction in the literature with respect to the exact involvement of vasomotor dysregulation with migraineurs (Morely, 1977). French, Lassers & Desai, (1967) reported normal vascular response while defective responses were reported by Appenzeller (1978). Cardiovascular reflex responses such as a valsalva maneuver have proven dysfunctional with migraineurs, but not in children with migraines (Havanka-Kanniainen, Tolonen & Myllyla, 1986). Due to such inconsistency in findings, Raskin (1988) speculated intracranial vasomotor dysregulation may be just another one of the many epiphenomena which merely complicates the migraine process.

Platelet Function/Dysfunction

Although Hanington (1986) suggested that platelet dysfunction is a causal factor in migraine headaches, Steiner, Joseph & Rose, (1985) and Joseph and Welch (1987) have provided evidence that platelets play nothing more than an epiphenomenal role in the pathogenesis of migraine pain. Platelets react to stress and tissue injury by aggregating. They also initiate a release of such substances as serotonin and Beta-thromboglobulin stored in the platelets (Weiss, 1982). It has been well documented that migraineurs experience a hyperaggregability of platelets (Hilton and Cumings, 1971; Couch and Hassanein, 1977; Hanington & Jones, 1981; Kruglak, Nathan & Korczyn, 1984). Although the exact role of serotonin in migraines is unknown (Lance, 1982), its relationship to migraine pathogenesis is well established (Dechant and Clissold, 1992). Serotonin is a

vasoconstrictor and a stimulator of smooth muscle contractions (Murray, Granner, Mayes and Rodwell, 1988). Platelet concentration is used in determining serotonin levels in the human body and therefore can be used to provide valuable information for migraine research (Raskin, 1988). Studies have looked at the effect of antiplatelet drugs to stop platelet aggregation and serotonin release which, in turn, may perpetuate the migraine headaches (Hawkes, 1978; Masel, Chesson & Peters, 1980; Ryan and Ryan, 1982). However, migraineurs did not benefit from the antiplatelet drug therapy (Raskin, 1988). These results supported Steiner et al. (1985) and Joseph and Welch (1987) in their hypothesis that platelet dysfunction was nothing more than an epiphenomenon in migraine pathogenesis.

Monoamine Oxidase

Monoamine Oxidase (MAO) is an enzyme which assists in the metabolism of serotonin, norepinephrine, tyramine, dopamine and phenylethylamine depending on the form of MAO (type A or B) (Raskin, 1988). Studies have reported that migraineurs have significantly decreased MAO activity when compared to normal/ control subjects (Sandler, Youdim, Southgate & Hanington, 1970; Sicuteri, Buffoni, Anselmi & Del Bianco, 1972). MAO-A is responsible for the degradation of serotonin and epinephrine while MAO-B is responsible for phenylethylamine degradation (Raskin, 1988). Tyramine and dopamine may be broken down by either of the MAO substrates (Lance, 1982).

It was speculated that the MAO-B substrate only had a role in what is commonly known as the dietary migraine since

phenylethylamine is often in foods which elicit a dietary migraine reaction (Sandler, Youdim & Hanington, 1974). Sandler et al. (1974) used platelets as a marker to follow the activity level of MAO-B (since only platelets contain this enzyme). The authors found that dietary migraineurs have similarly reduced activity of MAO-B compared to non-dietary migraineurs. This demonstrated that MAO-B played a role in both dietary and non-dietary (i.e.; common and classical) migraines (Raskin, 1988). Raskin (1988) cited numerous studies which theorized the role of MAO in migraines, none of which have been substantiated. The conclusive evidence is that MAO activity level in migraineurs is significantly different than controls (i.e.; non-migraineurs) which has left the role of MAO in migraines unresolved (Raskin, 1988).

Fatty Acids

Fatty acids are the simplest form of lipids which provide necessary energy nutrients from dietary fat (Hunt and Groff, 1990). Hockaday, Williamson and Whitty (1971) and Anthony (1978, 1976) have reported an increase in blood levels of free fatty acids in patients who suffer from migraine headache. Anthony (1986) speculated that an increase in free fatty acid may be responsible for the release of serotonin from platelets during a migraine attack. This hypothesis has yet to be substantiated in the literature and thus remains a subject of future research (Raskin, 1988).

Histamine

Histamine is an inflammatory mediator secreted mainly by mast cells to cause vasodilation and increased permeability to protein. It is also thought to be responsible for depolarization of

nearby nerve endings initiating action potentials in afferent nerve fibers (Vander, Sherman and Luciano, 1985). The role of histamine has been studied in migraine research ever since Pickering and Hess (1933) first elicited a headache reaction with histamine administration. Interest in the role of histamine in migraine pathogenesis has fluctuated over the years (Lance, 1982). Ostfeld, Chapman, Goodell and Wolff (1957) speculated histamine's role was merely coincidental since a histamine antagonist had no effect on the pattern of migraine headaches. Although attempts have been made to eliminate histamine as a causal factor in migraine headache pain, researchers continue their quest to discover its role (Anthony and Lance, 1971; Heatley, Denburg, Bayer & Bienenstock, 1982; Haimart, Pradalier & Launay, 1987). Raskin (1988) speculated that histamine was nothing more than a secondary response to the tissue injury created during headache episodes, which concurs with histamine's physiological role in the human body.

Norepinephrine

Norepinephrine is an amine hormone (catecholamine) produced in the adrenal gland and secreted directly into the blood stream (Vander, Sherman and Luciano, 1985). Norepinephrine (as well as serotonin) acts on descending axons in the spinal cord to regulate pain (Vander, Sherman and Luciano, 1985). Stress and anxiety are two trigger factors which have been clinically linked to migraine headaches (Saper, 1983). The common catecholamine response to stress and anxiety is elevation of blood levels of norepinephrine and epinephrine (Lance and Hinterberger, 1976). However, during headache attacks, plasma norepinephrine levels have decreased

(Fog-Moller, Genefke & Bryndum, 1978). This could account for an inability to control pain since this is one of norepinephrine's role in the body. No substantial evidence has specifically outlined norepinephrine's role in the migraine headache phenomenon, and thus, it too has been categorized as an epiphenomenon (Raskin, 1988).

Bradykinin

Bradykinin is a inflammatory peptide thought to be released by damaged tissue which, in turn, depolarizes surrounding nerves to produce pain sensation (Vander, Sherman and Luciano, 1985). When Chapman et al. (1960) found neurokinin in the perivascular tissue corresponding to the time of onset of migraine headaches, researchers began to look at the composition of neurokinin (Raskin, 1988). Bradykinin was purported to be the mysterious neurokinin substance in the perivascular tissue during migraine attacks (Raskin, 1988). The suspected involvement of bradykinin prompted researchers to explore bradykinin's involvement in migraines (Sicuteri, Fanciullacci and Anselmi, 1963; Sjaastad, 1970). Elkind, Friedman and Grossman (1964) demonstrated that a vascular headache was not reproduced with intradermal injections of bradykinin. Therefore, Lance (1982) speculated that the role of bradykinin in migraines was merely a local reaction to the previous cascade of events, such as the histamine release from mast cells or serotonin absorption by the vessel walls.

Prostaglandins

Prostaglandins are unsaturated fatty acids which are produced from the precursor, arachidonic acid, when appropriate enzymes are

present (Vander, Sherman and Luciano, 1985). Prostaglandins have numerous roles in the human body, some of which include blood clotting, regulation of smooth muscle contraction, modulation of neurotransmitter release and action, multiple processes in the reproductive system, control of hormone secretion and body's defense against injury and infection (Vander, Sherman and Luciano, 1985).

Interest in the role of prostaglandins in migraine headaches originated when Carlson, Ekelund and Oro (1968) found that an intravenous injection of prostaglandin E_1, a potent vasodilator, resulted in a vascular headache with some accompanying secondary symptoms. Although an increased plasma prostaglandin level has not been found during a migraine episode (Welch and Lance, 1975; Anthony, 1976; Sandler, 1975), Raskin (1988) suggested that prostaglandins would be almost undetectable in arterial blood. Prostaglandin E_1 is a potent extracranial and intracranial vasodilator (Welch, Spira, Knowles & Lance, 1974), however its role in the regulation of intracranial blood flow is unknown (White and Hagen, 1982).

Prostaglandins may also be part of a cascading response during migraine headaches, as suggested by Raskin (1988) and Lance (1982). Holmes (1970) reported that, with the release of serotonin into the ventricles, there is a significant release of prostaglandin E_1 in the ventricular fluid. Lance (1982) speculated that the release of prostaglandin E_1 may create the vasodilation in the intracranial blood vessels. Although the mechanism by which prostaglandins may be related to the pathogenesis of migraine headaches is unknown, the

fact that an injection of prostaglandin E1 produces migraine headaches is a significant finding (Carlson et al., 1968).

Opioid Peptides

Opioid peptides are specific amino acid chains which have analgesic properties similar to such drugs as morphine and codeine, but are naturally produced in the human body (Vander, Sherman and Luciano, 1985). It has been concluded that endogenous (produced in the body) opioid peptides are the most potent neurotransmitter in the central nervous system that modulate pain (Raskin, 1988). Li (1978) discovered a peptide in the pituitary of cattle which was termed Beta-lipotropin (Figure 2-6a). Further analysis of this peptide showed that if the Beta-lipotropin was cleaved, it produced enkephalins and endorphins (Terenius and Wahlstrom, 1974; Hughes, 1975) (Figure 2-6b).

Figure 2-6a: ß-lipotropin amino acid sequence for humans.(Adler, 1982).

Amino Acid sequence 1-10
Amino Acid sequence 11-20
Amino Acid sequence 21-30
Leu-Ala-Asp-Leu-Val-Ala-Ala-Glu-Lys-Lys-40
Asp-Glu-Gly-Pro-Tyr-Arg-Met-Glu-His-Phe-50
Arg-Trp-Gly-Ser-Pro-Pro-Lys-Asp-Lys-Arg-60
Tyr-Gly-Gly-Phe-Met-Thr-Ser-Glu-Lys- Ser 70
Gln-Thr-Pro-Leu-Val-Thr-Leu-Phe-Lys-Asn 80
Ala-Ile-Ile-Lys-Asn-Ala-Tyr-Lys-Lys-Gly- 90
Glu - OH.

Figure 2-6a: ß-lipotropin amino acid sequence for humans.(Adler, 1982).

61-65	Met-Enkephalin (or could be Leu-Enkephalin)
61-76	a-Endorphin
61-77	g-Endorphin
61-87	d-Endorphin
61-91	b-Endorphin

ß lipotropin is a 91 amino acid sequence produced in the anterior pituitary in association with adrenocorticotropic hormone (ACTH)(Hadley, 1988). Pro-opiomelanocortin is a large protein substance made up of corticotrophs and melanotrophs and is also the common precursor to ß lipotropin and corticotropin (Hadley, 1988). When the ß lipotropin peptide (Figure 2-6a) is cleaved, it not only makes ß endorphin, but may be further cleaved into a smaller amino acid chain termed an enkephalin. In the ß lipotropin peptide, amino acids 61-91 are considered the opiate fragment *C* (ß-endorphin) (Figure 2-6a) of which amino acids 61-65 are considered the Met-Enkephalin (Methionine-Enkephalin). The other substance which was identified has leucine at the end of the 61-65 amino acid sequence and as such is termed Leu-Enkephalin (Adler, 1982)(Figure 2-6b).

Opiate Receptors

There have been numerous studies performed on rat brains to locate anatomical sites of opiate receptors (Pert & Snyder, 1973; Simon, Hiller & Edelman, 1973). It was not until Hiller, Pearson and Simon (1973) studied cadavers that human brain tissue was analyzed. The anatomical regions of the brain found to have the highest concentration of binding sites are listed in Table 2-2. All areas are components of the limbic system except the pulvinar of the

thalamus (Kandel et al., 1991). It should also be noted that the only other anatomical systems which form part of the limbic system which did not have high concentration of receptors were the hypothalamus and hippocampus (Hiller et al., 1973). Migraine headaches are known to have a psychological component to them (Saper, 1983) and the limbic system is the centre for emotion and behavior (Kandel et al., 1991). A malfunction of the limbic system may not only produce the increase in pain associated with migraine headaches, but also the psychological distress associated with migraine headaches. This is supported by Greist, Klein, Eischens, Gurman and Morgan (1979) who endorse the theory that endorphins are mediators of psychological diseases.

Table 2-2: Highest concentration of opiate receptors in the brain.(Hiller et al., 1973).

Olfactory trigone	Parahypocampal gyrus
Amygdala	Periventricular gray matter
Septal Nuclei	Temporal lobe
Supra orbital gyrus of frontal lobe	Centromedian nucleus of
Preoptic area and supraoptic nucl.	thalamus
Cingulate gyrus	**Pulvinar of thalamus
Dorso-median nucl. of thalamus	Frontal lobe of cortex

**Indicates not part of the limbic system.

Although exact involvement of natural opioids in migraine is unknown (Raskin, 1988), researchers have found decreased cerebral spinal fluid levels of met-enkephalin (Anselmi, Baldi, Casacci & Salmon, 1980) as well as decreased levels of plasma ß-endorphin (Baldi, Salmon & Anselmi, 1982). On the other hand, plasma endorphin levels have been shown to increase concomitantly with exercise (Friaoli, Moretti, Paolucci, Alicicco, Crescenzi & Fortunio, 1980). However, there has been no increase in plasma endorphin

levels with ischemic induced pain (Gullner, Nicholson & Wilson, 1982). Therefore, utilizing plasma endorphin levels as the sole indicating factor for pain modulation may be misleading until a more specific role of endogenous opiates is definitively established (Raskin, 1988).

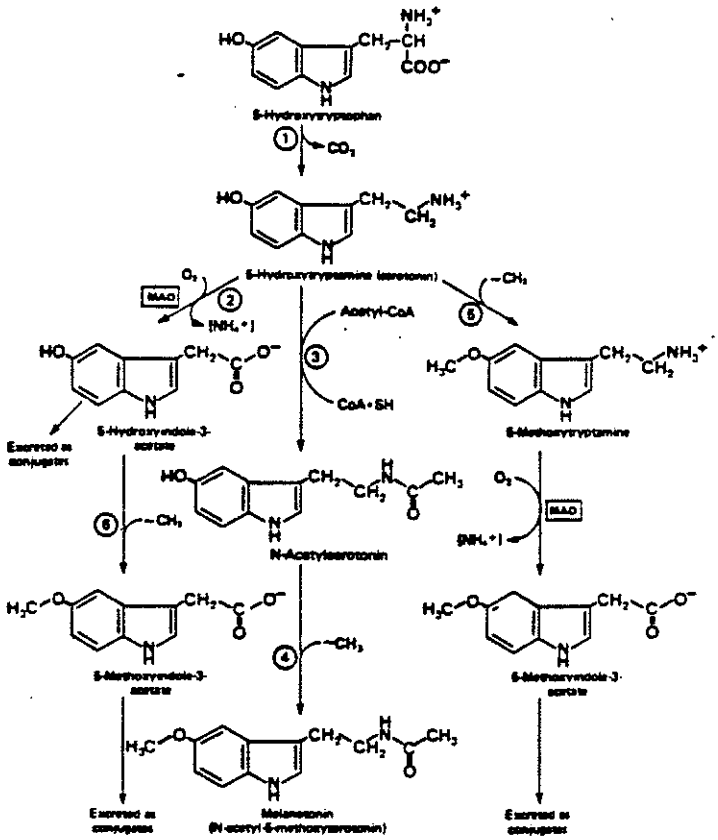
Serotonin

To understand exactly how serotonin is involved in migraine headaches, a complete review of the function of serotonin is fundamental (Raskin, 1988). Serotonin synthesis takes place in the gastrointestinal cells where it is picked up and stored in platelets, which are, themselves, unable to produce serotonin (Raskin, 1988). Serotonin is found primarily in the gastrointestinal tract (80%), with eight per cent (8%) found in the brain and traces of serotonin found in the plasma (Raskin, 1988). Serotonin is metabolized from the dietary amino acid source, tryptophan (Murray, Granner, Mayes & Rodwell, 1988). Through a complex series of biochemical reactions, tryptophan is eventually converted to 5-hydroytrytamine (serotonin) and may be broken down to its bi-product, 5-hydroxyindoleacetic acid (5-HIAA), found in the urine of patients suffering from migraine headaches (Murray et al., 1988)(Figure 2-7). "Platelet-bound serotonin may be naturally released during the thrombin-induced release reaction (i.e.; natural clot formation due to injury) by a variety of agents including collagen, immune complexes, viruses and epinephrine" or can be released artificially by the drug reserpine (Weiss, 1982, pg. 105). In fact, migraine headaches induced by reserpine may be aborted with an intravenous administration of serotonin, but with extremely uncomfortable side

effects (Anthony, Hinterberger & Lance, 1967; Kimball, Friedman and Vallejo, 1960).

Serotonin's relationship to migraine headaches was first reported when Sicuteri, Testi and Anselmi (1961) found excessive amounts of 5-HIAA in the urine of migraineurs. Subsequent findings revealed that eighty five per cent of migraine headache patients had increased urinary serotonin as well as decreased platelet serotonin levels during migraine attacks (Anthony and Lance, 1975; Anthony, 1986). These measurements are far more conclusive, and thus useful, than the occasional increase in the by-product of serotonin in migraineurs (Curzon, Theaker and Phillips, 1966).

Figure 2-7: Conversion of dietary tryptamine to serotonin. (Murray et al., 1988).



Anthony, Hinterberger and Lance (1967) also discovered traces of an extremely low molecular weight serotonin-releasing-factor in the blood of migraineurs during migraine episodes. Due to the low molecular weight of this releasing factor, identifying this substance has been problematic (Lance, 1991). Raskin (1988) suggested that this unidentifiable serotonin-releasing-factor may be released following any one of the trigger factors involved with migraine headaches (Table 2.7), but this theory has yet to be substantiated. Many researchers in the field of migraine headache research (Raskin, 1988; Lance, 1991; Dechant and Clissold, 1992) included serotonin in their models describing the pathogenesis of migraine headaches due to the overwhelming evidence of serotonin's involvement with these headaches (Table 2-3).

Table 2-3: Serotonin's involvement in migraine headache. (Raskin, 1988, pg104).

Urinary 5-hydroxyindoleacetic acid and serotonin increased.
Platelet-bound and free plasma serotonin decreased.
Plasma serotonin-releasing factor appears during headache attacks.
Headache:
Precipitated by reserpine.
Relieved by serotonin and its metabolic precursors.
Migraine drugs depress central serotonergic neuronal activity.

Serotonin has been located within specific nerve cells in the brain particularly responsible for such functions as sleep cycle regulation, mood change, extrapyramidal motor activity, hypothalamic regulation of hormone release and pain perception (Shenker, Gross and Grekin, 1985; Fuller and Clemens, 1981; Shima, Nakahama and Yamamoto, 1986; Fields, 1987; Baldessarini, 1983). Serotonin has numerous functions including control of intestinal

motility and vasoconstriction (Raskin, 1988). It affects smooth muscle, collagen tissue and nerves (Christian and Smythies, 1978). It is also an important neurotransmitter in the central nervous system (Gerschenfeld, Hamon and Paupardin-Tritsch, 1978).

Circulating serotonin has complicated effects on the vascular system. It can either vasoconstrict or vasodilate blood vessels depending on the targeted vascular bed, the resting blood vessel tonus, and the concentration of serotonin (Raskin, 1988). In general, serotonin is a vasoconstrictor of large arteries (Dechant and Clissold, 1992) while it is a vasodilator of small arterioles and capillaries (Raskin, 1988). The reason for such variation in function of serotonin is due to the various types of receptors found throughout the body (Dechant and Clissold, 1992)(Table 2-4).

These various types of serotonin receptors and their different actions have been identified using pharmacological research (Lance, 1991). Depending on the type of drug utilized for a migraine headache, prophylactic or abortive, different serotonin receptors would be targeted (Raskin, 1988). Prophylactic medication is usually used on a daily basis for prevention or reduction of migraine headaches (Mathew, 1990a). Examples of this type of medication include methyserfide, tricyclic antidepressants, and calcium channel blockers (Mathew, 1990a). Alternatively, abortive medication involves interrupting a migraine once symptoms (such as pain) have begun (Raskin, 1988). Examples of this medication include ergotamine, dihydroergotamine, sumatriptan or butorphanol (Raskin, 1981; Lance, 1991; Elenbaas, Iacona, Koellner, Pribble, Gratton, Racz & Evens, 1991).

Table 2-4: Classification of serotonin (5-HT) receptors and summary of some functional responses mediated by receptor subtypes. Abbreviations: 5-HT=5-hydroxytrytamine; CNS=central nervous system; PI=phosphoinositol; GI=gastrointestinal tract; cAMP=adenosine 3', 5' monophosphate (cyclic AMP).
(Dechant and Clissold, 1992, pg. 782).

Receptor Subtype	Location	Functional Response
5-HT_{1A}	Neuronal-mainly in the CNS.	Hypotension; Neuronal hyperpolarisation.
5-HT_{1B}	Found in humans and rodents.	Marked difference in pharmacological activity between human & rat receptors.
5-HT_{1C}	CNS (high density in choroid plexus).	Increased turnover of PI.
5-HT_{1D}	CNS sensory fibers.	Inhibition of neurotrans-mitter release; Inhibition of neuropeptide release.
5-HT_{1E}	CNS	??
5-HT_{1}-"like"	Intracranial Vasculature	Contraction of cephalic arteries and arteriovenous anastomoses.
5-HT_{1}-"like"	Vascular smooth muscle. GI smooth muscle.	Relaxation.
5-HT_2	Vascular smooth muscle. Platelets. Lung, CNS. GI tract.	Vasoconstriction; Platelet aggregation; Brochoconstriction.
5-HT_3	Peripheral and central neurones	Membrane depolarization; Activation of sensory afferents.
5-HT_4	GI tract. CNS. Heart	Increase in cAMP; Activation of neurotransmitter release.
5-HT_{s31}	?	?

Lance (1991) suggested that prophylactic medication acted as a 5-HT_2 antagonist, exerting action centrally, specifically at the dorsal raphe nucleus. Action of 5-HT_2 receptors are mainly excitatory which means that stimulation of the dorsal raphe nucleus increases extracranial and intracranial blood flow (Goadsby, Piper, Lambert & Lance, 1985a; Goadsby, Piper, Lambert & Lance, 1985b). Therefore, if prophylactic drugs act as an 5-HT_2 antagonist, resultant vasoconstriction is due to inhibition of the 5-HT_2 receptor's normally excitatory action (Lance, 1991; Dechant and Clissold, 1992).

Abortive medication is thought to act primarily at the 5-HT_1 receptor sites, more specifically the 5-HT_{1D} receptor (Dechant and Clissold, 1992). The 5-HT_1 receptors are located in the first and second layer of the cortex, the posterior hypothalamus, the central grey matter, the raphe nuclei and the substantia gelatinosa (Pazos, Probst and Palacios, 1987). The raphe nuclei are responsible for endogenous pain control while the substantia gelatinosa is the gateway for pain impulses into the spinal cord (Lance, 1991). All 5-HT_1 receptors are inhibitory in action and when the receptors on the trigeminal nerve are stimulated, there is cessation of neuropeptide binding in the dura mater (Buzzi and Moskowitz, 1991). Sumatriptan, an abortive medication, stimulates these 5-HT_{1D} receptors imparting vasoconstriction of certain blood vessels thought to be involved in the migraine process (Dechant and Clissold, 1992). Sumatriptan is thought to cause constriction of certain intracranial blood vessels such as the basilar artery (Parsons, Whalley, Feniuk, Connor & Humphrey, 1989), pial artery (Hamel and Bouchard, 1991)

and isolated perfused dura mater (Humphrey, Fenuik, Matevalian, Parsons & Whalley, 1991).

The involvement of the serotonergic system in migraine headaches is well accepted in the literature (Dechant and Clissold, 1992; Lance, 1991; Raskin, 1988). Its exact involvement has yet to be completely understood (Dechant and Clissold, 1992). It is known that antimigraine drugs, whether they be prophylactic or abortive, function centrally on 5-HT receptors in the brain (Lance, 1991), as well as on structures considered to be peripheral, such as the trigeminovascular system (Raskin, 1988).

Raskin (1988) has offered a rationale for the role of serotonin in migraines in an attempt to account for some of the other phenomena commonly associated with migraine headaches. For instance, gastrointestinal disruption at or around the time of the headache may be a problem of dysfunctional serotonin receptors in the myenteric plexus (Raskin, 1988). It is also well known clinically that migraine headaches tend to cluster around the time of menses, yet commonly disappear during the latter stages of pregnancy (Rapport and Sheftell, 1990). It is possible that ovarian hormones cause a modulation of serotonin receptors (Raskin, 1988).

One means of aborting migraine pain is to sleep (Rapaport and Sheftell, 1990). Aghajanian (1981) speculated that this abortive mechanism may be a result of the cessation of serotonin raphe neurons firing during sleep. These are a few clinical circumstances which may be explained by a dysfunctional serotonergic system (Raskin, 1988). More scientific evidence is required as these clinical

inferences are merely speculation based on anecdotal observations and patterns (Raskin, 1988).

MIGRAINE TREATMENT

To fully appreciate the hypothesis of using exercise as a possible means to control migraine headaches, it is important to review the various treatment avenues historically and currently available to a migraineur (Rapoport and Sheftell, 1990). The Egyptians were the first to document treatment for what is believed to be migraine headaches in or around 1200 B.C. (Major, 1930). Advice consisted of instructing people afflicted with headaches to strap a clay crocodile firmly to the head and place herbs in its mouth (Lance, 1982)(Figure 2-8).

Figure 2-8: Treatment of Headache in 1200 B.C. (Lance, 1982, pg. 2).

Although there have been significant advances in the understanding and treatment of migraine headaches since 1200 B.C. the exact etiology of migraine headaches remains unknown. This gap in knowledge has forced health care practitioners to opt for more global treatment protocols which generally involve pharmaceutical, preventative and non-pharmaceutical approaches (Saper, 1983).

The Pharmaceutical Approach

As touched on previously in this chapter, the pharmaceutical approach has been divided into prophylactic and abortive categories (Mathew, 1990a). Briefly, prophylactic drug treatment for migraines consists of a daily dosage taken by a migraineur to prevent the onset of headaches (Saper, 1983). Abortive drug treatment is utilized when the onset of a headache cannot be avoided, which necessitates this form of intervention (Mathew, 1990a). Abortive and prophylactic medication are commonly used by the same patient to combat migraine headaches (Dechant and Clissold, 1992). The advantage of medications is, quite simply, either reduction of the symptoms or prevention of the headache altogether (Mathew, 1990a). The side effects from medication is an encouragement to preferentially use non-pharmaceutical treatments for migraines (Graham, 1979).

Disadvantages of the Pharmaceutical Approach

The pitfalls of a pharmaceutical approach for migraines are numerous (Mathew, 1990a) and have prompted many researchers to seek alternative treatments (Rapoport, 1988; Graham, 1979; Blanchard, 1987; Epstein and Abel, 1977). Some of the side effects associated with pharmaceutical medication can be just as problematic

as the headaches they prevent (Graham, 1979). For example, Mathew (1990a) provided a list of some side effects such as weight gain, lethargy, water retention, constipation, hair loss, depression, memory impairment, and nocturnal hallucinates.

Side effects associated with abortive drugs, such as ergotamine (ergot), include ergotism and gangrene which may involve as many of the deleterious effects associated with prophylactic drugs (Compendium of Pharmaceuticals and Specialties [CPS],1985; Graham, 1979). Ergotism has been defined as a "chronic poisoning produced by ingestion of an ergot marked by cerebrospinal symptoms, spasms, cramps, or a kind of dry gangrene" (i.e.; without proteolytic decomposition)(Anderson, 1982, pg.217). CPS (1985) lists more adverse effects associated with abortive medication (Table 2-5).

Table 2-5: Adverse effects of using Ergotamine. (CPS, 1985).

1.	Ergotism.
2.	Gangrene.
3.	Nausea and vomiting.
4.	Weakness in legs.
5.	Muscle pains in extremities.
6.	numbness and tingling of fingers and toes.
7.	Precordial distress and pain.
8.	Transient tachycardia and bradycardia.
9.	edema*
10.	itching*

*indicates rare, in sensitive patients only.

It is difficult to conceive that migraineurs would be willing to continue with pharmaceutical therapy which involves such negative repercussions, but in actuality, these secondary effects are often less painful and taxing than the migraine itself (Graham, 1979; Mathews, 1990a). Therefore, development of drug-free (non-pharmaceutical)

treatment for migraines has become a priority for many clinicians and researchers in this field (Mathew, 1990a; Rapoport, 1988; Graham, 1979).

The need for non-pharmaceutical treatment is even more apparent when one considers the effects of the drug-induced headaches also known as the analgesic rebound headache (Rapoport, 1988). These headaches may result from overuse of either abortive or prophylactic drugs (Mathew, 1990b). Saper and Jones (1986), reported cases where ergotamine dosages exceeded safe limits by as much as ten to fifteen mg/day after which subjects described headaches indicative of a drug induced headache. These types of headaches may be differentiated from typical migraines in that they are frequent (most daily) and consistent (Lance, 1978).

Analgesic headaches typically resulted when patients who experienced an episodic migraine took an analgesic drug to alleviate the symptoms but then became addicted to the drug (Mathew, 1990b). The withdrawal from the drug actually caused yet another headache (Mathew, 1990b). A vicious cycle develops because people increase the dosage as immunity to the previous dosage level grows (Mathew, 1990b). Rapoport (1988) studied seventy daily headache patients who reported ingesting fourteen or more analgesic tablets per week. It was determined that of all the interventions, discontinuation of the analgesic drug considerably improved the condition in sixty per cent of the patients within one month (Rapoport, 1988). Rapoport (1988) speculated the mechanism by which these patients increased their sensitivity to pain was via serotonergic pathways. Use of analgesic drugs suppresses the

serotonin system which is thought to have a role in the reduction of pain based on its relationship with the opiate system (Dechant and Clissold, 1992; Raskin, 1988; Lance, 1982).

Mathew (1990a) explained that in order to treat migraines, clinicians would have to take a multimodality approach since the exact etiology remains unknown. Table 2-6 summarizes Mathew's (1990a) suggestions to achieve a more holistic or multimodality approach.

Table 2-6: The multimodality approach to migraine headaches. *indicates the area of research in the present study.(Mathew, 1990a, pg. 911).

1.	Discontinuation of offending drugs.
2.	Attempts to break cycle of continuous headache by treatment modalities such as intravenous dihydroergotamine.
3.	Initiation of prophylactic pharmacotherapy.
4.	*Concomitant behavioral intervention which includes biofeedback therapy, individual behavioral counseling, family therapy PHYSICAL EXERCISE and dietary instructions.
5.	Adequate instructions about the ill effects of medication with special focus on drug induced rebound headaches.
6.	Continuity of care.

Preventative Approach

Control of trigger factors is a suggestion often discussed with patients by experts in the field of migraine headaches since an all-encompassing treatment has yet to be discovered (Lance, 1982; Saper, 1983; Raskin, 1988; Graham, 1979). Although prevention of trigger factors is not without error, Saper (1983) has reported clinical success with migraine patients. Saper (1983) provided a comprehensive list of factors that have been both clinically and experimentally documented as affecting migraines (Table 2-7).

Table 2-7: Possible trigger factors for migraine headaches. (Saper, 1983, pg. 35).

Psychological	Medicines
stress/anxiety	reserpine
anger	hydralazine
"let down"	MAO*
exhilaration	nonsteriodal anti-inflammatory agents*
Dazzling light	vasodilators*
	antiasthmatic agents
Hormonal	thiazide derivatives
menarche	propranolol*
menstruation	amphetamines, diet pills
menopause	ephedrine
pregnancy (1st trimester)	
delivery	
birth control pills	Marked weather changes
exogenous estrogens	
Sleep	Head/Neck Trauma
too much	mild
too little	severe
napping	
Diet**	Toxins

*may have benefit in some patients.
**see Table 2-8 for more detail.

Obviously some of these trigger factors cannot be avoided, such as the hormonal factors (Saper, 1983). However, recognition of these predisposing factors may stimulate other coping strategies (Lance, 1982). Identifying the trigger factors which initiate migraine attacks unfortunately comes with experience (Saper, 1983). Diet is one of the trigger factors listed in Table 2-7 which requires further explanation based on the frequency which it is associated with migraine attacks (Table 2-8)(Saper, 1983).

Table 2-8: Food triggers associated with migraine attacks. (Saper, 1983, pg. 41).

Tyramine containing foods	Alcohol products
chocolate	wine/champagne
aged cheese	liquor, beer
vinegar	
relishes	Fatty foods
dressings	
sauces	Nitrate-containing foods
catsup	hot dogs
liver, kidney, organs	sandwich meats
alcohol (see below)	others
sour cream	
yogurt	
yeast extracts	MSG-containing foods
others	
	Caffeine
Citrus Fruits	too much
	"rebound"
Milk and milk products	
Onions	Seafood

Although the relationship between foods and migraines is not well understood, Selby and Lance (1960) estimated that 25 per cent of migraineurs experience headaches associated with some form of food.

Non-Pharmaceutical Approach to Migraines

Since causal factors of migraine headaches are not well understood, clinicians have prescribed treatment which can help mask symptoms (i.e.; pharmaceuticals) or prevent the onset of migraine headaches (i.e.; trigger factors) (Raskin, 1981; Graham, 1979; Spierings, 1988). These approaches are problematic in that they are not one hundred per cent successful with all patients (Saper, 1983). For this reason, researchers have endeavored to find a non-

pharmaceutical approach for alleviation of migraines (Rapoport, 1988; Graham, 1979; Blanchard, 1987; Epstein and Abel, 1977).

Lance (1982) suggested that clinicians treating patients with migraine headaches should try a preventative approach. If that approach fails, physiological and psychological means (i.e.; non-pharmaceutical) should be employed to control neurovascular reactions and as a last resort, when all other approaches had failed, a pharmacological intervention can be employed.

Many non-pharmaceutical approaches have been identified by practitioners, some of which include: psychological management; relaxation therapy; biofeedback; transcendental meditation; hypnotherapy; acupuncture; and exercise (Rapoport and Sheftell, 1990; Lance, 1982).

Exercise and Migraines

Although there have been studies where exercise has induced migraine headaches (Thompson, 1987; Miller, 1977; Massey, 1982; Toshikatsu and Takahashi, 1990; Paulson, 1982), there has also been both clinical (Rapoport and Sheftell, 1990; Atkinson, 1977; Kumar, 1988; Darling, 1991; Lance, 1982) and scientific (Lockett and Campbell, 1991; Grimm et al., 1981; Fitterling et al., 1988) evidence to support the use of exercise as a preventative modality for migraine headaches. Clinicians who prescribe exercise as a means of preventing migraine attacks base much of their approach on anecdotal evidence (Rapoport and Sheftell, 1990). However, in order to understand the cause and effect of exercise on migraine headaches, more scientific evidence is required (Lockett and Campbell, 1992). Lockett and Campbell (1992) studied the effect of

an aerobic exercise program on 20 females suffering from classical migraine headaches. Although they found promising trends in their results, their methodology may have precluded more convincing results. Lockett and Campbell's (1992) six week study could have been improved with a longer data collection period.

Lockett and Campbell (1992) used theWest Haven-Yale Multidimensional Pain Inventory and Daily Headache Diary which collected ordinal and nominal level of data (Table 2-9). Nominal level of data may be explained as only belonging to a category whereas ordinal level of data has numbers which imply relative ranking, but have no absolute meaning (Barr, 1989). In this case a non-parametric statistical procedure may have been more appropriate rather than the statistical procedure they reported.

The placebo effect is quite significant in the migraine population and some researchers have speculated that it can be as high as forty per cent (Rapoport and Sheftell, 1990). Lockett and Campbell (1992) suggested that the positive results and trends which occurred with their exercise program may have been due to a placebo effect. Although no statistical significance was demonstrated, the authors stated a strong belief that exercise could benefit migraineurs, and recommended that more research would be required to substantiate such a belief (Lockett and Campbell, 1992).

Some researchers (Thompson, 1987; Miller, 1977; Massey, 1981; Toshikatsu and Takahashi, 1990; Paulson, 1982) have found exercise to be detrimental to the treatment or prevention of migraine headaches, but Lambert and Burnet (1985) speculated that exercise induced headaches may be prevented if proper warm up and proper

breathing techniques are employed during the exercise period. For instance, all studies which found an exercise induced migraine headache (Thompson, 1987; Miller, 1977; Massey, 1981; Toshikatsu and Takahashi, 1990; Paulson, 1982), reported a Valsalva maneuver during the exercise period. Porter and Jankovic (1981) believed that the Valsalva maneuver created a transient increase in cranial blood pressure leading to vasodilation of intracranial blood vessels, and then a migraine headache. It is believed that the Valsalva maneuver causes the collection of carbon dioxide in the body, which Dalessio (1980) has speculated to be the cause of an exercise induced headache. Dalessio (1980) found exercise induced headaches dissipated if the patient was permitted to breath pure oxygen, which he felt supported his theory. Therefore, if care and precaution are taken, it has been suggested that migraineurs may benefit from a regular exercise program (Rapoport and Sheftell, 1990; Lance, 1981; Lockett and Campbell, 1991).

Pain Measurement

With headaches, as with any other type of chronic pain, the major goal of physical medicine or preventative intervention is to relieve pain and reduce any associated disabilities (Izzo and Aravabhumi, 1982). Investigation of human pain mechanisms rely on the assessment of an ill-defined and private event (Wall and Melzack, 1989). Due to the subjective nature of pain, quantifying an individual's pain may prove to be difficult. Wall and Melzack (1989) listed some properties of an ideal pain measure which are outlined in Table 2-9.

Table 2-9: Ideal pain measures. (Wall & Melzack, 1989).

1.	Provides a sensitive measurement free of biases inherent in different assessment methods.
2.	Provides immediate information about accuracy and reliability.
3.	Separates the sensory discriminative aspects of pain from its hedonic qualities.
4.	Assesses experimental and clinical pain with the same scale, permitting comparisons between the two.
5.	Provides absolute rather than relative scales that allow assessment of pain between groups and within groups over time.

To classify headache pain, Wall and Melzack (1989) classified headache pain as a response dependent method. Examples of possible response dependent methods could include techniques such as categorical responses, visual analogue scales, cross modality matching and verbal responses (Wall and Melzack, 1989).

Visual Analogue Scale (VAS)

The VAS collects data related to pain as an objective measure which provides interval or even ratio level of data (Siegal, 1956). Keele (1948) was one of the first to address the problems associated with the measurement of pain in humans (Table 2-10) and was also one of the contributors to the development of the VAS.

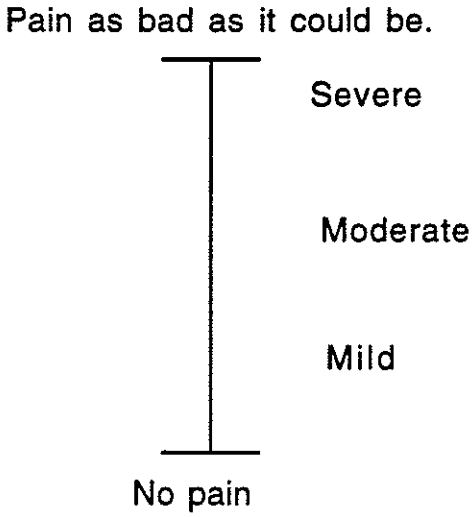
Table 2-10: Problems with measuring pain in humans. (Keele, 1948, pg. 6).

1) Difficulty in finding words to describe an unusual if not unique experience.
2) Confusion about what features of this experience are relevant to the observer.
3) Difficulties in remembering the experience.

The evolution of the VAS began with Keele's (1948) scale of pain which utilized the words agony, severe, moderate, slight and nil to describe a continuum. Huskisson (1974) felt that these word

groupings did not allow for enough quantitative measurement and designed a graphic rating scale (Figure 2-9).

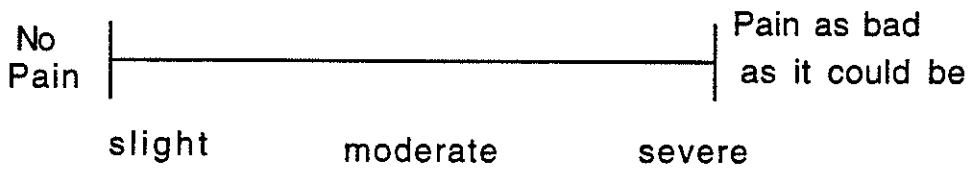
Figure 2-9: An example of a graphic rating method for measuring pain. (Huskisson, 1974).



Although researchers used this scale successfully in the field of psychological research (Freyd, 1923; Aitken, 1969) more accurate pain measurement tools evolved. Scott and Huskisson (1976) devised a series of small experiments to determine the best form of VAS or the best graphic rating scale (GRS). The experiment compared variations of six visual analogue scales: three that were horizontally aligned (Figure 2-11); three that were vertically aligned (Figure 2-10). The difference between the three scales was the amount or type of description provided on the scales. For example, one scale had one millimeter (mm) incremental lines, another had more descriptive words along the scale and the last had the description at both ends of the ten mm line with no other description in between. The results of each of the sub-experiments were correlated to a standard description of pain, and if significantly different from this standard,

were not considered to be a valid or reliable measure of chronic pain. The only two pain measurement techniques which were not significantly different from the pain standard were the two horizontal visual analogue scales with word descriptions (severe, moderate and slight) spread along the ten mm line in minutely varying ways. Descriptor words (pain as bad as it could be and no pain) were placed at each end of the ten mm line (Scott and Huskisson, 1976)(Figure 2-10).

Figure 2-10: Example of the Horizontal VAS used in Scott and Huskisson's (1976) article.



Pharmaceutical studies have utilized the VAS (also known as Linear Analogue Scale - LAS) which will permit future inter-modality (i.e.; pharmaceutical verses non-pharmaceutical) statistical comparisons (Elenbaas et al., 1991).

CHAPTER 3
METHODOLOGY

Introduction

Various clinicians with expertise in headache treatment suggest that non-pharmaceutical treatment for migraine headaches, exercise included, should be considered whenever possible (Atkinson, 1977; Rapoport and Sheftell, 1990; Lockett and Campbell, 1992). The objective of this study was to establish the relationship between exercise and the frequency and intensity of migraine headaches.

There was some methodology adopted from Lockett and Campbell (1992) since they had some excellent methodological features. To enhance the homogeneity of subject variables, only females were studied (Lockett and Campbell, 1992). Patients were screened for both headache and physical condition with the medical screening and headache questionnaire (Appendix A) as modeled after Campbell (1987) and Canadian Standardized Test of Fitness (CSTF)(1987). Fitness levels were assessed with a submaximal Canadian Aerobic Fitness Test via a Monarch stationary cycle (CSTF, 1987).

A key difference between Lockett and Campbell's (1992) study and the present study was the instrumentation used to measure headache pain. Lockett and Campbell (1992) used the MPI and the Daily Headache Diary, however, evidence suggests that the Visual Analogue Scale (VAS) provides at least interval level or even ratio level of data (Price, McGrath, Rafii and Buckingham, 1983; Folstein and Luria, 1973; Siegal, 1956). This has allowed the use of parametric statistical analyses to be performed without violation of assumptions on which they are based (Barr, 1989).

Subjects

Subjects were limited to people who met the following criteria (Table 3-1).

Table 3-1: Subject Selection Criteria.

(1)	Non-pregnant females only.
(2)	Subject must have been aged 18-45.
(3)	Must not have exercised regularly in the past year.
(4)	Must have been diagnosed as common or classical migraine headaches.
(5)	Must have been able to pass the pre-experimental medical screening deeming them fit to participate in the study.
(6)	Must not have been on any medication which can alter athletic performance.
(7)	Non-smokers.
(8)	Must not have suffered from more than eight migraines per month or less than two migraines per month.
(9)	Must not have been afflicted with migraines which are triggered by exercise or other physical exertion.
(10)	No subjects with asthma, hypertension or heart disease.
(11)	Must have been willing and able to walk and jog.

The sample population was limited to female subjects for a couple of reasons. Approximately seventy five per cent of all migraine suffers are female (Rapoport and Sheftell, 1990). In addition, having all female subjects increased the homogeneity of subjects (Lockett and Campbell, 1992). The effect of menarche, menopause and pregnancy have been clinically linked to migraine headaches and thus, only non-pregnant females between the ages of eighteen and forty six were permitted to take part in the study (Saper, 1983). Subjects in this age range had normal menses which was verified in the medical screening and headache questionnaire (Appendix A).

Subjects were limited to those relatively sedentary in the year prior to the study. For the purpose of this study, sedentary was defined as people who had not exercised regularly in the previous year. This was determined using telephone screening along with the medical assessment and headache questionnaire (Appendix A). For each subject, the diagnosis of common or classical migraines was confirmed by Dr. B.A. Anderson, Head of Neurology at St. Boniface General Hospital. The International Classification of Headaches (1988) was used as a guide to determine headache type.

Subjects who passed the pre-experimental medical screening were deemed fit to participate in the study free of risk (Appendix A). The pre-experimental screening was modeled after the Canadian Standardized Test of Fitness (CSTF)(1987) and Physical Activity Readiness Questionnaire (PAR-Q). Essential clinical tools such as heart rate and blood pressure were used to assess each subject's suitability for the study.

Subjects were limited to those not currently taking medication which might influence athletic performance (Appendix B). This helped to control for anomalies in heart rate and blood pressure during exercise testing and avoid complications during the exercise program. In the study by Fitterling et al. (1988), three out of five subjects were on beta adrenergic blocking agents which may have confounded their fitness test results. To avoid such a complication in this study, subjects could not be taking any medication listed in Appendix B. The study was limited to non-smokers in order to eliminate variables which might hinder optimal athletic performance and fitness level gains.

Subjects who suffered from more than eight migraines per month were not included in the study as the migraine frequency may interfere with the completion of the study's exercise requirements. Subjects who suffered from less than two migraines per month (on average) were not included in the study since detecting a change in migraine frequency would be too difficult between twelve week blocks. Subjects' headache frequency was determined by the medical screening and headache questionnaire (Appendix A). Those subjects who suffered from migraines which arose due to physical exertion were not included in the subject pool. Subjects with asthma, hypertension and/or heart disease were not permitted to participate due to the conflict with exercise and exercise performance (as screened by the headache questionnaire). Subjects on acute treatment and prophylactic or abortive medication that might interfere with physical training were excluded from the study.

Sampling Procedure

A total of 30 subjects was desired when the search for subjects started. One way of searching for subjects was with advertisement, in the form of a sign around the University of Manitoba Campus, local pharmacies and hospitals. Advertisement in the Faculty newspaper at the University of Manitoba, the Winnipeg Sun newspaper, a local radio call in show (CJOB) and a live interview on local television (MTN) were additional methods of recruiting subjects.

A total of 103 respondents were screened by telephone to ensure interested subjects met the criteria after which, only 30 subjects remained. Those subjects were asked to complete a medical screening and headache questionnaire and return it to the University

of Manitoba. Dr. B.A. Anderson then reviewed the questionnaires and determined that 24 respondents met the subject criteria.

The subjects were then scheduled for a medical screening and questionnaire review with Dr. B.A. Anderson and Mark Lafave. All subjects met the criteria and were accepted to take part in the study. This process of collecting subjects took approximately two months. Considering the multitude of media which was used to solicit subjects (radio, television, newspaper and flyers), and the length of time that had passed, it was decided to commence the study. The rationale for this decision was based on the fact that there were no other respondents who wanted to take part in the study.

Experimental Procedure

Once all subjects were chosen and accepted into the study, they each received a package which contained an introductory letter and two consent forms (Appendix D). The consent forms included the fitness test consent form (as modeled after the CSTF consent form, 1987) and a general consent form. The introductory letter instructed the participants to read and sign the consent forms as well as come prepared to ask any questions regarding the study at their first fitness assessment. The letter also explained what was required during the fitness test and the expected time frame required to complete the test. Each subject was also instructed to re-schedule their fitness assessment if they had experienced a migraine attack 48 hours prior to the scheduled appointment.

Figure 3-1 summarizes the experimental procedure used for this study. Group 1 acted as the control group during the first twelve weeks (Points **A** to **B**), and the experimental group during the

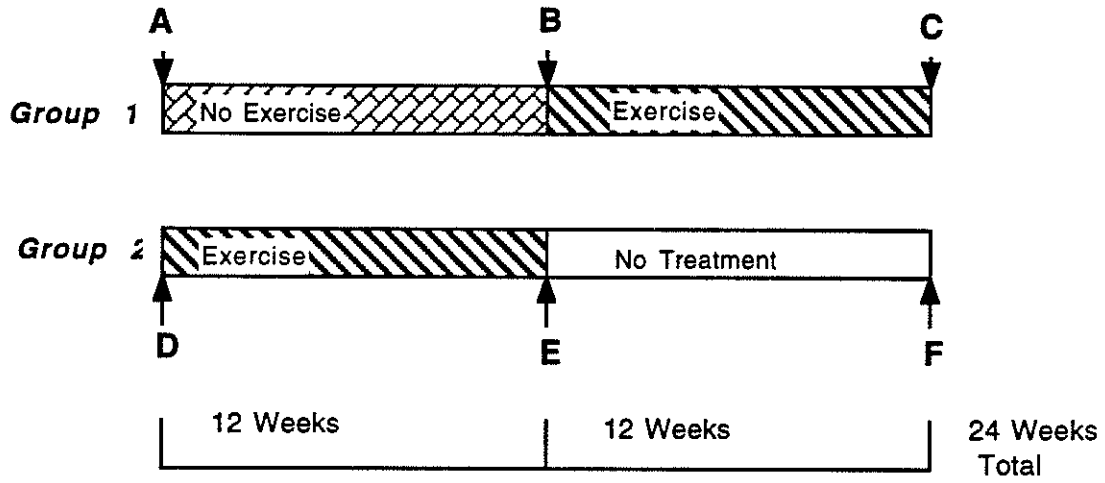
successive twelve week block (Points **B** to **C**). Group 2 acted as the experimental group since they only received the treatment (i.e.; exercise) during the first twelve week block (Points **D** to **E**). However there was no formal treatment during the second twelve week block (Points **E** to **F**).

At the beginning of the experimental period (points **A** and **D**), all subjects in both Group 1 and Group 2 received a submaximal fitness test. Group 1 subjects received a second fitness assessment following the first twelve week period (point **B**). These same subjects also attended an introductory fitness class which outlined what was required for the next twelve week exercise block (Points **B** to **C**). Prior to the start of the exercise session, all subjects received their own data collection booklet which contained the necessary daily information which they were required to document (Appendix E) as well as any other pertinent exercise information (Appendices F, G).

The introductory classes were instructed in basic exercise principles which included the importance of a warm-up and stretching program pre- and post-exercise sessions. Each subject was instructed to perform a five minute brisk walk as their warm-up. Then, each subject was instructed to stretch for five minutes which included the stretches in Appendix F. A copy of the stretches were provided in the data collection booklet for each subject to review daily as needed. Each subject was then instructed to increase their heart rate between sixty and ninety per cent of their maximum heart rate with the walk/jog program. Sixty to ninety per cent of the subject's maximum heart rate is considered the aerobic training zone (American College of Sports Medicine, 1991). Maximum heart rate

was determined by the following formula: 220 - age = maximum heart rate (Fox, Bowers and Foss, 1989). Each subject determined her heart rate training zone and endeavored to achieve this level during the 20 minute walk/jog program. There was space allotted in the data collection booklet for the recording of each person's

Figure 3-1: Schematic representation of the study.



Measurements:

***Group 1* = Control & Experimental Group**

Point **A** - submaximal fitness assessment.
Point **B** - submaximal fitness assessment.
- introductory fitness class.
Point **C** - submaximal fitness assessment.
- post-study questionnaire (general impression).

Between Points **A** and **B** and **C**:
Daily Measurement of;
1] Pain.
2] Headache Frequency.
3] Medication Quantity and Type.
4] Exercise Information.

***Group 2* = Experimental Group**

Point **D** - submaximal fitness assessment.
- introductory fitness class.
Point **E** - submaximal fitness assessment.
- post-study questionnaire (general impression).
Point **F** - compliance survey.

Between Points **D** and **E**:
Daily Measurement of 1], 2], 3] and 4] above.
Between Points **E** and **F**:
No formal treatment.

individual heart rate training zone for future reference.

Subjects were instructed to jog for as long as possible during the 20 minutes, but if they became too fatigued to jog for the entire time, they were instructed to walk briskly to maintain their heart rate training zone. Heart rate was estimated during exercise performance either by the carotid or by the radial pulse (Fox, Bowers and Foss, 1989) at the mid-way point of each exercise session (i.e.; the ten minute mark). Each subject was provided with a set of instructions outlining their responsibility during her exercise session (Appendix G). Exercise sessions were to take place three times per week (a week being 7 days) for a total of twelve weeks. To ensure the subjects were not having difficulty with the exercise and to promote exercise compliance, subjects were contacted once a week by phone from the researcher or research assistant.

After the twelve week exercise session, Group 2 subjects had one last submaximal fitness assessment and were requested to fill out the post-study questionnaire outlining their general impression of the study (Appendix H). Group 1 subjects followed the exercise session previously described for Group 2. Both groups were requested to fill out a daily measurement of pain at breakfast, lunch, dinner and bedtime (measured with the visual analogue scale), headache frequency, quantity as well as type of medication and lastly, the pertinent exercise information during their respective exercise periods (Appendix E). The formal part of the study for Group 2 subjects ended after the first twelve week period.

Data Collection

Subjects' height, weight, age, mean headache frequency and the first fitness test measurement were recorded at the outset for future comparison. The Visual Analogue Scale (VAS) was used to measure the subject's headache pain intensity. The reliability and validity of the VAS has been reported by Price et al. (1983) and Hukisson (1974). Subjects were instructed to use the visual analogue scale by stroking a line somewhere between the "no pain" and "pain as bad as it could be" ends of the scale. No pain would be equivalent to zero centimeters, whereas 8 centimeters would be indicative of pain as bad as it could be. This measurement was taken four times a day during regimented times so as to assist the subject in remembering to fill out the data collection (Hukisson, 1974). Headache pain intensity was measured at breakfast, lunch, dinner and before bedtime. Headache pain, frequency and quantity of medication was recorded using a daily headache diary (Appendix E). Subjects were asked to fill in the exercise information in the booklet. The daily diary was used for both Groups 1 and 2.

A submaximal bicycle ergometre test was used to estimate each subject's VO_2 maximum after twelve and twenty four weeks for Group 1 and after twelve weeks for Group 2 (Appendix I). A Monarch bicycle ergometre was utilized for the submaximal test. Prediction for VO_2 maximum was used according to Astrand (1960)(Appendix J).

Data Analysis

To determine homogeneity between experimental and control groups, an independent (unpaired) t test was performed on the following variables: height, weight, age, mean headache frequency and the first fitness test measurement.

In consultation with the University of Manitoba Biostatistical Department, the three hypotheses stated in Chapter One were analyzed. To compare group one, block one (no exercise - control) to group two, block one (exercise - experimental), a split plot, repeated measures statistical analysis was used. To compare group one, block one (no exercise - control) to group one, block two (exercise - experimental), a randomized block, repeated measures statistical analysis was used.

Comparisons using this statistical analysis were made to determine if there were any significant changes in fitness in groups one and two as a consequence of the exercise program. Changes in fitness levels between group one and two were also investigated as were changes in fitness levels in group one during the period of no exercise and the period when they did exercise.

CHAPTER FOUR

RESULTS

The search for suitable subjects for this study attracted one hundred and three respondants from the newspaper, radio and television advertisements and flyers. After a telephone screening to ensure potential subjects met the criteria, thirty subjects remained. The thirty subjects filled out the medical screening and headache questionnaire and were reviewed by the research team. There were 24 suitable subjects who met the criteria and were asked to come in for the medical screening to ensure safe participation in the study. Throughout the course of the study, eight subjects dropped out for a variety of reasons. The final number of participants in each group was eight, meaning the total of participants for the entire study was sixteen.

Table 4.1 describes subject profiles for both groups one and two. Eight subjects were randomly assigned to group one. The mean height of group one was 161.63 centimetres, the mean weight was 62.57 kilograms, the mean age was 38.88 years, the mean estimated number of headaches per month was 2.75 and mean fitness level in test number one was 30.12 millilitres/kilogram/ minute. The mean height of group two was 165.63 centimetres, the mean weight was 75.69 kilograms, the mean age was 34.00 years, the mean estimated number of headaches per month was 2.83 and the mean fitness level for test number one was 28.65 millilitres/ kilogram/minute.

To ensure the two groups, which were randomly assigned by random number tables, were not significantly different from each other, an unpaired t-test was performed on subject profile variables.

These tests revealed that there were no significant differences between groups one and two.

Table 4.1: Pre-study statistics of subject profile variables.

Subjects	Variables				
	Height (cm)	Weight (kg)	Age (years)	Estimated Headaches (mean/month)	Fitness Level #1 (ml/kg/min)
Group 1:					
1.	143	43	43	2	29.24
2.	163	64.6	45	3	32.16
3.	161	55	40	4	34.00
4.	164	66	29	2	30.00
5.	166	63	42	2	21.79
6.	150	49	43	4	35.75
7.	180	97.3	35	3	22.00
8.	160	62.8	43	2	36.00
Mean	160.9	62.9	40	2.75	30.12
Group 2:					
1.	164	65.1	27	2	38.00
2.	169	54.9	38	2.5	26.28
3.	161	50.5	28	2.5	40.00
4.	170	78.9	41	2.5	25.69
5.	169	93	29	2	32.00
6.	169	73.9	24	3.5	22.00
7.	165	91.1	43	4	24.45
8.	158	97.4	42	2	15.77
Mean	165.6	75.6	34	2.63	28.02

Dependent Variable Comparisons

To compare headache frequency and headache pain between group one's non-exercise block and group two's exercise block, a split plot, repeated measures analysis was used. Subjects's raw data scores for these variables are in Appendix J. However, the mean values for group one's exercise and non exercise blocks as well as

group two's exercise block for each of the dependent variables (over twelve weeks) are in Tables 4.2, 4.3, 4.4, 4.5 and 4.6. The results indicated that there were no significant differences for any of the dependent variables (when comparing group one's non exercise block to group two's exercise block)(see Appendix J for the Statistical Analysis).

Comparison of headache pain and frequency between group one exercise and non-exercise was analyzed via a randomized block design, repeated measures analysis. There was no significant difference found when comparing any of the dependent variables. The mean headache frequency and headache pain for group 1's exercise and non exercise sessions are in Tables 4.2, 4.3, 4.4, 4.5 and 4.6 below (see Appendix J for the Statistical Analysis).

Table 4.2: Mean headache frequency for groups one and two exercise blocks and group one's non exercise block over a twelve week period.

Dependent Variables	Weeks	Groups		
		Grp. 1 Exercise	Grp. 1 No Exercise	Grp. 2 Exercise
Headache Frequency*	1	3.00 ± 2.14	2.25 ± 1.28	2.38 ± 1.85
	2	2.50 ± 2.45	2.50 ± 1.41	2.13 ± 1.89
	3	2.00 ± 1.51	1.63 ± 1.41	1.63 ± 1.41
	4	2.38 ± 2.39	2.13 ± 0.99	2.75 ± 2.43
	5	2.50 ± 2.33	2.13 ± 2.23	1.75 ± 1.28
	6	2.00 ± 2.20	2.75 ± 2.87	2.13 ± 1.81
	7	2.25 ± 2.49	2.50 ± 2.00	1.00 ± 1.20
	8	1.63 ± 1.60	2.50 ± 1.51	2.13 ± 2.10
	9	2.00 ± 2.39	2.88 ± 1.89	2.50 ± 2.62
	10	2.25 ± 2.19	2.13 ± 2.10	2.63 ± 2.61
	11	1.75 ± 1.67	2.00 ± 2.39	2.00 ± 1.85
	12	1.38 ± 0.92	1.57 ± 1.13	2.13 ± 2.03

* Headache frequency is measure by the mean number of headaches per week.

Table 4.3: Mean breakfast pain for groups one and two exercise blocks and group one's non exercise block over a twelve week period.

Dependent Variables	Weeks	Groups		
		Grp. 1 Exercise	Grp. 1 No Exercise	Grp. 2 Exercise
Breakfast Pain*	1	0.57 ± 0.75	0.45 ± 0.46	0.33 ± 0.38
	2	0.43 ± 0.59	0.34 ± 0.26	0.66 ± 1.06
	3	0.20 ± 0.30	0.40 ± 0.53	0.45 ± 0.62
	4	0.39 ± 0.64	0.51 ± 0.49	0.98 ± 0.94
	5	0.52 ± 0.75	0.23 ± 0.29	0.31 ± 0.27
	6	0.44 ± 0.46	0.32 ± 0.32	0.51 ± 0.36
	7	0.46 ± 0.79	0.27 ± 0.37	0.36 ± 0.59
	8	0.19 ± 0.28	0.43 ± 0.58	0.69 ± 1.00
	9	0.22 ± 0.41	0.54 ± 0.84	0.91 ± 1.20
	10	0.35 ± 0.36	0.30 ± 0.43	0.74 ± 0.94
	11	0.37 ± 0.40	0.35 ± 0.41	0.26 ± 0.35
	12	0.25 ± 0.30	0.34 ± 0.50	0.51 ± 0.57

* Headache intensity is measured out of a total possible worst at 8 centimetres, versus least pain at 0 centimetres.

Table 4.4: Mean lunch pain for groups one and two exercise blocks and group one's non exercise block over a twelve week period.

Dependent Variables	Weeks	Groups		
		Grp. 1 Exercise	Grp. 1 No Exercise	Grp. 2 Exercise
Lunch Pain*	1	0.65 ± 0.68	0.59 ± 0.51	0.59 ± 0.44
	2	0.47 ± 0.53	0.58 ± 0.64	0.71 ± 0.89
	3	0.30 ± 0.44	0.58 ± 0.66	0.37 ± 0.68
	4	0.43 ± 0.62	0.50 ± 0.38	0.71 ± 0.74
	5	0.36 ± 0.49	0.35 ± 0.32	0.61 ± 0.44
	6	0.22 ± 0.29	0.42 ± 0.39	0.48 ± 0.50
	7	0.40 ± 0.52	0.33 ± 0.39	0.46 ± 0.60
	8	0.13 ± 0.20	0.36 ± 0.49	0.63 ± 0.73
	9	0.25 ± 0.33	0.60 ± 0.78	1.09 ± 1.41
	10	0.48 ± 0.49	0.42 ± 0.33	1.02 ± 1.27
	11	0.43 ± 0.55	0.43 ± 0.32	0.54 ± 0.85
	12	0.29 ± 0.34	0.35 ± 0.67	0.83 ± 1.12

* Headache intensity is measured out of a total possible worst at 8 centimetres, versus least pain at 0 centimetres.

Table 4.5: Mean dinner pain for groups one and two exercise blocks and group one's non exercise block over a twelve week period.

Dependent Variables	Weeks	Groups		
		Grp. 1 Exercise	Grp. 1 No Exercise	Grp. 2 Exercise
Dinner Pain*	1	0.73 ± 0.73	0.30 ± 0.29	0.65 ± 0.70
	2	0.42 ± 0.50	0.46 ± 0.54	0.65 ± 0.78
	3	0.23 ± 0.35	0.35 ± 0.56	0.93 ± 1.05
	4	0.38 ± 0.47	0.37 ± 0.30	1.09 ± 1.03
	5	0.30 ± 0.44	0.51 ± 0.44	0.46 ± 0.54
	6	0.44 ± 0.43	0.39 ± 0.48	0.58 ± 0.76
	7	0.35 ± 0.44	0.38 ± 0.46	0.49 ± 0.59
	8	0.20 ± 0.32	0.48 ± 0.54	0.79 ± 0.87
	9	0.16 ± 0.25	0.65 ± 0.80	1.36 ± 1.85
	10	0.32 ± 0.42	0.29 ± 0.34	1.03 ± 1.43
	11	0.32 ± 0.50	0.36 ± 0.55	0.69 ± 0.81
	12	0.24 ± 0.39	0.52 ± 0.70	0.89 ± 1.25

* Headache intensity is measured out of a total possible worst at 8 centimetres, versus least pain at 0 centimetres.

Table 4.6: Mean bedtime pain for groups one and two exercise blocks and group one's non exercise block over a twelve week period.

Dependent Variables	Weeks	Groups		
		Grp. 1 Exercise	Grp. 1 No Exercise	Grp. 2 Exercise
Bedtime Pain*	1	0.59 ± 1.04	0.41 ± 0.26	0.59 ± 0.60
	2	0.46 ± 0.69	0.49 ± 0.35	0.70 ± 0.97
	3	0.13 ± 0.25	0.25 ± 0.32	1.01 ± 1.19
	4	0.39 ± 0.49	0.45 ± 0.49	0.80 ± 0.75
	5	0.34 ± 0.56	0.62 ± 0.71	0.34 ± 0.57
	6	0.57 ± 0.78	0.29 ± 0.31	0.79 ± 1.07
	7	0.33 ± 0.33	0.56 ± 0.57	0.49 ± 0.67
	8	0.35 ± 0.29	0.32 ± 0.39	0.72 ± 1.05
	9	0.19 ± 0.31	0.82 ± 0.87	1.09 ± 1.52
	10	0.27 ± 0.41	0.26 ± 0.34	0.35 ± 0.34
	11	0.20 ± 0.35	0.39 ± 0.55	0.43 ± 0.34
	12	0.12 ± 0.23	0.27 ± 0.45	0.19 ± 0.20

* Headache intensity is measured out of a total possible worst at 8 centimetres, versus least pain at 0 centimetres.

Exercise Compliance

Subjects were instructed to exercise at least three times per week over the twelve week block. However, a one hundred per cent compliance rate was not observed for either experimental groups. The frequency that each subject exercised three times per week is listed in Table 4.7.

Table 4.7: Number of weeks each subject exercised 3, 2 and 1 time per week over the 12 week study period.

Subjects	# weeks of exercise 3X/week	# weeks of exercise 2X/week	# weeks of exercise 1X/week	# weeks of exercise 0X/week
Group #1				
1.	2	4	0	6
2.	4	4	3	1
3.	6	5	0	1
4.	8	2	2	0
5.	4	3	3	2
6.	2	5	0	5
7.	5	1	1	5
8.	10	2	0	0
Group #2				
1.	10	0	2	0
2.	7	3	1	1
3.	7	5	0	0
4.	0	4	4	4
5.	4	5	2	1
6.	8	3	1	0
7.	1	5	5	1
8.	8	1	2	1

Subjects who did not exercise three times per week may have exercised twice, once or not at all for any given week. The mean percentage of time the subjects exercised over the twelve week study is graphically represented for group one in Figure 4.1 and group two in Figure 4.2.

Figure 4.1 Mean percent of time that subjects in group one exercised three, two, one or no times per week over the twelve week study.

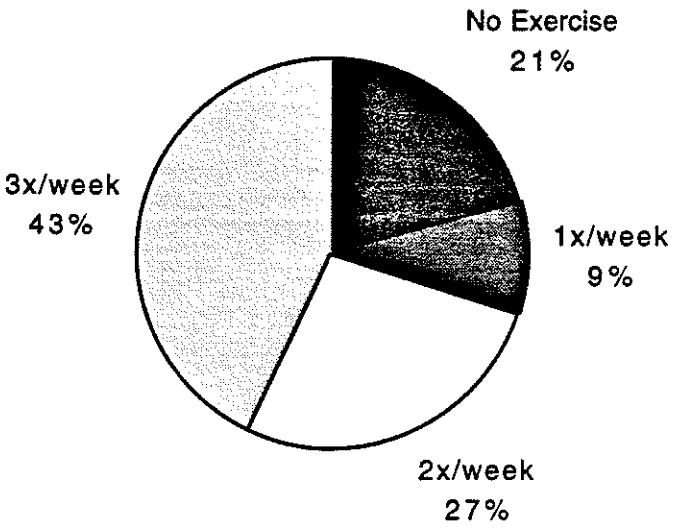
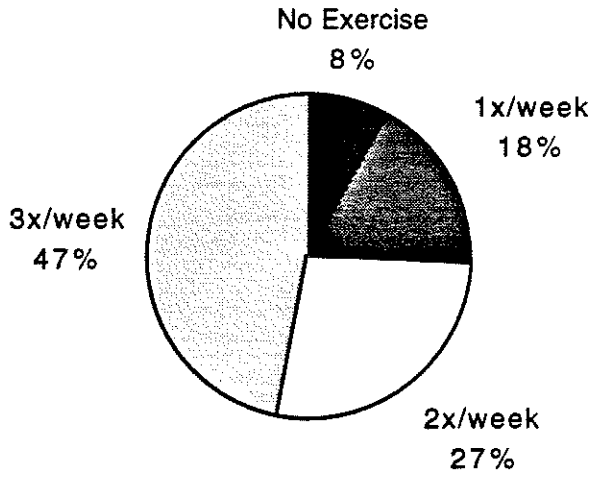


Figure 4.2: The mean percent of time subjects in group 2 exercised three, two, one or no times per week over the twelve week study.



Fitness Level Comparisons

A one way ANOVA was used to compare the fitness levels of subjects before and after the treatment intervention (i.e.; exercise). Group one had an additional fitness test between their control group period and the commencement of the treatment. In total, group one had three fitness tests, while group two had two fitness tests. All of these tests were compared using a one way ANOVA. Table 4.8 lists the fitness tests taken on three occassions for group one and two occassions for group two. There was a significant difference ($P =/< .05$) between group one's first fitness test measurement compared to fitness test measurements two and three. All other comparisons within groups and between groups were not significantly different from each other (see Appendix J for the Statistical Analysis).

Table 4.8: Fitness test measurements for groups one and two at the beginning and end of the study as well as the mid-way point for group one.

Subjects Group 1*	Test #1 (ml/kg/min)	Test #2 (ml/kg/min)	Test #3 (ml/kg/min)
1.	29.24	27.00	43.00
2.	32.16	29.00	29.00
3.	34.00	34.00	36.00
4.	30.00	30.00	36.00
5.	21.79	33.00	33.00
6.	35.75	35.00	35.00
7.	22.00	30.00	30.00
8.	36.00	36.00	44.00
Group 2			
1.	38.00	32.00	n/a
2.	26.28	26.00	n/a
3.	40.00	41.00	n/a
4.	25.69	29.00	n/a
5.	32.00	44.00	n/a
6.	27.00	42.00	n/a
7.	24.45	29.00	n/a
8.	15.77	20.00	n/a

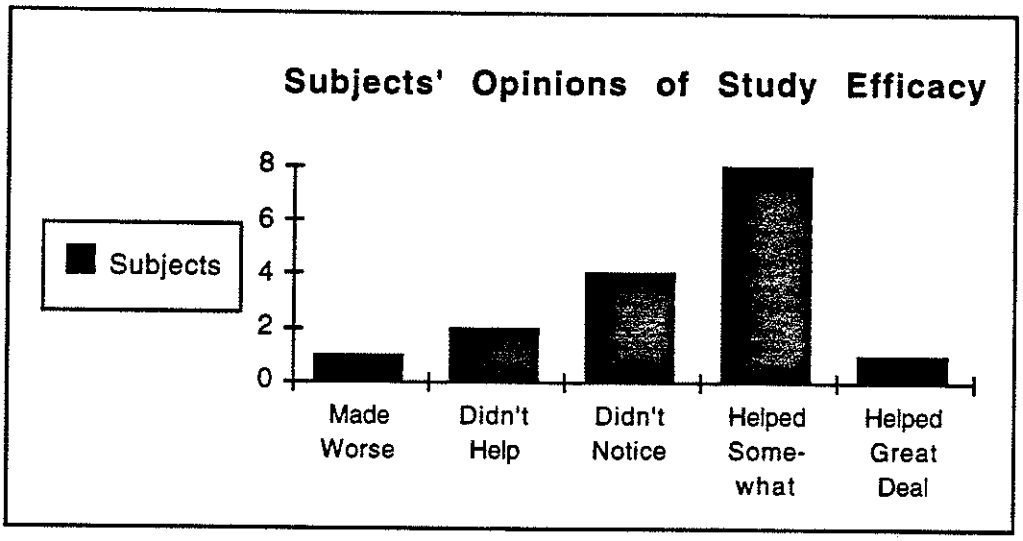
*Comparing group one's first fitness test to the second and third resulted in a significant difference between them at $P =/< .05$.

Final Questionnaire Results

The final questionnaire collected descriptive data provided by subjects at the end of the study. Eleven out of sixteen subjects said they felt ill since the beginning of the study. Nine subjects said feeling ill consisted of a cold while the other two had a physical (orthopedic problem). Nine out of sixteen subjects said they thought their diet changed over the course of the study. Twelve out of sixteen subjects felt they had some type of stress over the course of the study. The type of stress was not described.

When asked to summarize their feelings on the overall effectiveness of the exercise program in reducing headache pain, one person thought it made their condition worse, two people thought it did not help at all, four people said they did not notice either way, eight people said it helped somewhat and one person said it helped a great deal (Figure 4.3).

Figure 4.3: Final questionnaire results on subjects' opinions of the effectiveness of the exercise program in reducing headache pain.



When asked for suggestions for future research involving the migraine population and exercise, the following comments were presented: "better access to the facility is needed; the time of the year for the study should be different; there should be neck stretches added to the program; another form of exercise should be chosen such as cycling, tai chi." When asked what they gained from the study, the following comments were made: "I learned a great deal about myself and how much chronic pain I have; The time to recover from my headaches was shortened; I felt like I had more energy; I felt my headaches were not as severe and I needed less medication."

CHAPTER FIVE
DISCUSSION

Why Use Aerobic Exercise in Headache Pain & Frequency Reduction?

The purpose of this study was to determine the effect of an aerobic exercise program (specifically walking/jogging) on classical and common migraine patients' headache pain and frequency. It was hypothesized that the exercise would decrease migraine headache pain and frequency. Various experts in the migraine headache field have also purported a similar hypothesis (Rapoport and Sheftell, 1990; Atkinson, 1977; Kumar, 1988; Darling, 1991; Lance, 1982; Lockett and Campbell, 1992; Grimm et al., 1981).

The American College of Sports Medicine (1991) has stated that in order for someone to receive physiological benefits/changes, he/she must exercise a minimum of three times per week, at a minimum of twenty minutes per exercise session (excluding warm-up and cool-down). As such, to evaluate the hypothesis of the present study, these physiological benefits/changes were guidelines for the exercise program. The underlying benefit of exercise and its effect on migraine headaches is thought to be increased levels of serotonin (Fox, Bowers and Foss, 1989).

Effect of Serotonin

Serotonin has been theorized as a leading factor involved in the pathology of migraine headaches (Raskin, 1988; Lance, 1991, Dechant and Clissold, 1992). Serotonin can affect many bodily functions such as sleep cycle regulation, mood change, hormone release and pain

perception, all of which are affected with migraine headaches (Shenker, Gross and Grekin, 1985; Fuller and Clemens, 1981; Shima, Nakahama and Yamamoto, 1986; Fields, 1987; Baldessarini, 1983). Serotonin is known to have regulatory effects on blood vessels (vasoconstrictor of large blood vessels and vasodilator of small arterioles) (Raskin, 1988), which is also known to be involved in migraine headache pathology (Lance, 1991; Dechant and Clissold, 1992). Since unstable serotonin levels have such a drastic effect on migraine headaches (Raskin, 1988), and since aerobic exercise can increase plasma serotonin levels (Fox, Bowers and Foss, 1989), a logical deduction could be that exercise can stabilize serotonin levels within the body and thus help reduce migraine headache frequency or migraine pain intensity. One problem with this hypothesis is that migraine headaches are not only associated with a fluctuation in serotonin levels. They may also be influenced by factors such as those in Table 2.7.

DID AEROBIC EXERCISE HELP?

Presumably, if the subjects of this study did to not exercise the prescribed three times per week, they would not receive the physiological benefits/changes hypothesized previously. Indeed, since the subjects did not exercise three times per week over the twelve week exercise block for this study (see Figure 4.1 and Table 4.3), a logical deduction would be to conclude they would not receive the benefits. In fact, according to the results presented in Chapter Four, it would appear that exercise was not effective in reducing migraine headache pain or frequency (Tables 4.2, 4.3, 4.4, 4.5 and 4.6).

CARDIOVASCULAR BENEFITS

To determine if the subjects had received any cardiovascular changes/benefits from the exercise they did perform, a one way ANOVA was performed to compare group one's non-exercise fitness test measurements to group one's exercise fitness test mesurement. The results demonstrated a significant difference between the first fitness test and the last two fitness tests. With the exclusion of two subjects (numbers five and seven) who appear to have a dramatic difference in their fitness test measurements one and two, there may have been very little difference. Since these subjects were in the control group, there should not have been a significant difference between fitness tests one and two, but these two subjects may have skewed the results. One explanation for a change in their fitness level would be that these subjects may have engaged in exercise activities independently since they had not received exercise instructions other than to maintain their present activity levels for participation in the control group. The change in these two subjects' fitness test measurements, coupled with the fact that four other subjects' (numbers one, three, four and eight) third fitness test measurement changed from the first would account for the significant difference between group one's first fitness test and the last two fitness tests. There was no significant difference between group two's first and second fitness test measurements. However, six of eight subjects (numbers three, four, five, six, seven and eight) did experience an increase between their first and second fitness test, however, this did not reach statistical significance.

Since the American College of Sports Medicine (1991) has placed a minimum threshold for people to meet in order to receive physiological benefits, and since subjects for this study did not meet or exceed those requirements, it can not be conclusively stated that exercise did or did not reduce headache pain or frequency. It can be stated conclusively that with the amount of exercise the subjects did perform that their fitness level did change for group one ($p<.05$) and this trend was also evident for group two, but this level of exercise did not significantly alter migraine headache pain or frequency.

Exercise Compliance with Headache Patients

In order to measure the effect of aerobic exercise on migraine patients' headache pain and headache frequency, exercise adherence is necessary (Haynes, 1984). In a study measuring the effect of behavioral management programs on adherence to exercise in migraine patients, Fitterling et al. (1988) found a behavioral adherence package to work for five out of five subjects. Positive results were calculated using Cooper Points (Cooper, 1977) which has been used in other exercise adherence studies such as Dubbert et al., 1984; Epstein et al., 1980; Keefe and Blumenthal, 1980; Wysocki et al., 1979. "A Cooper Point is a standardized measure of the amount of aerobic benefit derived from different exercise topographies, intensities and durations" (Fitterling et al., 1988, pg. 11). The behavior management package Fitterling et al. (1988) offered included instructions, modeling, behavioral contracting, goal setting, stimulus control, performance feedback and praise, shaping and verbal strategies.

Instructions and modeling consisted of explanation and demonstation of the exercise requirements. The behavioral contract stated that if the subject complied with the exercise requirements, they would be refunded five dollars per week of their one hundred dollar deposit which they had given at the beginning of the study. Subjects received performance praise and those refunded more than eighty five dollars received a gift in the form of a pedometer (given to them to use at the beginning of the study) and relaxation training. Telephone prompts were performed by the researcher every one to two weeks over the twelve week program. Significant others were instructed on monitoring and reinforcing exercise behavior. Performance praise was also given during on-site exercise sessions.

Although Fitterling et al. (1988) only used five subjects in total, the study seemed to have important relevance. Subjects' initial Cooper Points were scored and measured over the period of the study. All subjects posted Cooper Points which permitted the subjects to be within the recommended criteria thought to be neccesary for significant aerobic training levels (Cooper, 1977). In addition, each of the subjects' vascular headache activity (as measured by the mean headache index) was decreased and the mean number of headache free days was also significantly increased. The use of behavioral modification in increasing exercise compliance for research is also supported by many researchers outside of the migraine headache field (Epstein et al., 1980; Haynes, 1984; Martin and Dubbert, 1982a; Martin and Dubbert, 1982b; Martin and Dubbert, 1984; Martin and Dubbert, 1985).

PATIENT COMPLIANCE/DROP-OUTS

It may still be possible that migraine patients could receive benefit with aerobic exercise, as has been suggested by Lockett and Campbell (1992) and Fitterling et al. (1988). However, there will always be the problem of compliance in order to meet the threshold of what would be considered beneficial. Many reasons exist to explain the poor compliance in this study. One major factor which would influence the number of times per week a migraine patient could exercise would be the number of migraines she experienced (Fitterling et al., 1988). For example, if a patient was to get an average of two headaches per week, only five days would remain as possible exercise days dropping the possible days of exercise from three days in seven to three days in five. This may place some impractical restrictions on some subjects.

The final questionnaire results also provided information about what may have hindered exercise compliance. For example, eleven out of sixteen subjects said they felt ill since the beginning of the study. Nine subjects said feeling ill consisted of a cold while the other two had a physical (orthopedic) problem. Another possibility could be that twelve out of sixteen subjects felt they had some type of stress over the course of the study. Although these variables were not accounted for in the statistical analysis, they do provide the experimentor with some plausible explanations for the poor compliance rate.

Subjects were asked for feedback on the ability to perform the exercise requested when follow up calls indicated that they were falling behind in the exercise frequency. One subject suggested that

there be easier access to the exercise facilities. In this study, subjects had many options for exercise facilities. Four subjects in group two stated that Max Bell Centre was too far for them to travel. Other arrangements were made at Seven Oaks Fitness Centre for those four subjects. In group one, there were five subjects who stated Max Bell Centre was an inconvenient location. Other arrangements were made at the Downtown YMCA, South YMCA and Seven Oaks Fitness Centre for these five subjects.

An additional suggestion was that the time of the year was not optimal for exercise. The study commenced in August, 1993 and went until February, 1994 for group one. In regards to the time of year, one recurring theme was that it was too cold to venture out for exercise. Some subjects in group two who chose to exercise outside stated it became quite cold in November, 1993. Subjects in group one complained that it was too cold to even go outside and drive to their exercise facility during January and February, 1994 (approximately six weeks at -30 degree celcius).

A third reason was that the form of exercise (walk/jog) was not suitable to most subjects. Some subjects even asked if they could replace the walk/jog with stationary cycling or cross country skiing. This was accepted only if their heart rate was in their heart rate training zone, in keeping with the American College of Sports Medicine guidelines (1991). The complaint of walking/jogging was that it seemed to induce a headache in certain cases. Subjects that continued with the walk/jog form of aerobic exercise predominantly walked briskly which was sufficient for most to raise their heart rate within their heart rate training zone. In fact, one lady could walk

briskly and raise her heart rate past ninety percent of her maximum heart rate. She was instructed to slow her pace down so that her heart rate was maintained within her heart rate training zone.

A final suggestion for improved compliance by a subject was that there be more neck stretches added or that exercise like tai chi be permitted. The experimentor explained to this subject that tai chi and stretching would probably not increase her heart rate sufficiently to make it aerobic in nature and would thus, not meet the criteria to which the hypothesis is based. She then suggested it as an adjunct to some type of aerobic exercise. In reponse, the experimentor explained that if positive effects were observed, it would not be known which treatment would have changed the dependent variables.

Dishman, Sallis and Orenstein (1985) provided a list of possible determinants for exercise compliance in Table 5.1 below. A suggestion for future research would be to address these issues. Fitterling et al. (1988) utilized a behavioral adherence package (discussed in Chapter Two of this document) which addressed most issues in Table 5.1 and in turn, attained positive results.

In addition to poor exercise compliance in this study, there was also a relatively large drop out rate of 33%. The study by Lockett and Campbell (1992), which studied the effect of aerobic exercise on classical migraine headaches, reported a drop out rate of 23%. Cooper (1977) reported a 30 to 60 % drop out rate of jogging programs. In a study where prisoners were placed on a jogging program, there was a 25% drop out rate reported (Pollock et al., 1977). Due to stringent criteria to take part in this study, it was

thought this obstacle may have contributed to low recruitment numbers. As a result, the study commenced with only twenty four subjects and finished with a total of sixteen subjects. There were many reasons for the high drop out rate in this study such as divorce, family problems, work committments, too many headaches, abnormal headache pattern three months after the delivery of a baby or just lost contact with the researcher.

Table 5.1: Summary of Variables That May Determine the Probability of Exercise (Dishman et al., 1985, pg. 161).

Personal Characteristics
Past program participation
Past extraprogram activity
School athletics, 1 sport
School athletics, >1 sport
Blue collar occupation
Smoking
Overweight
High risk of coronary heart disease
Type A behavior
Health, exercise knowledge
Attitudes
Enjoyment of activity
Perceived health
Mood disturbance
Education
Age
Expect personal health benefit
Self-efficacy for exercise
Intention to adhere
Perceived physical competence
Self motivation
Evaluating cost and benefits
Behavioral skills
Environmental Characteristics
Spouse support
Perceived available time
Access to facilities
Disruptions in routine
Social reinforcement (staff, exercise partner)
Family influence
Physical influences
Cost
Medical screening
Climate
Incentives
Activity Characteristics
Activity intensity
Perceived discomfort

STUDY RELEVANCE

Although there was poor exercise compliance and insignificant changes in headache frequency and headache pain intensity, this study does provide some valuable insights. In fact, Lockett and Campbell (1992, pg. 52) reported positive results with their exercise program on the affective distress scale just because their was "an inclination toward improvement" even though it was statistically insignificant. In addition, Lockett and Campbell (1992) reported that migraine frequency, intensity and duration did decrease, although not significantly.

Feedback from subjects who took part in this study indicated that there were benefits gained from the exercise. One subject said "I learned a great deal about myself, and how much my life centres on pain." As a result of the study, they found that exercise might be included in one of their coping mechanisms to deal with the pain. Many subjects provided verbal feedback to Mark Lafave on the final fitness assessment that they really enjoyed themselves and thought that the exercise either helped or thought that if they had exercised more that it would have helped with their migraine and pain reduction. Some subjects said that they felt that the exercise program helped to reduce the severity of their migraine episodes, even if it did not reduce the frequency. These comments were made long before the statistical analysis was performed. Although this study failed to provide a quantitative change in subjects migraine pain and frequency, anecdotal evidence provided by subjects suggested that exercise is a viable option to reduce migraine frequency or pain.

The current study has shown a lower threshold of exercise compliance (less than three times per week) which will not produce significant results. This, in itself, may provide valuable information to the migraine community or the research community. Anyone wishing to do future research on this population must keep this in mind when designing a study.

Although quantitative data collected from this study showed exercise did not have an effect on headache pain and frequency, the qualitative data taken from the final questionnaire proved to be promising and diverse. One person thought exercise made their condition worse, two people thought it did not help at all, four people said they did not notice either way, eight people said it helped somewhat and one person said it helped a great deal (Figure 4.2). More than fifty percent of the subjects had a positive comment for the use of exercise. This illustrates the diversity of subjects and complexity of migraine headaches. If there was one constant determining factor involved in migraine pathology, treatment would prove much more straight forward. However, as explained in Chapter Two, there may be many factors which can effect migraine headache (Table 2.7). This may account for the diversity in subjects' individual headache pain intensity and frequency as well as their comments on the effectiveness of exercise as a treatment of migraines. After a review of the results from the various studies which have used aerobic exercise as a treatment of migraine headaches, it appears that exercise, alone, will not provide drastic reduction in headache frequency and pain for all subjects (Lockett and Campbell, 1992; Fitterling et al., 1988). It may provide relief

for some, though not for others. Concentration on the differences between these may provide further information on identifying individuals which respond to exercise versus those who would not (responders vs. non-responders). Certainly, the role of exercise in the treatment of migraine headache pain and frequency requires further research.

SUMMARY & CONCLUSIONS

This study analyzed the effect of an aerobic exercise program on classical and common migraine headaches. The study solicited subjects (103 respondents) with on 24 subjects who actually met the criteria to take part in the study. The subjects were divided into 2 groups of 12. One group would act as an only an experimental group while the other would act both as a control group and experimental group for comparison to themselves. Subjects that only acted as the experimental group commenced the aerobic exercise program immediately lasting for 12 weeks. These subjects were instructed on a proper warm up and cool down which included some stretches. In addition, the aerobic portion of the exercise consisted on a walk/jog program to allow subjects to get their heart rate within their own heart rate training zone. The entire time during the 12 week experimental period, subjects were instructed to collect information on their headache pain using the visual analogue scale at four distinct points throughout the day (morning, noon, dinner and bedtime). In addition, subjects were asked to document when they had migraine headaches. The group that was acting as the control group during the first 12 weeks of the study on collected information on their headache pain and frequency.

Subjects' fitness levels were tested before the study started, at the end of 12 weeks and again at the end of 24 weeks for the group who commenced the exercise program after collecting information on just their headache pain and frequency during the first 12 weeks. The group that commmenced the exercise program were given the same instructions as the first group which exercised, but now they would act as their own control group for statistical comparison.

Statistical comparison was performed to see if there was a significant difference between the group that did not exercise and the group that did exercise for the following dependent variables: headache pain measured by the visual analogue scale; headache frequency; fitness level measured by a submaximal fitness test. Results revealed that subjects did not benefit from the amount of aerobic exercise they had performed. However, although subjects were requested to exercise at least three times per week, they only did so 44.79 % of the time. As a result, it could be concluded that the amount exercise the subjects did perform was not sufficient to produce pain relief effects or reduction of the frequency of headaches.

Although the quantitative data did not prove to benefit the subjects, the final questionnaire at the end of the study revealed more promising trends for future research. Over 50% of the subjects thought that the exercise helped their headache situation to some extent even though their results did not prove this. This also meant that just under 50% did not feel exercise had any effect at all, or, made their headache worse. This diversity of subjects is thought to be the result of the numerous factors which have possible effects on

migraine headaches. It would be interesting to determine which of those factors had some effect on exercise and migraine. This would be a suggestion for future research.

RECOMMENDATIONS FOR FUTURE RESEARCH

Although this study did not reveal positive quantitative results, there was a positive outcome since more was learned about the effect exercise has on migraine headaches. Subjects must at least meet the standards in place by the American College of Sports Medicine to reach cardiovascular benefits. It is at that point that one will known the true effect of aerobic exercise on migraine headaches. Even if all subjects did the required exercise, there may not have been positive results because of such diversity what causes migraine headaches. An exploratory study is needed similar to this study, except variables which are known to have an effect on migraine headaches should be closely monitored. That way, if a subject does not benefit from the exercise, there may be a trend towards a variable which is responsible. In addition, there may be different types of exercise which may benefit different people suffering from migraines. For example, if a person suffers from migraine headaches, but their major trigger factor is stress, they may benefit from a form of exercise which includes a stretching program to help target muscles known to be involved with stress such as levator scapulae. The diversity of subjects may also require the collaboration of various methods pain reduction. In continuation with the previous example, a person may benefit from actual relaxation therapy and biofeedback.

In conclusion, it is still thought that migraineurs may benefit from a cardiovascular training program. However, special attention must be paid to group or categorize subjects according to what seems to trigger the headaches since they may have a direct relation as to the efficacy of the exercise. If a large enough sample population can be found with a large variety of trigger factors, chances of determining the true affect of aerobic exercise may be possible.

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Appendix A

Sample Medical Screening and Headache Questionaire

MEDICAL ASSESSMENT

I agree to the release of the information from the medical assessment and any information about my health as it relates to my participation in this program, to the University of Manitoba as a condition precedent to my participation in the exercise program.

Signature_____Date_____

Name_____

Witness Signature_____Date_____

Name _____

Physical Examination

Blood Pressure_____Heart Rate_____

EKG Reading (please enclose a copy)_____

_____

_____

Please comment on resultant restrictions to exercise eg: avoiding Valsalva activities (bowling, weight lifting).

		Exercise Restrictions:
1.	Angina	yes/no
2.	Congestive heart failure	yes/no
3.	Dysrythmias	yes/no
4.	Hypertension	yes/no
5.	Respiratory problems	yes/no
6.	Vascular insufficiency	yes/no
7.	Joint dysfunction or arthritic complaints	yes/no
8.	Other_____	

Is this person elibible to participate in this study? Yes/No.

If not, why?_____

_____

_____

Physician's Name (please print)_____

Physician's Signiture_____

Date_____

The efficacy of aerobic exercise in preventing migraine headaches.

MEDICAL SCREENING & HEADACHE QUESTIONAIRE

NOTICE TO PATIENTS:
Thank you for your interest in in our study. In order to help us decipher if you meet the stringent requirements for our study, we ask you to please fill out this medical assessment and headache questionaire. Some reasons for you not being eligible for this study include the improper type of migraine headache, hypertension or cardiac problems. Generally, this medical assessment and headache questionaire helps the research team determine that you can take part in our study safely.

Some of the questions are difficult and some are repetitive. Do the best you can. If there are some questions you would sooner not answer, just leave them blank. Questions under the **medical assessment** section may be left until you come to meet with Dr. B.A. Anderson. You should try to answer the rest of the questions before meeting with Dr. B.A. Anderson.

If there are other things that you would like to add, feel free to add them at the end of the assessment/questionaire.

MEDICAL SCREENING AND HEADACHE QUESTIONAIRE

Your name or initials_____
Your date of birth_____
Your occupation_____
Marital Status_____

Contact in case of emergency: Name_____

Phone Number_____

Your personal Physician's Name and Address_____

_____

THINGS THAT SEEM TO BRING ON A HEADACHE

At what age did you start having headaches?_____
What brings on a headache?_____

_____

_____

_____

In addition to the things that you notice bring on a headache, do any of the following bring on a headache:

stress_____
anger_____
feeling depressed_____
red wine_____
other alchohoic beverages (specify)_____
smoke_____
fumes_____
being hungry_____
sleeping in_____
ovulation_____
menstrual periods_____
fatigue_____
sex_____
sudden exertion_____
exercise (specify)_____

_____

ice cream_____
Chinese food_____
chocolate_____

cheese_____
mik, yogurt_____
peanut butter_____
other foods (specify)_____
other factors not mentioned_____
_____
_____

TIMING OF HEADACHE

Are there special times of the day or the week that you are likely to get a headache?_____
_____
Do you commonly get headaches on the weekends?_____
_____
How many headaches would you get per month (on average)? If you do not know, put your closest guess._____

WARNING SYMPTOMS OF HEADACHE

Do you get symptoms that tell you that a headache is about to develop? List those symptoms._____
_____
_____
_____
_____

In addition to the warning symptoms you have listed, do you experience any of the following preceding your headaches?

feeling cold_____
looking pale_____
feeling faint_____
being dizzy_____
feeling tense_____
tunnel vision_____
double vision_____
numbness (specify what part of the body)_____
trouble speaking_____

losing vision in one eye_____
colored or white lights in your vision_____
blurred vision_____
zig zag lines in your vision_____
dimness or blacking out of vision_____
spots in front of your eyes_____
other visual troubles (specify)_____
other symptoms different than those listed (specify)_____
what proportion of your headaches are preceded by warning symptoms? (all, half, one in ten, etc...)_____

CHARACTERISTICS OF YOUR HEAD PAIN

Do you experience more than one type of headache?_____

Answer the following questions in order to describe your most severe type of headache. Leave any description of your more minor headache types to later on.

In what part of your head does your headache begin?_____

When your headache is fully develped, what part of the head is maximally involved?_____

What is the nature of the pain you experience most of the time (i.e.; is it steady, sharp pain, stabbing, throbbing, like a toothache, etc...)_____

How long does it take for the headache to build up to its maximum?_____

How long will most of your headaches last?_____

What time of the day is the headache most likely to start?_____

Describe important characteristics of your headache not already mentioned.____

_____

_____

SYMPTOMS ASSOCIATED WITH HEADACHE

What symptoms do you experience along with the headache pain?_____

_____

_____

_____

In addition to the symptoms you notice, do you have any of the following:

nausea_____

vomiting_____

dizziness_____

numbness_____

loss of speech_____

weakness of a part of the body (specify)_____

disturbances of vision (please describe)_____

stomach pain_____

diarrhea_____

increased thirst_____

increased urination_____

confusion_____

tiredness_____

runny nose_____

extra tearing in one or the other eye_____

neck pain and stiffness_____

SYMPTOMS THAT FOLLOW HEADACHE

What symptoms do you experience as leftovers once the headache pain has subsided? Indicate how long these last.

Symptom	**Duration**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Do you notice the following symptoms after your head pain has subsided? If so, indicate how long they last.

neck pain and stiffness_____

nausea_____

fatigue_____

confusion_____

background mild head pain_____

tenderness in the scalp_____

depressed mood_____

other (specify)_____

Do you develop neck pain and stiffness with your headache?_____

_____

Does the neck pain and stiffness come on at the beginning, during or after the headache?_____

_____

If the neck pain and stiffness is a prominent feature, i.e.; how bad is it?_____

_____

How long will the neck pain and stiffness last?_____

_____

How long does it take you before you feel back to normal after a headache?____

_____

FREQUENCY OF HEADACHES

How often are you experiencing your most severe type of headache? Indicate the number of times.

each day? _____

each week? _____

each month? _____

in two months? _____

DESCRIPTION OF LESS SEVERE TYPES OF HEADACHE

If you experience more than one type of headache, briefly describe the other types of headaches you experience. Mention the degree to which they interfere with your daily life.

_____

_____

_____

_____

_____

Regarding your less severe type of headache, how frequent are they?

each day? _____
each week? _____
each month? _____
in two months? _____

TREATING YOUR HEADACHES

Regarding yhour most severe type of headache, what things have you noticed will help to relieve your headache?_____

_____

_____

_____

In addition to the things that you notice will relieve your most severe headaches, do any of the following help?

cold compresses_____
coffee_____
sleep_____
a dark room_____
neck massage_____
pressure against the scalp_____
other (please describe)_____

What do you do when the headache starts? (i.e.; do you lie down, do you pace the floor, etc...)_____

_____

_____

Do you often fall asleep or feel as though you could?_____

_____

Do you take medications right at the start of the headache? During your warning symptoms?_____

_____

Do you delay taking the medications until the headache is well established? If so, how long do you delay taking the medication?_____

_____

_____

MEDICATIONS CURRENTLY TAKEN FOR MOST SEVERE HEADACHE

What medication do you now take for your headaches (list each one, dosage or number of pills and its effect):

Name of medication	Size and # of pills	Your comments on pill effectiveness
eg. Tylenol	regular strength, 2 every 4 hrs	no effect

What other things do you do for your headache? _____

How do you treat the headaches you consider less severe or milder headaches? _____

How many (what percentage) of your headaches are you able to control using the treatment you have just described? _____

MEDICATION TAKEN FOR OTHER CONDITIONS

List the OTHER medications you are presently taking for conditions other than your headaches.

Name and Dose	Why Taken	How long on this?

Do you think that any of these medications make you more liable to headaches or cause your headaches? If so, indicate which medication might be at fault. _____

MEDICATIONS TAKEN IN THE PAST FOR HEADACHE

Describe your experience with the following medications that you might have taken for headache.

ASA (aspirin)_____

222_____

292_____

282 Meps_____

Anacin_____

Bufferin_____

Motrin_____

Naprosyn or Anaprox_____

Tylenol_____

Tylenol #1_____

Tylenol #2 or #3_____

Codeine_____

Percocet or percodan_____

Phenaphen_____

Talwin_____

Chlorpromazine_____

Elavil (or amitriptyline)_____

Sandomigran_____

Cafergot_____

Ergomar_____

Gynergen_____

Bellargal_____

Inderal (or propranolol)_____

Atenolol_____

Adalat (or nifedipine)_____

Verapamil_____

Diltiazem/cardizem_____

Sansert (methylsergide)_____

Prednisone or other steroids_____

Sibelium (flunarizine)_____

Other ergot medications_____

Imitrex_____

Other_____

List any other medications you might have been on or were given once or twice. Briefly describe your experience with it._____

_____

_____

Are there any medications that you take for your headaches that you take every day? If so, please list those medications indicating how many you take everyday._____

_____

_____

NONMEDICAL TREATMENTS FOR HEADACHE

Have you tried any nonmedical treatments? If so, list them together with your feelings as to how well they worked (i.e.; psychotherapy, acupuncture, relaxation therapy, reflexology, chiropractic treatment, oxygen therapy, physiotherapy, laser therapy, etc...)._____

_____

_____

_____

PERSONAL HABITS

Do you consume coffee every day? If so, how may cups?_____

_____

Do you drink alcohol? If so, how much and how many days of the week do you drink this much alcohol? What type of alcohol do you usually drink?

_____

_____

Do you get regular exercise?_____If so, describe type of exercise and its frequency (be specific)?_____

_____

_____

Do you smoke?_____

OTHER HEADACHE CHARACTERISTICS

Do your headaches have any of the following characteristics:

1. Have your headaches changed from their usual pattern recently? Are they more frequent? Less frequent?_____

_____

2. Do you headaches wake you up in the middle of the night?_____

_____

3. a) Do you get up in the morning with a headache most mornings?_____

b) Do you feel nauseated and/or sometimes vomit after getting up in the morning and having breakfast?_____

4. Do your headaches tend to start later in the day or are they present when you get up in the morning?_____

5. Do your headaches tend to worsen as the day goes on?_____

6. Do your headaches tend to get better as the day goes on?_____

7. Have you lost any weight in the last several months? If so, how much? If so, have you deliberately been trying to lose weight?_____

8. Has your energy level (i.e.; stamina) been decreasing in the last six months?_____

9. Are you having aches and pains in your shoulder or hip areas in the last 6 months? Is this present daily? Is it increasing?_____

10. Are you feeling depressed?_____

11. Have you found that you wake up in the early morning hours and are unable to fall back to sleep?_____

12. Have you found that you can not fall asleep at nights, and tend to lie awake tossing and turning?_____

13. Have you lost interest in your usual hobbies and interests?_____

14. Have you lost interest in sex?_____

15. Are you unable to perform sexually or have you noticed a decline in your abilities?_____

16. Do you feel helpless in your current situation (i.e.; unable to help yourself) unable to see any good prospects for your future?_____

17. Have you been worrying that your headaches represent a sign of a serious disease such as a brain tumor? _____

_____

18. Have you ever experienced a headache that started extremely suddenly (i.e.; like a thunderclap?). If so, describe when this was. What part of the head did you experience this pain in?_____

_____

19. How much do your headaches interfere with your daily living?_____

_____

20. Do you miss work or school because of headaches?_____

_____

21. How many days have you missed in the last month?_____

_____

22. Do you have to miss social engagements because of headache?_____

_____

23. How many days of each month are ruined for you because of headache?_____

24. Are there things about your job that influence headache? _____

_____

25. Do your sleep habits influence headache?_____

_____

FAMILY HISTORY OF HEADACHE

Do other members of your family (i.e.; your blood relatives) suffer from headaches? If so, list which relatives are affected and list the type of headaches you believe they have._____

_____

_____

FAMILY HISTORY OF OTHER DISEASES

If there any family history of:

stroke_____
high blood pressure_____
aneurysm_____
brain hemorrhage_____
brain tumor_____
heart disease_____
diabetes_____
other disease_____

PAST HISTORY - RELATED OR UNRELATED TO HEADACHE

List any surgical operations you have had_____

_____

_____

Do you have a normal menstrual cycle?_____

If you are female, have you had a hysterectomy? Were ovaries removed? Were you placed on hormone preparations after? Are you still taking the hormone preparations?_____

_____

List any hospital admissions you have had. Please give a date, location and name of hospital as well as reason for admission._____

_____

_____

_____

List any other illnesses you have had_____

_____

_____

Do you have a history of:

high blood pressure_____
heart disease_____
asthma_____
other lung disease (specify)_____
allergies (specify)_____
diabetes_____
high cholestorol_____
thyroid disease_____
depression_____
other significant problems_____

OTHER SYMPTOMS THAT ARE BOTHERING YOU NOW

List any other symptoms that have been concerning you lately._____

_____

_____

CHILDHOODHEALTH

As a child, did you suffer from any of the following: (if so, describe nature and severity of the problem).

nosebleeds_____
motion sickness_____
car sickness_____
unexplained stomach pain_____
dizziness on change of position_____
easy fainting_____
seizures, epilepsy, convulsions_____
other_____

PHYSICIANS YOU HAVE SEEN REGARDING HEADACHE

Name	Location	When seen

OTHER CHARACTERISITICS OF YOUR HEADACHES

Please list any other characteristics of your headaches that might help in improving my understanding of your problem._____

OTHER CONCERNS

Appendix B

Medications Relevant to Exercise Training and Testing

Medications Relevant to Exercise Training and Testing

Drug Names

Generic Name	*Brand Name*
Beta Blockers	
Acebutolol	Sectral
Atenolol	Tenormin
Metoprolol	Lopressor
Nadolol	Corgard
Pindolol	Visken
Propranolol	Inderal
Timolol	Blocadren
Alpha and Beta Blockers	
Labetalol	Trandate, Normodyne
Nitrites and Nitroglycerin	
Isosorbide dinitrate	Isordil
Nitroglycerin	Nitrostat
Nitroglycerin ointment	Nitrol ointment
Nitroglycerin patches	Transderm Nitro Nitro-Dur II, Nitrodisc
Calcium Channel Blockers	
Diltiazem	Cardizem
Nifedipine	Procardia, Adalat
Verapamil	Calan, Isoptin
Nicardipine	Cardene
Nitrendipine	Baypress
Digitalis	
Digoxin	Lanoxin
Diuretics	
Thiazides	
Hydrochlorothiazide (HCTZ)	Esidrix
"Loop" Furosemide	Lasix
Ethacrynic acid	Edecrin
Potassium-Sparing	
Spironolactone	Aldactone

Generic Name	*Brand Name*
Triamterene	Dyrenium
Amiloride	Midamor
Combinations	
Triamterene and hydrochlorothiazide	Dyazide, Maxzide
Amiloride and hydroclorothiazide	Moduretic
Others	
Metolazone	Zaroxolyn
Peripheral Vasodilators	
Noadrenergic	
Hydralazine	Apresoline
Minoxidil	Loniten
Angiotensin-Converting Enzyme (ACE) Inhibitors	
Captopril	Capoten
Enalapril	Vasotec
Lisinopril	Prinivil, Zestril
Alpha Adrenergic Blocker	
Prazosin	Minipress
Terazosin	Hytrin
Antiadrenergic Agents Without Selective Blockade of Peripheral Receptors	
Clonidine	Catapres
Guanabenz	Wytensin
Guanethidine	Ismelin
Guanfacine	Tenex
Methyldopa	Aldomet
Reserpine	Serapasil
Antiarrhythmic Agents	
Class I	
IA	
Quinidine	Quinidex, Quinaglute
Procainamide	Pronestyl, Procan SR
Disopyramide	Norpace

Generic Name	*Brand Name*
IB	
Tocainide	Tonocard
Mexiletine	Mexitil
Lidocaine	Xylocaine, Xylocard
IC	
Encainide	Enkaid
Flecainide	Tambocor
Multiclass	
Ethmozine	Moricizine
Class II	
Beta Blockers	
Class III	
Amiodarone	Cordarone
Bretylium	Bretylol
Class IV	
Calcium Channel Blockers	
Bronchodilators	
Methylxanthines	
Aminophylline	Theo-Dur
Sympathomimetic Agents	
Ephedrine	
Epinephrine	Adrenalin
Metaproterenol	Alupent
Albuterol	Proventil, Ventolin
Isoetharine	Bronkosol
Terbutaline	Brethine
Cromolyn sodium	Intal
Hyperlipidemic Agents	
Cholestyramine	Questran
Colestipol	Colestid
Clofibrate	Atromid-S
Dextrothyroxine	Choloxin
Gemfibrozil	Lopid
Lovastatin	Mevacor

Generic Name	*Brand Name*
Nicotinic Acid (niacin)	Nidobid
Probucol	Lorelco
Other	
Dipyridamole	Persantine
Warfarin	Coumadin
Pentexifylline	Trental

Appendix C

Written media to solicit subjects.

Dear prospective participant;

My name is Mark Lafave and I am a graduate student at the University of Manitoba presently attempting to complete my Masters of Science Degree in the area of Athletic Therapy. As part of a Masters Degree, each student must complete a large scale research project and prepare a thesis. The topic I have chosen involves the development of an exercise program for people who suffer from Migraine headaches.

In order to complete my degree, I must run my research study on the topic above. What I am here to ask you is if there is anyone interested in volunteering in my study. Since this is part of my education, I do not have any funding for which honariums will be available. However, I feel that what you may learn by taking part in my study may benefit you.

The time commitment would involve 1 hour sessions, 3 nights per week for a total of 8 weeks. You will also be asked to keep a daily headache diary for a total of 16 weeks. As well, there will be a $1^1/_2$ -2 hour fitness assessment session once before and once after the 8 week exercise session.

There are some restrictions as to which participants I can accept into the study:

(1)	Non-pregnant females only.
(2)	Subject must be aged 18-45.
(3)	Must not have exercised more than twice per week.
(4)	Must be diagnosed as common or classical migraine headaches.
(5)	Must be able to pass the pre-experimental medical screening deeming them fit to participate in the study. This will include a twelve lead EKG.
(6)	Must not be on any medication which can alter athletic performance (i.e.; fitness testing).
(7)	Non-smokers.
(8)	Must not suffer from more than six migraines per month or less than 2 migraines per month.
(9)	Must not be afflicted with migraines which are triggered by exercise or other physical exertion.
(10)	No subjects with asthma, hypertension or heart disease.
(11)	Must not be on prophylactic or abortive medication for migraines which can alter athletic performance.

If you are interested in volunteering for my study, could you please fill out our preliminary headache questionaire and medical screening. You can pick one up from me now, or you can contact me later at either of these numbers:

Home =
University =

Thank you for your time!

Appendix D

Introductory Package to Subjects Containing:

1) Introductory Letter.
2) Consent form for fitness assessment.
3) Consent form to take part in the study.

Dear :

Thank you for agreeing to participate in this study designed to help you with the pain associated with your migraine headaches. The contents of this package should help you prepare the initial assessment and plan for the upcoming education and physical activity sessions.

I have included a copy of the consent forms that you will be asked to sign. It briefly describes the study and some of the measurements that will be conducted. Please read it prior to your fitness assessment. Come prepared to ask us any questions or concerns about the study that you may have.

At this appointment, you will receive instructions on how to utilize the daily headache diary including the Visual Analogue Scale (VAS). You will also have a submaximal fitness test performed to analyze your current level of fitness. It is necessary that you bring a t-shirt and shorts or sweatpants and runners so you will be comfortably dressed for the fitness test. You should expect to spend $1\ ^1/_2$ - 2 hours at the assessment.

Prior to coming to your appointment, it is necessary that you complete the following tasks:

- fill-out the fitness test consent form.
- fill out the study consent form.

Prior to coming to this initial assessment/appointment, you should ensure that you have not had a migraine attack within 48 hours of your appointment. If you have had an migraine attack, could you please phone to re-schedule your appointment.

I look forward to meeting you and starting the sessions. Thanks again for your willingness to participate.

Sincerely,

Mark Lafave

University of Manitoba, Faculty of Physical Education and Recreation Studies.
The Efficacy of Aerobic Exercise in Preventing Migraine Headaches.

Consent form:

I, the undersigned, do hereby acknowledge:

- my consent to perform a fitness test consisting of 3 possible stages of a 12 minute bicycle test to analyze my current level of fitness.

- my understanding that the heart rate and blood pressure will be measured prior to and at the completion of the test.

- my consent to the tests conducted by an appraiser who has been trained to administer the test in his/her undergraduate degree.

- my understanding that the interpretation of the results can not be provided until the end of the experiment because the result may bias me in some way so as to affect the results.

- my understanding that there are potential risks; i.e.; episodes of transient lightheadedness, fainting, abnormal blood pressure, chest discomfort, leg cramps and nausea, and that *I willfully assume those risks.*

- my obligation to immediately inform the appraiser of any pain, discomfort, fatigue or any other symptoms that I *may suffer* during and immediately after the testing.

- my understanding that I may stop or delay any further testing if I so desire and that the testing may be terminated by the appraiser upon observation of any symptoms of distress or abnormal response.

- my understanding that I may ask any questions or request further explanation or information about the procedures at any time before, during and after the testing.

- that I have had a Medical Examination and the Physician has cleared me for testing and exercise safely.

"that I hereby release the University of Manitoba, it's agents, officers and employees from any liability with respect to any damage or injury (including death) that I may suffer during the administration of the Fitness test except where the damage or injury is caused by the negligence of the University of Manitoba or it's agents, officers and employees acting within the scope of their duties.

_____ _____

signature date

_____ _____

witness date

THE EFFICACY OF AN AEROBIC EXERCISE PROGRAM ON THE PREVENTION OF MIGRAINE HEADACHES

Description of Study

The proposed study will deliver a basic aerobic exercise program to people afflicted with common and classical migraine headache.

Each person will take part in either the eight week baseline measurement of pain (according to the VAS), headache frequency and quantity of medication or some subjects will begin on the exercise program immediately for a total of eight weeks. When subjects complete their baseline measurement of pain during the first eight weeks of the study, they will then be placed on the exercise program for another eight weeks. Subjects who began on the exercise program for the initial eight weeks of the study will be asked to either continue with the exercise program if they found benefit, or go back to their lifestyle they had before the study. Those subjects in the latter category might also be asked to fill out a follow-up survey at a later date, not as yet determined.

Before each of the subjects get started on the exercise program, there will be an initial meeting to go over your responsibilities as a participant in this study. There will be a short (about 45 minutes to 1 hour) class instructed by Mark Lafave explaining what is requested of each person. As well, Mark will cover basic exercise principles, stretches and proper monitoring of exercise intensity via heart rate. Once you have been instructed and taken through one exercise session as a group, you will be required to exercise three times per week on your own. That does not mean that the research team is not available to you, just that we would like to each of you somewhat autonomous. If you have any questions or problems, there will be various options for you. The most convenient would be Mark Lafave who is at the exercise facility a great deal and can be reached at or at home at The other options are Dr. B.A. Anderson at or At the end of the week 16 of the study, you will be requested to complete a general impression of the study.

Measurements

Fitness Level (MVO2)

Your fitness level will be assessed at three points during the study. Fitness level will be assessed using a submaximal stationary bike test where we use you heart rate and workload intensity to determine your maximal uptake of oxygen (i.e.; fitness level). The first test will take place during week one of the study. The second test will take place during week eight of the study and finally, the final assessment of fitness level will take place at week sixteen of the study.

Pain Level, Headache Frequency and Quantity of Medication

These measurements will take place daily on collection sheets which are provided. You will receive a data collection booklet which will have instructions to use these daily data collection sheets as well as ample supplies of the daily data collection sheets.

Medical Assessment and Headache Questionaire

To ensure that everyone interested in the study meets the stringent criteria for subjects, the medical assessment and headache questionaire was designed. This will simply assist the research team in determining your eligibilty for the study. It covers material associated with headaches as well as physical parameters which could limit you in the study.

Post-Study Questionaire

Since we can not control all factors that might affect your headaches, we have designed a questionaire which gives you the opportunity to explain your general health (physical and mental) as well as what might have affected them. As well, this questionaire will give you the opportunity to comment on the over-all effectiveness of the study.

Follow-Up Questionaire

This is not a formal part of the study, but the researcher would like the opportunity to follow up each of the subjects who participated in the study at some point in the future. This might take place as an informal questionaire asking if the study had changed you personal exercise habits and if that has helped you migraine headaches.

University of Manitoba, Faculty of Physical Education and Recreation Studies

CONSENT FORM

THE EFFICACY OF AN AEROBIC EXERCISE PROGRAM ON THE PREVENTION OF MIGRAINE HEADACHES

I have read the description of the study, understood the measurement procedures involved and consent to participate in the study.

I also understand that my participation in this study is voluntary and that I may withdraw from it at any time without prejudice.

All information will be kept confidential.

****

I understand that the research team will be made aware of any data collected during my migraine process, exercise behaviors as well as my assessment results.

I understand that participation in this research study, is done at my own risk and I hereby release the University of Manitoba, their agents, officers and employees from any liability, with respect to damage or injury (including death) that I may suffer during my participation in this research study.

_____ _____

Date Participant

_____

Witness

Appendix E

Instructions for the data collection sheet and sample data collection sheet.

Instructions for using the data collection sheet

During the first eight weeks of this experiment, we would like to collect some information concerning your headache pain, headache frequency, quantity of medication and your exercise habits. Information will be collected on a daily basis. You should use one data collection sheet per day. Your name and date has to be placed at the top of every page.

To use the visual analogue scale, just stroke a vertical line at any point on the horizontal line between the terms "no pain" and "pain as bad as it could be." This measurement should be taken at or about the four times specified under the time column. For example, you may wake up with no headache pain and thus you would stroke a vertical line on or around the "no pain" side of the scale.

Under the "headache" section is some information we need when you get a headache. Just say whether or not you have had a headache during that day, this time of the day the symptoms began, the time of the day the symptoms dissipated (i.e.; pain), the type of medication taken (if any), the quantity of medication taken or any other form of treatment which you used for your headache.

Finally, under the "Exercise" section, we would just like to gather some information as to your exercise habits. If you do not exercise this day, just leave this section blank. If you do exercise this day, put down what you did for exercise (i.e.; type), your heart rate if you can take it and the time you exercised.

Daily Data Collection Sheets

Name_____Date_____

Time	Visual Analogue Scale	
Breakfast	No Pain |----------	| Pain as bad as it could be
Lunch	No Pain |----------	| Pain as bad as it could be
Dinner	No Pain |----------	| Pain as bad as it could be
Bedtime	No Pain |----------	| Pain as bad as it could be

****

Headache:

Yes/No:_____Symptom Onset (time):_____

Medication (type):_____Symptom Relief (time):_____

Medication (quantity):_____Treatment:_____

Exercise:

Type:_____Heart Rate:_____

Time (length):_____

Personal Comments:

Appendix F

Sample stretches for the exercise program with instructions for each.

Figure D-1a:
Calf Stretches
Keeping upper body upright from the hips, (no bending or hunching over), support weight and balance yourself by placing hands on wall,m chair, etc. With both feet pointing forward, take a step back so that a stretch can be felt in the calf, when the entire foot is touching the floork, and the leg is straight.

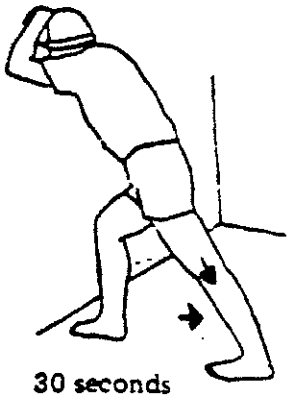


Figure D-1b:
This second exercise must also be done with the above, as they stretch different muscles. It is performed as above with the exception that the back leg is bent.

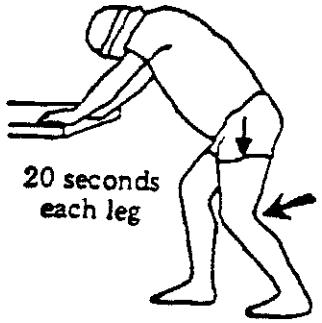


Figure D-2a:
Quadriceps Stretch
Keeping upper body straight, balance yourself by putting one hadn against a wall. Lift one foot behind body, and grasp the ankle with the opposite hand. The leg is then pulled back so that the knee is flexed and the hip is hyperextended. Therefore the leg must be pulled away from the body.

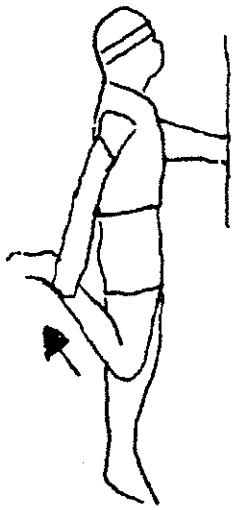


Figure D-3a:
Hamstring Stretches
Modified Hurdler's stretch:
In a sitting position, bend the right knee so that the right foot is beside the left thigh. Keeping the left leg straight, reach with both hands for the left foot, bending at the hips. Repeat on the other leg. Note: You do not have to grab the foot, only reach to stretch the muscle.

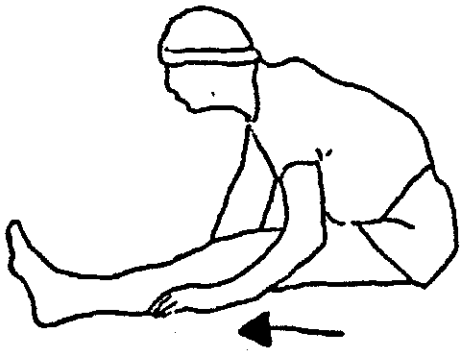


Figure D-3b:
Supine Hamstring Stretch:
Lying on your back, with your head resting on the floor, bend one knee to 45 degrees. The other leg is lifted straight and slowly pulled in towards the chest by the arms.

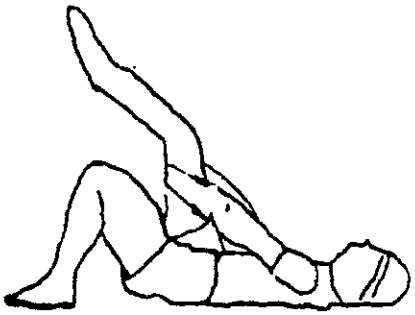
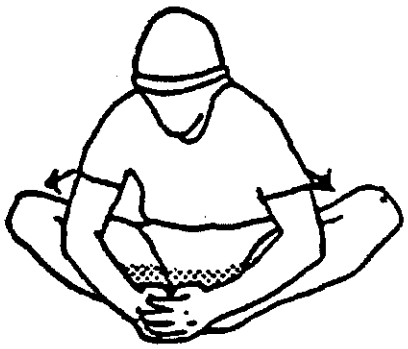


Figure D-5:
Groin Stretch (adductors):
Sit on the floor, with the soles of your feet together. Grasp the feet and toes with your hands and apply pressure to the inside of your legs with your elbows.



Appendix G

Guidelines for Exercise Sessions

Guidelines for Exercise Sessions

1. Start out with a brisk walk for five (5) minutes.

2. Perform stretches provided in your data collection booklet.

3. Begin jogging exercise at a comfortable, yet active pace to increase your heart rate to your heart rate training zone.

   220 - Age = Maximum Heart Rate (beats per minute)
   60 - 90 % of Maximum Heart Rate = Heart Rate Training Zone (bpm)

4. At the ten (10) minute mark of exercise, you should walk briskly and take a ten second heart rate count to ensure you are within the heart rate training zone (Note: remember to convert to beats per minute by multiplying by 6).

5. Step 4 above will tell you whether you need to increase your intensity for the last ten minutes of exercise. It will also tell you not to exceed the heart rate training zone.

6. As a cool down after the twenty minutes of exercise, you should walk at a comfortable face for 2 -3 laps (Note: this should be significantly slower than the warm up walk was).

7. You should finish with each of the stretches done previously.

8. The entire exercise session should not take much more than 1 hour.

Appendix H

Post Experimental Survey for extraneous variable and general impression.

Name_____
Date_____

The following questions will help me, as a researcher, to understand the factors which affect your migraines. Exercise is not the lone determinant of your migraines, so we would like to explore alternative channels.

Have you felt ill since you started the program?

no
If yes, continue;

What type of illness did you have?

For how long?

Have you had any unusual circumstances in your life that caused you to be extremely tense? no
If yes, continue;

Why were you tense?

For how long?

Have you noticed any changes in your:

1) Diet (explain) _____

2) Home Life (better or worse==>explain)_____

3) Medication (i.e.; changed types)_____

If you had to summarize the effectiveness of this exercise program in reducing your pain, which one of the following would best characterize it:

1. It made me condition worse.
2. It did not help at all.
3. I did not notice.
4. It helped somewhat
5. It helped a great deal.

AppendixI

Fitness assessment protocol.

The following procedure is taken directly from Astrand's (1960) manual:

> Energetic bodily activity should not be engaged in during the hours preceding the work test, nor should the test be performed earlier than about an hour after a light meal, or after a longer time if a heavier meal has been taken.
>
> Experience shows that the basal resting heart rate does not normally give any information over and above that provided by the work test. The available time will thus have to help the operator to decide whether the test is preceded by rest in a reclining or sitting position.
>
> Adjust the saddle and handle bar to suit the subject. Studies have shown that mechanical efficiency, (expenditure of energy), does not vary with the height of the handle bar and saddle, provided that this is kept within reasonable limits. The most comfortable position, and in the case of very heavy work the most effective one, is the saddle height that, when the subject has the front part of his foot on the pedal, gives a slight bend of the knee joint in the lower position (i.e.; with the front part of the knee straight above the tip of the foot).
>
> Provided that the work is not too heavy, respiration and circulation increase during the first few minutes and then attain a steady state. The increase in heart rate can be established by counting the heart rate once every minute. After 4-5 minutes the heart rate has generally reached the steady state. (In order to work the muscle need oxygen and nutritive substances, carbon dioxide and waste products have to be removed. This transport exerts a load on respiration and circulation.) As a rule, about 6 minutes is thus sufficient to adapt the heart rate to the task being performed. The heart rate should be counted or recorded every minute, the mean value of the heart rate at the 5th and 6th minutes being designated the working pulse for the load in question. If the difference between these last two heart rates exceeds 5 beats per minute, the working time should be prolonged one or more minutes until a constant level is reached. The pulse rate is most easily felt over the carotid artery just below the mandible angle, (do not press too hard) or on the chest over the heart, and the most exact value is obtained by taking the time for 30 pulse beats (start a stop watch showing tenths of a second a the "0" pulse beat). Using Table B-1, the time recorded for 30 beats can be converted into the heart rate per minute.

Figure B-1: Conversion of the time for 30 pulse beats to pulse rate per minute

Seconds	Beats/min.	Seconds	Beats/min.
22.0	82	15.0	120
21.9	82	14.9	121
21.8	83	14.8	122
21.7	83	14.7	122
21.6	83	14.6	123
21.5	84	14.5	124
21.4	84	14.4	125
21.3	85	14.3	126
21.1	85	14.2	127
20.9	86	14.1	128
20.8	87	14.0	129
20.7	87	13.9	129
20.6	87	13.8	130
20.5	88	13.7	131
20.4	88	13.6	132
20.3	89	13.5	133
20.2	89	13.4	134
20.1	90	13.3	135
20.0	90	13.2	136
19.9	90	13.1	137
19.8	91	13.0	138
19.7	91	12.9	140
19.6	92	12.8	141
19.5	92	12.7	142
19.4	93	12.6	143
19.3	93	12.5	144
19.2	94	12.4	145
19.1	94	12.3	146
19.0	95	12.2	148
18.9	95	12.1	149
18.8	96	12.0	150
18.7	96	11.9	151
18.6	97	11.8	153
18.5	97	11.7	154
18.4	98	11.6	155
18.3	98	11.5	157
18.2	99	11.4	158
18.1	99	11.3	159
18.0	100	11.2	161
17.9	101	11.1	162
17.8	101	11.0	164
17.7	102	10.9	165
17.6	102	10.8	167
17.5	103	10.7	168
17.4	103	10.6	170
17.3	104	10.5	171
17.2	105	10.4	173
17.1	105	10.3	175
17.0	106	10.2	176

16.9	107	10.1	178
16.8	107	10.0	180
16.7	108	9.9	182
16.6	108	9.8	184
16.5	109	9.7	186
16.4	110	9.6	188
16.3	110	9.5	189
16.2	111	9.4	191
16.1	112	9.3	194
16.0	113	9.2	196
15.9	113	9.1	198
15.8	114	9.0	200
15.7	115	8.9	202
15.6	115	8.8	205
15.5	116	8.7	207
15.4	117	8.6	209
15.3	118	8.5	212
15.2	118	8.4	214
15.1	119	8.3	217
		8.2	220
		8.1	222
		8.0	225

Example: if it takes 12.4 seconds for the heart to beat 30 times the heart rate is 145 beats per minute.

N.B.: For the inexperienced it is rather difficult to count the pulse rate: the metronome is distracting, the subject is in motion, and the pulse may be of variable intensity. Training unexperienced leadership is important.

The pulse rate may be measured preferably during the last 15-20 seconds of every working minute.

Choice of Load: For trained, active sports men, the risk of strain in connection with a work test is very slight. For female subjects a suitable load is 600 kpm/min. (2kp and 50 pedal turns), for male subjects, 900 kpm/min., (3kp). If the heart rate exceeds about 130 beats per minute the load can be considered adequate and the test can be discontinued after 6 minutes. If the heart rate is slower than about 130 beats per minute, the load should be increased after 6 minutes by 300 kpm/min. (to 3kp and 4 kp braking power respectively). If time permits testing at several loads, increase by 300kpm/min. in 6 minute periods for as long as the heart rate remains below about 150 beats per minute (time for 30 heart beats = 12.0 seconds). The next working period may be continued for 6 minutes, even if the heart rate then exceeds 150 beats per minute.

For persons expected to have a lower physical work capacity, for instance completely untrained, older individuals, or

delicate persons, smaller loads should be chosen, and an initial intensity of 300 kpm/min. will be suitable.

If a physician is not present, work test on persons over 40 years of age should be discontinued if the heart rate exceeds 150 beats per minute (time for 30 pulse beats = 12.0 seconds), and the load should not be raised above 600 kpm/min. for female subjects or 900 kpm/min. for male subjects, (2 kp and 3 kp respectively).

If the subject experiences pressure or pain in the chest, pain radiating into the left arm and/or jaw, or insistent stitch or troublesome shortness or breath, the test must be discontinued.

The test must not be run as a contest to manage the heaviest load. A load giving a heart rate of 130-140 beats per minute is sufficient to test the circulatory function when it is intended to compare with results from repeated tests on later occasions.

The volumes of oxygen required to cover the energy demand during exercise with different work are presented in Table B-2.

Table B-2: Oxygen uptake during steady state of various work loads for subjects with a normal mechanical efficiency.

Work Load		Oxygen uptake liters/min
watt	kpm/min.	
50	300	0.9
100	600	1.5
150	900	2.1
200	1200	2.8
250	1500	3.5
300	1800	4.2
350	2100	5.0
400	2400	5.7

Significance of Oxygen Transport Capacity

For every liter of oxygen consumed in combustion 4.7 -5.05 kilogram calories are liberated. Measurement of the oxygen uptake during work thus estimates the amount of aerobic energy transfer. The greater the maximal oxygen transport (maximal aerobic power), the greater the potential energy output. A high oxygen transport capacity also implies that a given energy output

can be accomplished with relatively less physiological strain. A task involving more continuous work, for example, ought not to load the oxygen transport organs to more then 50% of their capacity.

From Tables 3 and 4, (according to the tables provided by Astrand, 1960, pg. 45-60) (for males and females respectively), the maximal oxygen uptake can actually be derived from the heart rate at a given load. Example: a male subject working at 900kpm/min has a heart rate of 147. His maximal oxygen uptake, according to Table 3, is 3.2 l/min. Oxygen uptake per kilogram body weight is given in Table 5(according to the tables provided by Astrand, 1960, pg. 45-60). A body weight of 74 kg = 45 ml/kg X min. If more than one load has been used, the maximal oxygen uptake is estimated as the mean of the values calculated for each work load. The Tables are based on a maximal heart rate of 195.

The following protocol has been adopted from Target Fitness at the University of Manitoba (this protocol adheres to the Canadian Standardized test of Fitness):

Preliminary Considerations and Observations

Preliminary Instructions and Screening

The participant should not have smoked or consumed food or caffeine beverages for at least two hours before taking the appraisal. The participant should also refrain from exercising or drinking alcoholic beverages for six hours prior to the appraisal. The appraiser should check that these condition have been adhered to , and if they have not, should postpone the test

Medical screening questionnaire, and medical release if required, must be completed, and the informed consent must be read, understood, and duly signed prior to the administration of the test.

Observations

In order to further determine the readiness of an individual to participate in the fitness appraisal, the appraiser should also not the following observations. The appraisal should be cancelled or postponed if the participant:

-demonstrates difficulty breathing at rest;
-coughs persistently;
-has lower extremity swelling;
-is currently on medication;
-has clearly ignored the preliminary instructions (e.g.; has just eaten a heavy meal, has alcohol on breath, etc...)
-for any other reason, not mentioned here, which the appraiser believes will predispose the participant to unnecessary discomfort.

Emergency

Emergency number - 555

If the rests are properly administered, the chance of an injury related incident occurring during the testing is unlikely. The most common incident is likely to be a dizzy spell or fainting. If this occurs, immediately lie the participant down in a supine position and elevate legs. Following recovery, the participant should remain lying on the floor with the legs elevated until the blood pressure returns to the pre-exercise level. If the participant does not recover within one minute, the appraiser should immediately request emergency assistance. This should be done by alerting the staff at the equipment desk. They will dial 555 which is the Campus Police. The Campus Police will call and direct the ambulance to the building and the equipment desk staff will assure easy access to your location.

In the even of a more serious occurrence, such as a cardiac arrest, the appraiser provides immediate emergency treatment such as CPR, and requests emergency services in the same manner as previously stated. In the event that the equipment desk is closed or the staff is unaviabable, you can call 9341 from any university phone or 911 from any pay phone (money is not required).

If a soft tissue injury (strain or sprain) occurs, the participant should be attended to t at the Athletic Therapy Clinic. Designate one individual to get the staff from the equipment desk to help the participant to the clinic. If the clinic is not open the equipment desk staff will handle the treatment of the participant.

If feasible, an injured or ill participant's physician should be advised. An incident report should be completed after any and all injuries no matter how minor. Forms are available in the Target Fitness Office, Room 124 and in Room 129. They should be completed immediately following the incident.

12 Minute Bicycle Test

Equipment: Bicycle ergometer, metronome, stethoscope, stop watch.

1. Record estimated maximum heart rate and 85% maximum heart rate.

2. Set tension scale at zero.

3. Adjust seat for subject (knee nearly extended in down pedal position).

4. Set metronome at 100 (representing 50 revolutions per minute).

5. Explain test procedure to subject and determine initial workload from subject's recent exercise habits. Instruct subject to begin pedalling to establish cadence before tension is applied.

6. Record heart rate during the last 15 second period for each minute.

7. Workloads - The purpose is to finish with a heart rate at or below 85% of the maximum heart rate. It is permissible to have a low heart rate (100-120 beats/min) during the first stage, but the 2nd and 3rd stage heart rates should increase above 120 bpm with terminating heart rate near 85% of age predicted maximum.

Expected Heart Rate:

Exercise Stage	Minutes of Exercise	Heart Rate
1	4th	115-130
2	8th	130-145
3	12th	145-85% max. HR

Suggested Workloads:

	Male			Female		
Stage	1	2	3	1	2	3
Inactive	1.5	2.5	3.0	1.0	1.5	2.0
Athlete	2.5	3.0	4.0	1.5	2.5	3.0

These are guidelines only. Heart rate in the 3rd and 7th minute must be assessed and workloads adjusted accordingly.

8. Workload changes should be done immediately after the measurements of minutes 4 and 8 (i.e.; before even looking up the heart rate otherwise a lot of time is lost in the next minute where the WL is not increased.

9. The workload must be increased with each stage. Where heart rate is close to target heart rate at any early stage, increase by 1/4 kp only.

10. If the third steady state is not reached between minute 11 and 12, extend the test for 1 to 3 minutes to achieve the steady state (difference between two consecutive minutes is equal to or less than 4 bpm). Consider the test invalid if the heart rate is still climbing after minute 15.

Appendix J

Statistical Analysis of the Dependent Variables Headache Pain and Fitness Levels.

General Linear Models Procedure

Dependent Variable: HAFRQ

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	37	351.8593750	9.5097128	4.92	0.0001
Error	154	297.4687500	1.9316153		
Corrected	191	649.3281250			

R-Square	C.V.	Root MSE	HAFRQ Mean
0.541882	63.99197	1.389826	2.17187500

Source	DF	Type III SS	Mean Square	F Value	Pr > F
EXER	1	1.1718750	1.1718750	0.61	0.4372
TIME	11	18.5156250	1.6832386	0.87	0.5697
EXER*TIME	11	15.2656250	1.3877841	0.72	0.7196
SUBID(EXER)	14	316.9062500	22.6361607	11.72	0.0001

Dependent Variable: BPAIN

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	37	44.86227760	1.21249399	6.33	0.0001
Error	154	29.51290938	0.19164227		
Corrected	191	74.37518698			

R-Square	C.V.	Root MSE	BPAIN Mean
0.603189	94.19676	0.437770	0.46473958

Source	DF	Type III SS	Mean Square	F Value	Pr > F
EXER	1	1.65949219	1.65949219	8.66	0.0038
TIME	11	4.11295573	0.37390507	1.95	0.0370
EXER*TIME	11	1.64712656	0.14973878	0.78	0.6583
SUBID(EXER)	14	37.44270312	2.67447879	13.96	0.0001

Dependent Variable: LPAIN

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	37	50.30957917	1.35971836	5.10	0.0001
Error	154	41.02636875	0.26640499		
Corrected	191	91.33594792			

R-Square	C.V.	Root MSE	LPAIN Mean
0.550819	91.43727	0.516144	0.56447917

Source	DF	Type III SS	Mean Square	F Value	Pr > F
EXER	1	2.11680000	2.11680000	7.95	0.0055
TIME	11	2.93183542	0.26653049	1.00	0.4486
EXER*TIME	11	2.24466250	0.20406023	0.77	0.6734
SUBID(EXER)	14	43.01628125	3.07259152	11.53	0.0001

Dependent Variable: DPAIN

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	37	82.61077760	2.23272372	7.74	0.0001
Error	154	44.40857187	0.28836735		
Corrected	191	127.01934948			

R-Square	C.V.	Root MSE	DPAIN Mean
0.650379	87.90494	0.536998	0.61088542

Source	DF	Type III SS	Mean Square	F Value	Pr > F
EXER	1	6.95782552	6.95782552	24.13	0.0001
TIME	11	4.43058073	0.40278007	1.40	0.1795
EXER*TIME	11	2.96735573	0.26975961	0.94	0.5082
SUBID(EXER)	14	68.25501563	4.87535826	16.91	0.0001

Dependent Variable: SPAIN

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	37	78.97518177	2.13446437	7.48	0.0001
Error	154	43.94494271	0.28535677		
Corrected Total	191	122.92012448			

R-Square	C.V.	Root MSE	SPAIN Mean
0.642492	92.55851	0.534188	0.57713542

Source	DF	Type III SS	Mean Square	F Value	Pr > F
EXER	1	4.18605469	4.18605469	14.67	0.0002
TIME	11	3.31798073	0.30163461	1.06	0.3998
EXER*TIME	11	4.18615156	0.38055923	1.33	0.2108
SUBID(EXER)	14	67.28499479	4.80607106	16.84	0.0001

General Linear Models Procedure

Dependent Variable: HAFRQ

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	30	216.8961253	7.2298708	2.50	0.0001
Error	160	462.9363354	2.8933521		
Corrected	190	679.8324607			

R-Square	C.V.	Root MSE	HAFRQ Mean
0.319043	77.53896	1.700986	2.19371728

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SUBID	7	185.2779503	26.4682786	9.15	0.0001
EXER	1	0.4362212	0.4362212	0.15	0.6983
TIME	11	20.6843041	1.8803913	0.65	0.7836
EXER*TIME	11	12.1241055	1.1021914	0.38	0.9620

Dependent Variable: BPAIN

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	30	19.20911938	0.64030398	3.93	0.0001
Error	160	26.07379161	0.16296120		
Corrected	190	45.28291099			

R-Square	C.V.	Root MSE	BPAIN Mean
0.424202	109.3980	0.403685	0.36900524

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SUBID	7	16.99428160	2.42775451	14.90	0.0001
EXER	1	0.00042181	0.00042181	0.00	0.9595
TIME	11	0.69463847	0.06314895	0.39	0.9595
EXER*TIME	11	1.51836391	0.13803308	0.85	0.5935

Dependent Variable: LPAIN

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	30	17.61810306	0.58727010	3.58	0.0001
Error	160	26.21917024	0.16386981		
Corrected	190	43.83727330			

R-Square	C.V.	Root MSE	LPAIN Mean
0.401898	98.05758	0.404808	0.41282723

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SUBID	7	14.53665476	2.07666497	12.67	0.0001
EXER	1	0.39152801	0.39152801	2.39	0.1241
TIME	11	1.77243122	0.16113011	0.98	0.4638
EXER*TIME	11	0.91132366	0.08284761	0.51	0.8975

Dependent Variable: DPAIN

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	30	19.26957591	0.64231920	4.45	0.0001
Error	160	23.07122200	0.14419514		
Corrected	190	42.34079791			

R-Square	C.V.	Root MSE	DPAIN Mean
0.455107	99.90151	0.379730	0.38010471

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SUBID	7	16.03797086	2.29113869	15.89	0.0001
EXER	1	0.30593613	0.30593613	2.12	0.1472
TIME	11	0.67896545	0.06172413	0.43	0.9418
EXER*TIME	11	2.27778348	0.20707123	1.44	0.1615

Dependent Variable: SPAIN

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	30	21.46103378	0.71536779	4.02	0.0001
Error	160	28.44695575	0.17779347		
Corrected	190	49.90798953			

R-Square	C.V.	Root MSE	SPAIN Mean
0.430012	111.3917	0.421656	0.37853403

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SUBID	7	16.17917997	2.31131142	13.00	0.0001
EXER	1	0.47481740	0.47481740	2.67	0.1042
TIME	11	2.31989135	0.21089921	1.19	0.3005
EXER*TIME	11	2.43411751	0.22128341	1.24	0.2619

Paired t-test Comparison of Group 1's First Fitness Test and the Third Fitness Test

DF	Mean X -Y	Paired t-value	Prob. (2 tail)
7	-5.875	-2.833	.0253*

*indicates significant at the .05 level.

Paired t-test Comparison of Group 1's Second Fitness Test and the Third Fitness Test

DF	Mean X -Y	Paired t-value	Prob. (2 tail)
7	-4	-1.965	.0901

Paired t-test Comparison of Group 2's First Fitness Test and the Second Fitness Test

DF	Mean X -Y	Paired t-value	Prob. (2 tail)
7	-5.875	-2.833	.0253*