THE UNIVERSITY OF MANITOBA

THE EFFECTS OF EXERCISE INTERVENTION ON SYMPTOMS AND PERCEIVED STRESS LEVELS OF PATIENTS WITH CROHN'S DISEASE

By

Colleen P. Loudon

Submitted to

the Faculty of Graduate Studies

In Partial fulfillment of the

Requirements for the Degree

MASTER OF SCIENCE

Faculty of Physical Education and

Recreation Studies

December, 1996

ISBN 0-612-16198-6

Name Colleen Loudon

Dissertation Abstracts International and *Masters Abstracts International* are arranged by broad, general subject categories. Please select the one subject which most nearly describes the content of your dissertation or thesis. Enter the corresponding four-digit code in the spaces provided.

SUBJECT TERM Exercise Physiology (Health Sciences) 0566 UMI

SUBJECT CODE

Subject Categories

THE HUMANITIES AND SOCIAL SCIENCES

COMMUNICATIONS AND THE ARTS
Architecture 0729
Art History 0377
Cinema 0900
Dance 0378
Design and Decorative Arts 0389
Fine Arts 0357
Information Science 0723
Journalism 0391
Landscape Architecture 0390
Library Science 0399
Mass Communications 0708
Music 0413
Speech Communication 0459
Theater 0465

EDUCATION
General 0515
Administration 0514
Adult and Continuing 0516
Agricultural 0517
Art 0273
Bilingual and Multicultural 0282
Business 0688
Community College 0275
Curriculum and Instruction 0727
Early Childhood 0518
Elementary 0524
Educational Psychology 0525
Finance 0277
Guidance and Counseling 0519
Health 0680
Higher 0745
History of 0520
Home Economics 0278
Industrial 0521
Language and Literature 0279
Mathematics 0280
Music 0522
Philosophy of 0998
Physical 0523
Reading 0535
Religious 0527
Sciences 0714
Secondary 0533
Social Sciences 0534
Sociology of 0340
Special 0529
Teacher Training 0530
Technology 0710
Tests and Measurements 0288
Vocational 0747

LANGUAGE, LITERATURE AND LINGUISTICS
Language
- General 0679
- Ancient 0289
- Linguistics 0290
- Modern 0291
- Rhetoric and Composition 0681

Literature
- General 0401
- Classical 0294
- Comparative 0295
- Medieval 0297
- Modern 0298
- African 0316
- American 0591
- Asian 0305
- Canadian (English) 0352
- Canadian (French) 0355
- Caribbean 0360
- English 0593
- Germanic 0311
- Latin American 0312
- Middle Eastern 0315
- Romance 0313
- Slavic and East European 0314

PHILOSOPHY, RELIGION AND THEOLOGY
Philosophy 0422
Religion
- General 0318
- Biblical Studies 0321
- Clergy 0319
- History of 0320
- Philosophy of 0322

Theology 0469

SOCIAL SCIENCES
American Studies 0323
Anthropology
- Archaeology 0324
- Cultural 0326
- Physical 0327

Business Administration
- General 0310
- Accounting 0272
- Banking 0770
- Management 0454
- Marketing 0338

Canadian Studies 0385
Economics
- General 0501
- Agricultural 0503
- Commerce-Business 0505
- Finance 0508
- History 0509
- Labor 0510
- Theory 0511

Folklore 0358
Geography 0366
Gerontology 0351
History
- General 0578
- Ancient 0579
- Medieval 0581
- Modern 0582
- Church 0330
- Black 0328
- African 0331
- Asia, Australia and Oceania 0332
- Canadian 0334
- European 0335
- Latin American 0336
- Middle Eastern 0333
- United States 0337

History of Science 0585
Law 0398
Political Science
- General 0615
- International Law and Relations 0616
- Public Administration 0617

Recreation 0814
Social Work 0452
Sociology
- General 0626
- Criminology and Penology 0627
- Demography 0938
- Ethnic and Racial Studies 0631
- Individual and Family Studies 0628
- Industrial and Labor Relations 0629
- Public and Social Welfare 0630
- Social Structure and Development 0700
- Theory and Methods 0344

Transportation 0709
Urban and Regional Planning 0999
Women's Studies 0453

THE SCIENCES AND ENGINEERING

BIOLOGICAL SCIENCES
Agriculture
- General 0473
- Agronomy 0285
- Animal Culture and Nutrition 0475
- Animal Pathology 0476
- Fisheries and Aquaculture 0792
- Food Science and Technology 0359
- Forestry and Wildlife 0478
- Plant Culture 0479
- Plant Pathology 0480
- Range Management 0777
- Soil Science 0481
- Wood Technology 0746

Biology
- General 0306
- Anatomy 0287
- Animal Physiology 0433
- Biostatistics 0308
- Botany 0309
- Cell 0379
- Ecology 0329
- Entomology 0353
- Genetics 0369
- Limnology 0793
- Microbiology 0410
- Molecular 0307
- Neuroscience 0317
- Oceanography 0416
- Plant Physiology 0817
- Veterinary Science 0778
- Zoology 0472

Biophysics
- General 0786
- Medical 0760

EARTH SCIENCES
Biogeochemistry 0425
Geochemistry 0996
Geodesy 0370
Geology 0372
Geophysics 0373
Hydrology 0388
Mineralogy 0411
Paleobotany 0345
Paleoecology 0426
Paleontology 0418
Paleozoology 0985
Palynology 0427
Physical Geography 0368
Physical Oceanography 0415

HEALTH AND ENVIRONMENTAL SCIENCES
Environmental Sciences 0768
Health Sciences
- General 0566
- Audiology 0300
- Dentistry 0567
- Education 0350
- Administration, Health Care 0769
- Human Development 0758
- Immunology 0982
- Medicine and Surgery 0564
- Mental Health 0347
- Nursing 0569
- Nutrition 0570
- Obstetrics and Gynecology 0380
- Occupational Health and Safety 0354
- Oncology 0992
- Ophthalmology 0381
- Pathology 0571
- Pharmacology 0419
- Pharmacy 0572
- Public Health 0573
- Radiology 0574
- Recreation 0575
- Rehabilitaion and Therapy 0382
- Speech Pathology 0460
- Toxicology 0383

Home Economics 0386

PHYSICAL SCIENCES
Pure Sciences
Chemistry
- General 0485
- Agricultural 0749
- Analytical 0486
- Biochemistry 0487
- Inorganic 0488
- Nuclear 0738
- Organic 0490
- Pharmaceutical 0491
- Physical 0494
- Polymer 0495
- Radiation 0754

Mathematics 0405
Physics
- General 0605
- Acoustics 0986
- Astronomy and Astrophysics 0606
- Atmospheric Science 0608
- Atomic 0748
- Condensed Matter 0611
- Electricity and Magnetism 0607
- Elementary Particles and High Energy 0798
- Fluid and Plasma 0759
- Molecular 0609
- Nuclear 0610
- Optics 0752
- Radiation 0756

Statistics 0463

Applied Sciences
Applied Mechanics 0346
Computer Science 0984
Engineering
- General 0537
- Aerospace 0538
- Agricultural 0539
- Automotive 0540
- Biomedical 0541
- Chemical 0542
- Civil 0543
- Electronics and Electrical 0544
- Environmental 0775
- Industrial 0546
- Marine and Ocean 0547
- Materials Science 0794
- Mechanical 0548
- Metallurgy 0743
- Mining 0551
- Nuclear 0552
- Packaging 0549
- Petroleum 0765
- Sanitary and Municipal 0554
- System Science 0790

Geotechnology 0428
Operations Research 0796
Plastics Technology 0795
Textile Technology 0994

PSYCHOLOGY
General 0621
Behavioral 0384
Clinical 0622
Cognitive 0633
Developmental 0620
Experimental 0623
Industrial 0624
Personality 0625
Physiological 0989
Psychobiology 0349
Psychometrics 0632
Social 0451

THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

*****

COPYRIGHT PERMISSION PAGE

THE EFFECTS OF EXERCISE INTERVENTION ON SYMPTOMS AND PERCEIVED STRESS LEVELS OF PATIENTS WITH CROHN'S DISEASE

BY

COLLEEN P. LOUDON

A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of Manitoba in partial fulfillment of the requirements of the degree

of

MASTER OF SCIENCE

TABLE OF CONTENTS

Page

Appendices

ABSTRACT

Despite the well documented benefits of exercise training in the prevention and management of chronic disease, guidelines for exercise prescription for patients with Crohn's disease appear to be almost nonexistent. Crohn's disease is a chronic inflammatory disease of the gastrointestinal tract whose clinical course may be highly influenced by life stress. Current research suggests that moderate exercise may be beneficial for persons afflicted with chronic immunodeficient or inflammatory disorders given the positive effects of exercise on immune system functioning. Exercise training may also be beneficial as a stress management technique capable of reducing the impact of unmanageable stressful life events on psychologic and physiologic health of these individuals.

The purpose of this study was to determine the effects of a 12-week mild walking program on symptoms and perceived stress levels of patients with Crohn's disease. Disease activity and stress levels were quantified by documentation of symptoms and life stress at baseline and following the 12-week program. The Canadian Aerobic Fitness Test (CAFT) and body mass index (BMI) were administered pre- and post-intervention. The walking program consisted of three progressive sessions per week of structured walking, 20-35 minutes per session at 60% of heart rate reserve (as predicted by Karvonen's formula).

Sixteen subjects with Crohn's disease with a mean age of 38.3 years were assigned to the walking group with 12 subjects (ten female and two male) completing the 12-week program.

The results indicated a significant reduction in stress levels ($p = 0.02$) and symptoms of Crohn's disease ($p = 0.0005$). Quality of life related to Crohn's disease significantly increased following the walking program ($p = 0.0135$).

The subjects demonstrated a significant increase in VO_2 Max ($p = 0.0013$), however, Body Mass Index did not significantly change over the 12-week walking period ($p = 0.068$).

Qualitative analysis revealed that the most significant benefits from the walking program cited by the participants were: increased energy, increased self-esteem, reduced stress, and feeling more in control and positive about their illness and health in general.

Participants walked an average distance of 3.5 km, 2.9 times per week for 32.6 minutes per session at 60% of predicted heart rate reserve for a 12-week period.

The results indicate that sedentary patients with Crohn's disease can tolerate low intensity exercise of moderate duration without an exacerbation of symptoms. Twelve weeks of walking was adequate to elicit psychological and physical improvements in this sample group.

ACKNOWLEDGEMENTS

There are several people that I would like to thank for their guidance during the completion of this thesis. I would first like to thank my advisor, Dr. Victor Corroll for his time, support and for all of his ideas and recommendations towards this project. I would also like to thank Dr. Janice Butcher for all of the support and knowledge she has continually given me during the last three years. I have been fortunate to have Dr. Charles Bernstein as my external committee member from the Faculty of Medicine and I would like to express my sincere thanks for his continued support and enthusiasm towards this project and for all of the expertise and ideas he has given me during this past year. I would also like to thank Trish Rawsthorne, Dr. David Goldenberg and the Crohn's and Colitis Foundation of Manitoba for their help in recruiting subjects for this project. I would like to express my sincere thanks to Dr. Elizabeth Ready who gave me the opportunity to assist with one of her walking studies in the past, which gave me the confidence and ideas for this project.

I heart warmingly thank my family and friends (especially Jackie Boonstra and Kim Howey) for their love and support over the past seven years. I dedicate this project to my parents, whose love and generosity allowed me to pursue this wonderful education.

A special thank-you to the love of my life (and world's greatest firefighter), Brendan Weselake for his love and

encouragement and for being a constant source of strength throughout this project.

Last but not least, I extend a big thank you to the 12 participants in this study, who made this project come to life.

Once again to everyone who has helped me along the way - thank you for believing in me.

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

The role of physical activity in many areas of disease prevention and health promotion is well documented. Participation in regular physical activity has been proven to be a significant factor in the prevention and rehabilitation of many chronic illnesses, like cardiovascular disease, diabetes and osteoporosis, and is considered to be an effective stress management technique (The Canadian Fitness and Lifestyle Research Institute, 1994). Current research suggests that moderate exercise may be beneficial for persons afflicted with chronic immunodeficient or inflammatory disorders given the positive associations between exercise, the neuroendocrine axis and immune system functioning (Traeger-Mackinnon, 1994). Exercise training may also be beneficial as a stress management technique capable of reducing the impact of unmanageable stressful life events on psychologic and physiologic health of these individuals (LaPerriere, Ironson, Antoni, Schneiderman, Klimas, & Fletcher, 1994). A major premise underlying the field of psychoneuroimmunology (PNI) is that stress may enhance vulnerability to certain diseases or exacerbate current disorders by exerting an immunosuppressive effect especially on these diseases intimately associated with the immune system (Dorian & Garfinkel 1987). Crohn's disease is a chronic inflammatory disease of the gastrointestinal tract that may be

highly susceptible to the effects of stress. Few studies have investigated the effects of exercise intervention on symptoms and perceived stress levels of patients with Crohn's disease. The possible interactions between exercise, Crohn's disease and stress are important, as exercise training may be able to enhance immunity and reduce the detrimental effects of stress in patients. Thus, symptoms may decrease as a result of exercise training, promoting greater overall health status and quality of life among patients with Crohn's disease. Exercise intervention may be a logical step in the therapeutic process for individuals with Crohn's disease.

Crohn's Disease: Etiology and Pathogenesis

Crohn's disease is a chronic, gastrointestinal disorder of unknown etiology characterized by cycles of remission and exacerbation (Garrett, Brantley, Jones, & McKnight, 1991). This disorder is marked by the presence of destructive inflammation that can affect any part of the GI tract, although the most common sites of inflammation occur at the terminal ileum of the small intestine and the ascending colon. The most common signs and symptoms of Crohn's disease are: chronic diarrhea, abdominal pain, fever, vomiting and weight loss (Kirsner, 1991).

Current epidemiological research has indicated that the number of new cases of Crohn's disease appears to be steadily increasing especially among the 15-35 age group. The reasons for this disturbing trend are currently unknown.

A simple cause and effect explanation for the etiopathogenesis of Crohn's disease has not emerged despite extensive investigation over several decades (Shanahan, 1994). Researchers have concluded, however, that the chronic inflammation that is characteristic of this disease cannot be ascribed to a specific pathogen (Strober & James, 1986). Rather, it is likely that the tissue injury that occurs in Crohn's disease involves a complex interaction among genetic predisposing factors, exogenous triggers (e.g., mucosal infections) and immune effector mechanisms. In addition, there are various endogenous modifying factors (e.g., stress hormones), via the neuroendocrine system that influence the clinical outcome of the disease (Shanahan, 1994). The brain-gut axis is receiving considerable attention from clinicians and is rapidly becoming one of the most compelling factors in Crohn's disease research today. In addition, researchers are investigating the relationship between the mucosal inflammatory response and the neuroendocrine system as most of the clinical manifestations of Crohn's disease are related to inflammation (Zipser, 1988). It has been observed that endogenous modifying factors such as the psychoneuroendocrine system do have regulatory effects on immune system functioning and the inflammatory response and may highly influence the course of Crohn's disease (Shanahan, 1994). However, there are still many unanswered questions concerning the relationship between neuroendocrine factors, how they modulate

the immune system and to what extent they are involved in the pathogenesis and exacerbation of Crohn's disease (Mayer, Raybould, & Koelbel, 1988).

The Stress Response and Psychoneuroimmunology

There is significant evidence from human and animal studies linking psychosocial stress to alterations in immunoneuroendocrine system functioning. Many researchers now believe that psychosocial and other stressors may increase a person's susceptibility to illness, especially immunological disorders, primarily through an immunosuppressive effect (Glass, 1989). It has been suggested that the central nervous system (CNS) may coordinate both behavioral and immunologic adaptation during stressful situations and any perturbations of these feedback loops may result in the development of inflammatory syndromes (Sternberg, 1992). Although the specific physiological mechanisms that are responsible for the changes in immune and neuroendocrine system functioning due to stress are uncertain, Kiecott-Glaser and Glaser (1992) suggested that cellular immune parameters may be altered by various mechanisms. These mechanisms include: stress-induced changes in neurotransmitters and neuropeptides; activation of the sympathetic nervous system and an increase in pituitary-adrenal hormones, particularly epinephrine (adrenaline).

Stress is listed as a secondary risk factor for many chronic health problems. Although inability to cope with stress is probably not sufficient to cause disease if no

predispositions exist, stress may manifest itself wherever a "weak link" is found (Franks, 1994). However, the interaction between these factors is not a simple stimulus (stress) - response (illness) relationship, but is affected by various modulators and mechanisms of the response itself, including the characteristics of the stressful event, the individual perception of the stressors and whether the stressors are acute or chronic in nature (Plowman, 1994). One of the major weaknesses in the literature is a lack of a true definition of stress, which can be highly individualistic in nature.

Psychoneuroimmunology (PNI) is an emerging field of immunology that examines the relationships among psychological, neuroendocrine and immunological parameters and the interaction of these systems with specific reference to an individual's health (LaPerriere et al., 1994). The area of PNI that is of greatest interest to researchers is being able to restore, stabilize or protect immunocompetence to sustain or enhance optimal states of health.

Crohn's Disease and the Stress - Illness Relationship

The stress-illness relationship in Crohn's disease has been investigated by many researchers over the past several decades yielding mixed results. While current research has concluded that stressful life events do not cause Crohn's disease, many studies have suggested that stress may affect the course of disease in already diagnosed patients by leading to an exacerbation of the primary symptoms of the disease

(Garrett et al., 1991). Similarly, Shanahan and Anton (1988) stated that stressful life events probably never initiate inflammation, but there is a widely held clinical suspicion that stress may influence the subsequent course and disease activity in some patients with Crohn's disease. In addition the disability caused by bouts of diarrhea, abdominal pain and the various other signs and symptoms of Crohn's disease are worrisome and stress-producing for all patients (Joachim, 1983). Given the current hypotheses that the immune and neuroendocrine systems play important mediator roles in the pathogenesis of Crohn's disease, it is not surprising that the effects of negative life stress may be an additional factor in this complex puzzle. Collins and Croitoru (1993) indicated that future research will be directed towards understanding the roles of the GI tract, the brain and the immune system in the mediation of the stress response and determining if there are any significant associations between stress, the neuroendocrine and immune axis and disease activity.

Exercise, Stress and Psychoneuroimmunology

The field of exercise immunology is a fairly recent one, as researchers are currently trying to isolate the effects of exercise in reducing illness predilection for persons already susceptible to, or afflicted by immune disease or dysfunction (Nash, 1994). It appears that there is an optimal level of physical activity conducive to resistance to illness, although the specific frequencies, types and intensities of exercise

are unknown at this point (Traeger-Mackinnon, 1994). Many clinicians have proposed exercise training as an intervention technique for the treatment of a wide variety of illnesses and for the promotion of health. Traeger-Mackinnon (1994) stated that stress is a known contributing factor in the onset and exacerbation of many illnesses and that regular exercise training may modulate the detrimental effects of the stress response. Exercise intervention has been proposed as being a buffering mechanism and may counteract various immunosuppressing factors that commonly occur in stressful states. Brown (1991) found that people who are physically fit are less vulnerable to the adverse effects of life stress than those who are less fit. There are some indications that moderate exercise training like walking, has immunomodulating effects while exhaustive, intense exercise may suppress immunity (Fitzgerald, 1991).

LaPerriere et al. (1994) have integrated all of the observed physiological effects of exercise and have proposed an exercise and PNI model. The authors designed this model as a demonstration of how exercise training may prevent or reduce episodes of infection, enhance health status and decrease the progression of chronic disease, particularly those illnesses that are immunosuppressive in nature. The relationship between exercise and psychoneuroimmunology is very complex as researchers are currently trying to isolate the various

immunologic diseases that may benefit from exercise intervention.

Exercise and Crohn's Disease

Current research in the field of psychoneuroimmunology has demonstrated that there are significant two-way interactions between the neuroendocrine and immune systems and that lifestyle factors, such a stress, may play a role in modulating the immune response. Researchers have also attempted to isolate the effects of exercise training on stress, the neuroendocrine system and immune disease. Although it has been demonstrated that regular physical activity may prevent or modulate many chronic diseases like cardiovascular disease, diabetes and osteoporosis, the effect of exercise training on the prevention and rehabilitation of Crohn's disease is less known. The Crohn's and Colitis Foundation of Canada (1993) suggested that patients with Crohn's disease should engage in regular physical activity to help reduce anxiety, tension and other stressors and that being active should help patients to better cope with the disease and feel better about themselves. Although these recommendations do not include physical activity as a way to reduce symptoms, exercise intervention may play an important role in reducing stress levels which in turn, may help alleviate the incidence and exacerbation of symptoms. In addition, another important reason for patients to engage in regular physical activity is because they are at risk for low

bone mineral density and thus, osteoporosis, due to reduced calcium intake, corticosteroid intake and reduced physical activity during active disease periods (Pigot, Roux, Caussade, Hardelin, Pelleter, DuPuy-Montbrun, Listrat, Dougados, Couturier, & Amor, 1992).

The interaction among exercise, the immune system and neuroendocrine parameters may be relevant to Crohn's disease given the current hypothesis that the etiopathogenesis of the disease seems to be strongly linked to the immune system and several neuroendocrine modifying factors. Perhaps exercise intervention will be able to modify these abnormal physiological responses and thus, strengthen patients' immunity. It seems logical to include this chronic, inflammatory disease among the many disorders that would benefit from exercise intervention.

Statement of the Problem

The purpose of this study was to determine the effects of a 12-week low intensity walking program on Crohn's disease symptoms, perceived stress levels and aerobic fitness of a group of patients with Crohn's disease.

Disease activity and stress levels were quantified by documentation of symptoms and perceived stress levels at baseline and following the 12-week walking program. Training progression included duration, distance and frequency of exercise and target heart rate per walking session.

Overview

This study examined a population of patients diagnosed with Crohn's disease who were recruited on a volunteer basis via the Inflammatory Bowel Disease Clinic at the Health Sciences Centre and the Crohn's and Colitis Foundation of Manitoba. The subjects that were involved in this study participated in a 12-week progressive walking program. Participants were required to have been previously sedentary, or must have had infrequent involvement in regular physical activity programs. The Inflammatory Bowel Disease Stress Index (Joachim & Milne, 1987) and the IBD-Q (Guyatt, Mitchell, Irvine, Singer, Williams, Goodacre, & Tompkins, 1989) were used in conjunction with the Harvey and Bradshaw (1980) Simple Index of Crohn's Disease Activity to assess psychological and physical well-being of participants before and after the 12-week exercise program. The CAFT step test and body mass index were also administered at pre- and post-study.

The walking program consisted of three sessions per week of structured walking. Subjects were required to document heart rate, duration and distance of walking as well as psychological and physical well-being in a log book. This log book was updated on a weekly basis by the investigator.

Research Hypotheses

1) The study group will demonstrate a positive change in symptoms of Crohn's disease following a 12-week walking program.

2) Perceived stress levels in the study group will also change during the exercise program.

3) Predicted VO_2 Max and body mass index will demonstrate a positive change following a 12-week walking program.

Rationale for Study

This study had both theoretical and practical value. Exercise intervention plays a positive role in the prevention and rehabilitation of many chronic diseases. Regular exercise training has also been shown to alleviate stress and improve psychological health in various population groups. The exercise-stress-illness relationship is of enormous interest to researchers as it is believed that stress may leave individuals vulnerable to disease or exacerbate current illness. Clinicians have attempted to implement exercise training as a way to buffer this stress-illness interaction. The immunomodulating effects of exercise are well documented in the literature where immune function is stimulated by low to moderate intensity exercise but suppressed by high intensity exercise. The interactions between exercise, stress and immunoneuroendocrine parameters are the focal point of research in the multidisciplinary field of psychoneuroimmunology.

Little research has been conducted regarding the effects of exercise intervention on symptoms and perceived stress levels in patients with Crohn's disease. Psychosocial stress has been hypothesized as being a significant exacerbator of

this disease. An important question to be addressed is whether exercise training can reduce perceived stress levels in patients, and thereby reduce symptom incidence and exacerbation. Rheumatoid arthritis, an inflammatory disease similar in disease tempo and stress reactivity to Crohn's disease may serve as an appropriate model. Exercise intervention has been successfully implemented as a therapeutic technique for individuals with rheumatoid arthritis. Exercise training would also be beneficial for patients with Crohn's disease who consequently, may suffer from low bone mineral density and who are at risk for skeletal disorders.

Walking is a safe, practical and low intensity form of exercise that anyone can do. Furthermore, it is an activity that participants in this study can continue upon completion of this study. Information regarding the effects of a progressive exercise protocol in relation to stress levels and symptoms of patients with Crohn's disease will be useful for exercise prescription and for future research in the area of exercise and Crohn's disease. The potential health benefits that these individuals experienced will be useful in implementing exercise programs as an important part of the therapeutic process of Crohn's disease.

Limitations

This "community based" study examined a sample of volunteers recruited through the Crohn's and Colitis

Foundation of Manitoba and the Inflammatory Bowel Disease Clinic at the Health Sciences Centre. Being a self-selected volunteer sample, these participants may have had different characteristics from the rest of the population with Crohn's disease. This group volunteered for this study because they wanted to participate in a walking program. This biased the overall representativeness of the sample and limited the external validity somewhat.

This study relied, to a large degree, upon self-recorded data which may have limited the reliability of the results. Stress levels and symptoms were recorded by each participant pre- and post-study. Forgetfulness, motivation and social desirability are extraneous factors that cannot be controlled for using self-recorded data. Thus, the subjective nature of self-recorded data may have influenced the results of this study. In addition, a true definition of stress has yet to be established in the literature so this was subjective to each participant.

It is a limitation that there was no control group. Although patients served as their own control, it is possible that exercise would benefit this group the same, less, or more than a healthy control group (or another chronic disease group) undertaking an exercise program.

It is a limitation that lifestyle factors such as diet, smoking and use of herbal remedies were not monitored in this study. It would have been valuable to monitor these lifestyle

factors in conjunction with the walking program to see if, in fact, they may have influenced the results. Time and availability constraints were the major reasons why these lifestyle factors were not monitored in this study.

The sample group studied was a fairly homogeneous population of persons with Crohn's disease. All participants were previously sedentary and were relatively healthy to ensure that they could complete the walking program. Persons who had more severe disease were excluded and this posed a potential bias in both sample selection and the external validity of the results. In addition, there are individual differences in terms of disease exacerbation in patients. For instance, rates of disease flare-ups are more likely to happen in patients who are in remission for only six months as compared to someone who has been well for four years. This was not a problem in terms of compliance and subject loss in this study. Two participants were just recovering from recent bouts with their disease. The remaining 10 participants have been in remission for at least one year.

There was also little control over the unsupervised walking sessions. Participants were instructed to accurately document all walking data (duration, distance and heart rate) from these sessions in their log book and all participants met with the investigator on a weekly basis. However, adherence to the 12-week walking program was a limitation of this study that was difficult to control for.

Delimitations

The sample group for this study consisted of 16 sedentary patients with diagnosed Crohn's disease who were relatively healthy. All participants were recruited on a volunteer basis. Having a relatively healthy sample group increased the likelihood of compliance and completion of the exercise program.

The exercise protocol selected for this study was walking because it was a safe, practical and low intensity activity that all participants could do. Accurate recording of walking data during the unsupervised walking sessions was emphasized to each participant. The length of the walking program was 12 weeks in order to facilitate improvements in fitness levels and to observe any trends in stress levels and symptoms. Three days per week of walking was adequate enough to observe changes in fitness levels, thus participants did not feel overwhelmed by the change in lifestyle and facilitated greater adherence to and enjoyment of the program.

Definition of Terms

Etiology: The specific causes of diseases.

Pathogenesis: The production or development of a diseased condition. Physiological perturbations that result in disease states (Berne & Levy, 1993).

Endogenous Modifying Factors: Physiological factors within the cells and tissues that modify the homeostatic mechanisms of the organ systems. Various neuroendocrine mechanisms may

influence the inflammatory activity of Crohn's Disease (Schauf, Moffett, & Moffett, 1990).

Neuroendocrine System: Bidirectional feedback pathways between the nervous system and the endocrine system. All tissues and system by-products are influenced in a bidirectional manner. i.e. neural control acts to evoke or suppress hormone secretion in response to both external and internal stimuli (Berne & Levy, 1993).

Neuropeptides: Peptides that are released from nerve terminals. Substance P is an example of a neuropeptide that transmits pain sensations (Schauf et al., 1990).

Brain-gut Axis: Bidirectional pathways between the central nervous system and the nerve plexuses of the gastrointestinal system. The gastrointestinal tract receives both sympathetic and parasympathetic innervation from the CNS (Berne & Levy, 1993).

Sympathetic Nervous System: A division of the autonomic nervous system that is activated during the arousal stage of the stress response.

Parasympathetic Nervous System: A division of the autonomic nervous system that is responsible for the vegetative functions of the body. This system works in a coordinated way with the sympathetic nervous system, sometimes acting reciprocally and sometimes synergistically to regulate homeostasis (Berne & Levy, 1993).

Hypothalamic-Pituitary-Adrenal Axis: Interconnecting pathways between the hypothalamus, pituitary and adrenal glands that are activated during the stress response and cause the release of several stress hormones, including ACTH, glucocorticoids and the catecholamines (Block, 1994).

Catecholamines: Two classes of hormones epinephrine (adrenaline) and norepinephrine (noradrenaline) that are released from the adrenal medulla during the arousal stage of the stress response.

Adrenocorticotrophic Hormone (ACTH): A stress hormone that is released by the anterior pituitary. Stimulates the growth of those specific zones of the adrenal cortex concerned with secretion of cortisol and other steroid hormones (Berne & Levy, 1993).

Lymphocytes: A type of white blood cell that is involved in specific immunity. Two general classes of lymphocytes exist: T cells and B cells (Schauf et al., 1990).

Interleukin-2: Molecules released during the immune response that stimulate T cell multiplication (Schauf et al., 1990).

Immunoglobulins: Protein molecules in which one end is specialized for recognition of "foreign" molecules and the other end activates components of the immune response. Also referred to as antibodies (Schauf et al., 1990).

Natural Killer Cells: Immune cells that may have a role in resistance to cancer (Schauf et al., 1990).

VO_2 Max: Maximal oxygen consumption. Expressed as Ml. O_2 kg./min.

Prednisone: A corticosteroid drug that is commonly prescribed to patients with Crohn's disease to treat inflammatory activity in the gastrointestinal tract.

CHAPTER TWO

REVIEW OF LITERATURE

Recent experimental evidence has indicated that exercise training may be beneficial in the prevention and rehabilitation of patients with chronic disease, including cardiovascular disease, diabetes mellitus and rheumatoid arthritis (Harkcom, Lampman, Figley-Banwell, & Castor, 1985). Many prospective analyses have also revealed that the negative impact of stressful life events on health declines as fitness levels increase and thus, exercise training may be a valuable resource for combating life stress (Brown & Siegal, 1988). The role of exercise training in the prevention and treatment of Crohn's disease has never been studied, although patients with this chronic, inflammatory disorder would likely benefit both psychologically and physiologically from regular physical activity.

This chapter will review in detail those aspects of exercise training, stress and psychoneuroimmunology that are important to the understanding of this area of research as well as to the testing of the research hypotheses. The attempt to integrate these parameters with the etiopathogenesis of Crohn's disease will specifically be addressed. The physiological significance of the neuroendocrine system on stress, exercise training and as a possible endogenous modifying factor in Crohn's disease will also be emphasized. The understanding of the involvement of

the neuroendocrine-immune axis in the stress response, exercise training and as an inflammatory mediator of Crohn's disease is essential since this will illustrate those mechanisms that will either promote or hinder the therapeutic benefits of exercise for these patients. A model of exercise training and rheumatoid arthritis, a disease similar in pathogenesis and stress reactivity to Crohn's disease will be addressed. A comprehensive literature review of the various modulating factors that are involved in the etiopathogenesis of Crohn's disease and their relation to stress, PNI and the effects of exercise training will be examined. The intentions of this review are therefore to consider the physiological implications of psychoneuroimmunology, stress and exercise intervention on the symptoms of Crohn's disease and to determine the extent to which these parameters interact to influence health status of individuals with Crohn's disease.

Crohn's Disease: Etiology and Pathogenesis

Crohn's disease is a chronic, inflammatory disease of the gastrointestinal tract that is becoming one of the most compelling medical conditions of the human population today. There is no known cause or cure for Crohn's disease, yet the number of new cases is steadily increasing. The exact causes of Crohn's disease are not currently known, however, researchers have concluded that the tissue injury that occurs may involve a complex interaction among genetic predisposing factors, immune effector mechanisms and exogenous triggers.

In addition, the clinical outcome of the disease is highly heterogenous and is highly influenced by several endogenous modifying factors like the neuroendocrine system for example (Figure 1) (Shanahan, 1994).

Crohn's disease can occur in any part of the GI tract, although in most patients it is usually isolated at the terminal ileum of the small intestine. The most common characteristics of Crohn's disease are: chronic diarrhea, abdominal pain, fever, vomiting and weight loss (Kirsner, 1991).

A fundamental feature of the pathology of Crohn's disease is a destructive inflammatory process that eventually penetrates all layers of the intestinal tract resulting in severe tissue scarring and bowel obstruction (Schwartz & Blanchard, 1991). Considerable progress has been made in the attempt to identify the various immunological and neuroendocrine factors that may play an important role in the mucosal inflammatory response of Crohn's disease. Fiocchi (1993) as cited by Matsuura, West, Youngman, Klein, and Fiocchi (1993) concluded that regardless of its cause, the final pathway of tissue damage in Crohn's disease is mediated by an abnormal immune response in the intestinal mucosa. The author stated that there is convincing evidence that the state of the activation of the immune system is enhanced in patients with the disease and that abnormal T-cell activation is

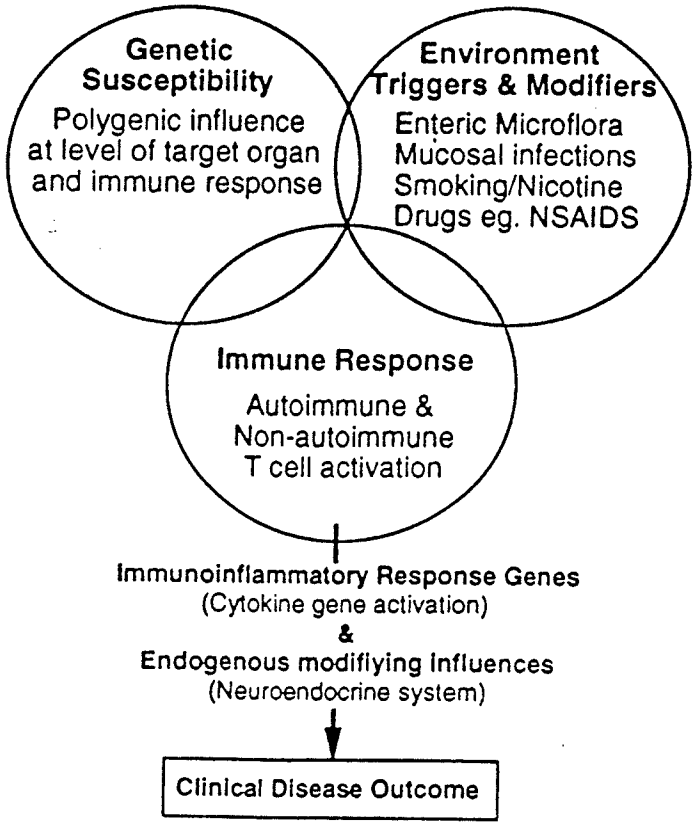


Fig 1 – Interacting elements in the pathogenesis of inflammatory bowel disease

Figure 1: Interacting elements in the pathogenesis of inflammatory bowel disease.

Redrawn from: Shanahan, F. (1994). Current concepts of the pathogenesis of inflammatory bowel disease. Irish Journal of Medical Science, 12, 544-549.

intimately associated with the inflammatory response of Crohn's disease. MacDermott (1994) stated that the highly activated immune effector cells produce prolonged and severe damage to the intestine and these immune mediated inflammatory processes exacerbate and perpetuate the intestinal injury of Crohn's disease. Many researchers have concluded that the associations between the immune system and Crohn's disease are strong, based on the observations that the pathology of the lesions in the intestinal tract display prominent immuno-abnormalities. Crohn's disease may begin as a spotty accumulation of lymphocytes and plasma cells situated near a mucosal crypt and this is followed by a rapid influx of macrophages (Strober & James, 1986). Similarly, Elson (1988) cited that in patients with Crohn's disease, the bowel wall is infiltrated with chronic inflammatory cells like lymphocytes and plasma cells. A decreased total lymphocyte count and circulating T-cell levels and a higher rate of IGG turnover have also been observed in patients. Tissue damage may arise as a nonspecific bystander effect in the presence of uncontrolled T-cell activation (Shanahan, 1994). Based on these observations, Elson (1988) proposed that because there are high numbers of immune cells clustered around intestinal lesions, and because there is a general association between the degree of infiltration of immune cells with disease activity, and ultimately the severity of the disease, the implications for the pathogenesis of Crohn's disease as being

immuno-deficient in nature seems logical given the current research. However, many issues concerning the immunopathogenesis of Crohn's disease remain unresolved and a definite causal relationship has not been established.

There are several research challenges that have to be addressed for the future. Firstly, because of the absence of a suitable animal model of Crohn's disease, any immunological abnormalities that are detected cannot be identified as being primary or secondary to the disease process. Secondly, the heterogeneity of the disease makes it likely that different pathogenic mechanisms may be involved with similar clinicopathologic outcomes. Hypotheses concerning immuno-related tissue damage are difficult to prove as the surface and crypt epithelia that line the intestine are distinct in terms of their responsiveness to inflammation (Shanahan, 1994). Third, many of the alterations in the features of the immune system have been inconsistent in their association with Crohn's disease and many of the underlying mechanisms responsible for this state are not well established in the literature (Podolsky, 1991). Fourthly, it is now known that various mediators of the neuroendocrine system play a crucial role in the regulation of intestinal immune and inflammatory responses thereby adding an additional variable to this already complex puzzle. The immunopathogenesis of Crohn's disease needs to be examined further due to the involvement of

other pathological mechanisms that contribute to the disease process.

As discussed earlier, Crohn's disease appears to arise as a result of an abnormal immune mechanism in response to a "trigger". Although these particular triggers have not been clearly identified, researchers are investigating the possible interrelationship of inflammatory mediators via the neuroendocrine system and control of the immune response (MacDermott, 1994). Abnormalities in the regulation of the immune response in Crohn's disease may occur as a result of the activation of various neuroendocrine parameters.

Shanahan (1994) stated that endogenous factors like the neuroendocrine system and the brain-gut axis probably contribute to the variability in the clinical expression of the disease and the regulatory effects of the neuroendocrine system on immuno-inflammatory mechanisms are well established. The adverse effects of the stress response have also been associated with the decrements in neuroendocrine-immune system functioning and thus, may also influence the clinical course of Crohn's disease. Stress and Crohn's disease will be addressed later in this review.

Most of the clinical signs and symptoms of Crohn's disease are related to inflammation which is why researchers have started to investigate the mediators of inflammation and their possible role in the etiopathogenesis of Crohn's disease (Zipser, 1988). The brain-gut axis has received considerable

attention from clinicians studying the pathogenesis of Crohn's disease. It has become evident that communication between the neuroendocrine and immune systems is bidirectional and neuroendocrine-immune regulation may have its greatest physiological influence in the intestinal mucosa (Shanahan & Anton, 1988) (Figure 2). Communicating pathways exist between the nerves within the intestinal mucosa and the muscle layers, thus lending support that neuropeptides may play a role in the coregulation of motility and inflammatory mucosal lesions of the GI tract (Mayer, Raybould, & Koelbel, 1988). Shanahan (1994) stated that the most significant evidence for an abnormality in the neuro-immune axis of Crohn's disease is a marked up regulation (approximately 1000-fold) of intestinal receptors for the proinflammatory neuropeptide, Substance P.

Shanahan (1987) and Levine, Clark, Devor, Helms, Moskowitz, and Basbaum (1984) as cited by Shanahan and Anton (1988) have found a direct involvement of Substance P in mediating tissue injury in experimental and rheumatoid arthritis which may have significant implications for the pathogenesis or exacerbation of Crohn's disease. The author discovered that peptide concentration of nerve terminals innervating inflamed joints is increased in subjects and thus, the authors hypothesized that the severity of the arthritis is probably attributable to the actions of Substance P. Similarly, Lembeck (1985) as cited by Mayer et al. (1988) stated that the role of Substance P as a mediator of

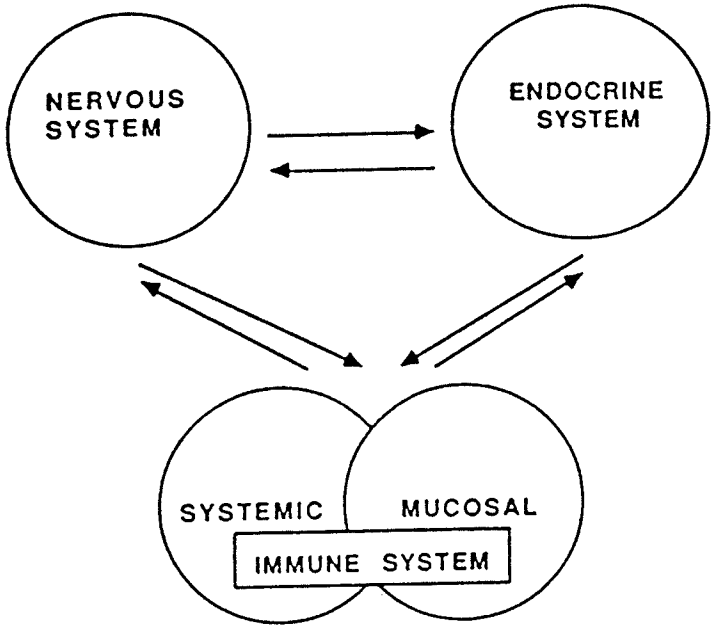


Fig 1. Intercommunication between the neuroendocrine system and the immune system.

Figure 2: Intercommunication between the neuroendocrine and immune system.

Redrawn from: Shanahan, F., & Anton, P. (1988). Neuroendocrine modulations of the immune system: Possible implications for inflammatory bowel disease. Digestive Diseases and Sciences, 33, 415-495.

neurogenic inflammation has been observed in many different tissues including the skin, eye, joints, respiratory tract and in certain parts of the GI tract. Substance P is released from the peripheral terminals of sensory neurons and local mechanical, chemical and physical irritants cause a release of substance P thereby causing inflammation. These changes cause significant alterations in mucosal lymphocyte functions (Shanahan & Anton, 1988).

Despite the convincing evidence for a role of Substance P and other neurogenic factors in the pathogenesis of Crohn's disease, additional research must be done as many of the current hypotheses have not proved causality. Many of the physiological changes observed in mucosal tissue have not been identified as being primary or secondary to the disease process and current studies of human mucosal lymphocyte function in Crohn's disease have been non-specific (Shanahan & Anton, 1988). In addition, little is known about the role and mechanisms of neurogenic inflammation within the GI tract which makes it very difficult for researchers to experimentally prove a direct link between neuroendocrine mediators and the pathogenesis/exacerbation of Crohn's disease (Mayer et al., 1988). Current literature has provided little justification as to whether these neurogenic factors contribute to the perpetuation of the inflammatory response of Crohn's disease or is an appropriate response to the inflammatory process (Shanahan, 1994).

In summary, the etiopathogenesis of Crohn's disease involves immune-related tissue damage that may be a result of an interaction of the immune system, endogenous modifying factors (neuroendocrine system) and genetic predisposing factors. The psychoneuroendocrine system has known negative effects on the immune system and the inflammatory response and thus may influence the clinical course of Crohn's disease (Shanahan, 1994). Neuroendocrine-immune system interactions may prove to be a significant component of the inflammatory process of Crohn's disease and offer a new and exciting approach to the disease (Shanahan & Anton, 1988). Interestingly, the current drug therapy for individuals with Crohn's disease involves corticosteroid agents whose main function is to inhibit the release of lymphokines and inflammatory mediators thereby lending support of an immune-neuroendocrine influence in the pathology of Crohn's disease (Strober & James, 1986).

The Stress Response and Psychoneuroimmunology

There is significant evidence from human and animal models linking psychosocial stress to alterations in immuno-neuroendocrine system functioning. Many researchers now believe that psychosocial stress may increase a person's susceptibility to illness, especially immunological disorders primarily through an immunosuppressive effect (Glass, 1989). It is becoming recognized through the scientific community that negative life stress may be a precipitating factor in

chronic disease by altering a person's susceptibility at a particular period of time (Rabkin & Struening, 1976). Stress has been listed as a major secondary risk factor for many health problems (Franks, 1994).

Although the specific physiological mechanisms that are responsible for the changes in immune and neuroendocrine system functioning due to stress are uncertain, Kiecott-Glaser and Glaser (1992) suggested that cellular immune parameters may be altered by: stress-induced changes in neurotransmitters and neuropeptides of the central nervous system; activation of the sympathetic nervous system and hypothalamic-pituitary-adrenal axis and an increase in pituitary-adrenal hormones, particularly cortisol and the catecholamines (adrenaline).

Psychosocial stress has been defined in various ways, however, Lazarus and Folkman (1984) as cited by Vollhardt (1991) have defined stress as "a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his/her well-being" (p. 37). In addition, stress can incorporate many nonspecific events, both internal and external that can make physiological and psychological demands on the individual (Ader & Cohen, 1993). One of the major flaws in stress-related research is a lack of a true definition of stress, as stress can incorporate many meanings to different people. What may be stressful to one individual

may not be for another. Researchers have attempted to focus on 'negative life stress' which may be detrimental to the body's homeostatic mechanisms over a long term period.

The mammalian response to a stressor involves a variety of adaptive physiologic mechanisms designed to restore the body's homeostasis (Sheridan, Dobbs, Brown, & Zwilling, 1994). Selye (1974) as cited by Rosato (1990) described several physiological responses that occur when the body prepares to combat stress. These include: adrenaline, the 'fight or flight' hormone is released; heart rate and blood pressure increase; extra blood is sent to the muscles and less to the GI tract and the immune system slows down. The author emphasized that these specific changes may cause a significant strain on the body's normal homeostatic functioning which may become destructive should these responses occur over a long term basis.

Researchers are investigating the primary physiological responses to stressors that may result in the most severe immunomodulations. This is mediated primarily by two specific neuroendocrine systems, the sympathetic nervous system and the hypothalamic-pituitary-adrenal axis (HPA) (Sheridan et al., 1994). The major effect of the stimulation of the HPA axis during stress is a down-regulation of immune system function. Corticotrophin-releasing hormone (CRH) which controls the release of the hormone ACTH from the anterior pituitary is thought to be the main coordinator of the stress response.

The release of ACTH stimulates the production of corticosteroids from the adrenal cortex. In addition, autonomic nervous system activation by CRH during the stress response results in a release of a second class of stress hormones, epinephrine (adrenaline) and norepinephrine (noradrenaline). During the arousal response to stress, the systems regulating growth, reproduction, thyroid function and immunity are down-regulated which over the long term offers little survival advantage due to the disrupted homeostasis (Black, 1994).

Corticosteroids have profound immunosuppressive effects and are elevated beyond normal levels during stress. In addition, corticosteroids decrease production of many cytokines (a specific type of immune cell) and decrease the effects of certain inflammatory molecules on various target tissues. It appears that the primary function of cortisol in stress states is to prevent unrestrained activation of the stress response mechanisms, such as the inflammatory response, that may themselves produce deleterious tissue injury. Any dysfunction in this regulatory mechanism may produce unwarranted inflammation (Wilder, 1992). The catecholamines epinephrine and norepinephrine which are also significantly elevated during the stress response display prominent immunosuppressive effects, especially on lymphocyte, monocyte and leukocyte function (Black, 1994). The clinical effects of these hormones on the body's homeostasis and overall immunity

are currently under investigation. Rosato (1990) stated that the body's immune system is somewhat depressed during the alarm stage of stress and it returns to fully functioning status during the recuperative stage. However, when stress is chronic it may remain suppressed for a long period of time thereby increasing susceptibility to illness. Changes in hormone levels via the neuroendocrine axis may be one of the most significant factors that depress the immune system from chronic stress.

Brantley, Dietz, McKnight, Jones, and Tulley (1988) examined the association between endocrine measures of stress and the Daily Stress Inventory, a commonly used measure to assess psychosocial stress. Eighteen adult male subjects completed the Daily Stress Inventory and had urinary levels of cortisol and vanillylmandelic acid (VMA), a metabolite of epinephrine and norepinephrine, taken over a period of nine days. In accordance with their hypotheses, the authors found that during the high stress days, both cortisol and VMA levels were significantly elevated compared with the low stress days. The results also suggested a substantial positive association in many subjects between the stress measures and endocrine hormone levels on a day to day basis. The authors concluded that their data provides limited support for the hypothesis that minor stress is related to endocrine hormone levels. Although the results from this study are encouraging, the authors noted several limitations in the research design. A

very small sample of highly educated (medical residents) males in stressful occupational situations do not provide a general representation of the population, thus limiting the external validity of this study. Persons who experience less extreme fluctuations in their daily stress levels, older, female or a less-educated sample should be used in future experiments. A larger sample size would be necessary to establish generalizability of the results. One other major problem with this study was the relatively short assessment period. It was noted by the authors that a longer measurement period would allow more confidence in the results and contribute further to the generality of the study.

Cacioppo (1993) found that mean norepinephrine, epinephrine and cortisol levels were increased following exposure to a brief psychological stressor in a group of 44 healthy men. Based on these observations, the author suggested that acute psychological stressors activate the sympathetic-adrenomedullary system across individuals and may affect immune function over a long term basis.

Naliboff, Benton, Solomon, Morely, Fahey, Bloom, Makinodan and Gilmore (1991) studied the immunological and neuroendocrine changes in a group of 23 women who were exposed to brief laboratory stress. The subjects were divided into two groups--a young group of 12 women (aged 21-41 years) and an older group of 11 women (aged 65+ years), and were randomly assigned to either a stress task (timed mathematical

questions) or to a non-stress task (viewing a videotape on a health topic). Each subject group performed both tasks over two sessions. The investigators found that both groups who were exposed to the stress task displayed a marked increase in circulating suppressor/cytotoxic T-cells and natural killer (NK) cell activity. In addition, those subjects also experienced an increase in heart rate, systolic blood pressure and elevated levels of catecholamines, two endocrine hormones that are immunosuppressive in nature. The authors concluded that rapid immunoneuroendocrine adaptations occur following exposure to a brief psychological stressor. However, this study only focused on the effects of acute stress from a manipulated laboratory situation using a fairly small sample size. Perhaps, more chronic stress of this type would lead to more detrimental changes in immunoneuroendocrine functioning. This study also failed to use a control group, so therefore, a baseline measure to compare to the experimental groups was not established. Anticipation of the stressful task may have altered subjects' normal responses and thus, subject characteristics like personality style and coping mechanisms may have confounded the data. In addition, the stressful task in this experiment cannot be applied to individual differences from stress as this task was fairly homogeneous in nature and probably too severe as compared to the minor daily stressors similar persons would experience in their lives (Naliboff et al., 1991).

Similarly, Schedlowski, Jacobs, Fluge, Aiker, Prohl, Stratmann, Richter, Hadicke, Wagner, Schmidt and Tewes (1993) studied the effects of acute psychological stress on immune and endocrine functioning among 25 male inexperienced parachutists. Immunological and endocrine parameters were measured before, during and after the first jump. The authors found that during the jump, the absolute numbers of lymphocytes, a specialized group of immune cells, reached more than double the baseline levels observed before the jump and dropped significantly below baseline after the jump. Heart rate, respiration rate and plasma concentrations of adrenaline and cortisol were significantly elevated in all subjects during and after the jump. These parameters slowly returned to baseline an hour following the jump. Based on the results, Schedlowski et al. (1993) stated that short-term psychological stress leads to an alteration in immunoneuroendocrine system functioning. The authors emphasized that whether these physiological effects observed are transient in nature or are long lasting following repeated exposure to stress remain uncertain. Limitations of this otherwise interesting study were that it had a small subject size, the participants were first-time jumpers so it is obvious that they would feel more stress than experienced, more conditioned jumpers. Also, the stressful task in this experiment (parachuting) is a very extreme situation, one that would not be relevant to the

general population in terms of the severity of the stress experienced in this experimental situation.

Synder, Roghmann, and Siegal (1993) examined the effects of stress on immunity in a group of 89 healthy Caucasian female students. Each subject had to complete a stressful life events questionnaire to determine the extent of stress experienced by the subjects. The authors found that those subjects who experienced more unpleasant stressful events displayed a tendency for lower lymphocyte proliferation and as a whole, these subjects had lower lymphocyte baseline levels over an 8-week period. Those subjects who reported low stress had higher lymphocyte proliferation responses. The investigators concluded that psychosocial stressors mediate the relationship between immune response and health. This was an interesting study and the results were similar to other experiments done in this area. However, there were several limitations in the research design. First, this study used a fairly homogenous sample group being 90% Caucasian, of younger ages and the majority of subjects were from middle or upper class families. Therefore, the external validity of this study is severely limited given that the results cannot be generalized to the whole population, especially ethnic groups, older persons or individuals from lower socio-economic groups. Second, there was no control group in this experiment to compare the differences in lymphocyte response to the experimental subjects. Third, self-report measures of stress

are problematic given that motivation, forgetfulness or other personality characteristics of the participants may have played a significant role in the results, thereby confounding the results.

Kiecott-Glaser and Glaser (1992) investigated the effects of examination stress on immune system functioning in a group of 60 medical students. The authors collected immunological data from each student during a 3-day examination period and compared this to a baseline value, a lower stress blood sample collected a month before the exams. It was found that there were significant declines in natural killer cell activity, cells which are thought to have antiviral and antitumour functions, and a lower T-lymphocyte count during the exam period compared to when there were no exams. However, the researchers are uncertain whether or not these periods of acute, intense stress will result in long term immunosuppression and thus, subsequent illness. Other factors such as the environment, coping mechanisms, being in a demanding occupation and personality styles may be involved in these highly stressful situations which may have contributed to the immunosuppression observed among these students.

Interestingly, Glass (1989) reported that in subjects with high perceived control and who are exposed to stressful events did not experience any clinically significant elevations of epinephrine or cortisol compared to subjects with low perceived control who experienced substantial

increases in these parameters during the same stressful events. However, it can be hypothesized that other psychosocial variables like coping style, the person's perception and adaptation to the stressful situation and personality characteristics in addition to perceived control attributed to these hormonal changes.

Current research studies have suggested that psychosocial stress can negatively alter basic immunoneuroendocrine system processes and these immunosuppressive effects may have a detrimental influence on the development and pathogenesis of many illnesses. However, because it is extremely difficult to experimentally measure immune and endocrine system parameters and given the limitations concerning self-report measures of stress, lack of a cause and effect model of stress and illness and the varied meaning of a stressor among individuals (Kropiunigg, 1993), the assumptions that psychosocial stress may play a significant role in disease etiology and exacerbation can only be validated given future research (O'Leary, 1990).

A major weakness in many studies that use psychological stress questionnaires as a measuring tool is that it is extremely difficult to pinpoint the exact physiological characteristics that mediate the stress response and also which of these factors influence some persons more than others. Pelletier (1992) identified several psychological characteristics that are variable among subject groups that

participate in stress-related studies. These include: coping style; a person's mood; suppressed anger; hopelessness; inattention to distress and daily hassles. Given that different people respond individually to stressful situations, these variables are relevant when attempting to measure the effects of stress in various subject groups. Thus, generalizing about the psychological effects of stress and how these parameters influence physiological functioning is limited. One other significant problem using stress questionnaires is the question of validity. Do the answers given by each participant represent their actual state of mind and feelings or are they based on how they think the experimenter would want them to answer based on wanting approval? Motivation, fatigue and other extraneous variables likely have a significant influence on subject behavior, when using self-report measures.

The clinical assessment of the interactions between stress, immunity and health is a difficult task for researchers and current literature has provided little justification for generalizing from one stressor to another or from one aspect of physiological function to another (Ader & Cohen, 1993).

Psychoneuroimmunology

Psychoneuroimmunology (PNI) is an emerging interdisciplinary field that examines the relationships among psychological (the mind and emotions), neuroendocrine (the

brain, CNS and endocrine systems) and immunological parameters and the interaction of these systems with specific reference to an individual's health (LaPerriere, Ironson, Antoni, Schneiderman, Klimas, & Fletcher, 1994). The main focus of PNI research is to examine the hypothesis that there is an inextricable interaction between mind and body at the heart of health and disease (Pelletier 1992). Current PNI research has revealed that there are extensive interconnections between the immune, nervous and endocrine systems and the physiological boundaries between these systems are becoming less distinct. Booth and Ashbridge (1992) have suggested that "psychological, neuroendocrine and immunologic processes exist in syncytium and they cannot be understood effectively in isolation but together constitute an irreducible dynamic process of self-determination." Therefore, the effects of psychological stress on the human organism must be viewed as complex interactions between immune and neuroendocrine mechanisms. Current PNI research has established several important interconnections between the immune and neuroendocrine systems. These include: stimulation of areas in the brain influence immune responses; lymphocytes are capable of responding to neuroendocrine and neurotransmitter signals with observable immunomodulating properties; lymphocytes can produce neuroendocrine factors and stress can influence immunologic reactivity and conversely, the immunologic state of the organism has consequences for behavior (Ader, 1992).

In addition, Kropiunigg (1993) stated that evidence for a mind-body paradigm is significant given the interactions of hormones, neurotransmitters and immune parameters in a network of bidirectional feedback loops between the brain and immune system.

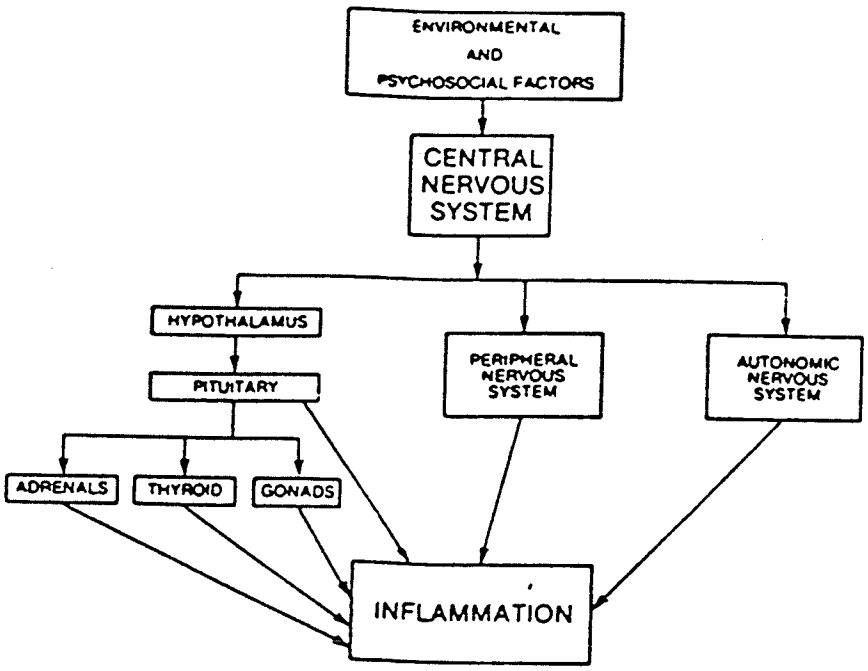
Researchers are investigating the neuroendocrine and immune system mechanisms of the stress response in attempt to find a causal role of stress in the onset and course of many chronic, immunosuppressive diseases. For example, Sternberg (1992) suggested that through special bidirectional feedback loops, the CNS and HPA axis may coordinate both behavioral and immunologic adaptations during stressful conditions and through various mechanisms, pathophysiologic perturbation of this feedback loop can result in the development of inflammatory syndromes such as rheumatoid arthritis (Figure 3). Corticosteroids, potent immunosuppressive, anti-inflammatory hormones are thought to play a significant role in these feedback circuits. Recent studies have found that disruptions in the immune system-CNS counter-regulatory feedback loop are associated with enhanced susceptibility to inflammatory disease in genetically CRH-hyporesponsive rats. In addition, studies using human models have revealed that alterations in HPA axis functioning do occur in inflammatory diseases (Sternberg, 1992).

Despite the growing research in the area of psychoneuroimmunology, the clinical and practical applications

of the findings are limited. Complete understanding of the complex interactions between the CNS, endocrine and immune systems are still incomplete and their relation to stress and disease is currently under investigation. Interestingly, Cacioppo (1993) stated that the interindividual variation in hypothalamic-pituitary-adrenocortical activation by brief psychological stressors may help explain why daily irritants and stressors have greater health consequences for some individuals than others. The functional significance of many of these immunoneuroendocrine interactions remain unknown (Ader, 1992). There is still insufficient data to establish a causal role of stress with disease onset and exacerbation, although select PNI studies have revealed significant associations between these parameters. Pelletier (1992) stated that one of the most challenging issues facing PNI researchers is whether behavioral or psychotherapeutic interventions like exercise and relaxation techniques for example, can directly enhance immune function and thereby prevent the onset or alter the course of disease involving the immune system? The answer to this question will no doubt change the face of disease prevention and management for the future. A multidisciplinary concept of health and disease may not be far off.

Crohn's Disease and the Stress-Illness Relationship

The stress-illness relationship has been the subject of intense investigation over the past several decades. The



The central nervous system regulates inflammation.

Figure 3: The central nervous system and its regulation of inflammation.

Redrawn from: Wilder, R. L. (1992). Neurobiology and inflammatory arthritis. Bulletin on the Rheumatic Diseases, 41, 1-3.

major focus of this research is the premise that stress may enhance vulnerability to certain diseases by exerting an immunosuppressive effect and this is especially critical for those who suffer from immunologic-related disorders (Dorian & Garfinkel, 1987). It has been hypothesized that stress may be a secondary risk factor for the development of major health problems and stress is also likely to exacerbate and affect the course of those disorders already diagnosed (Frank, 1994).

The stress-illness association has been proposed as being a predominant factor in many diseases, including Crohn's disease. Waranch (1988) stated that there is persuasive evidence that psychological stress plays a significant role in the exacerbation of GI disorders including Crohn's disease, and an estimated 60% of GI disorders are influenced somewhat by psychological stress. Although it is clear that stress is not the primary cause of Crohn's disease, stress may, however, affect the course of the disease by leading to exacerbation of the major signs and symptoms of the disease (Garrett, Brantley, Jones, & McKnight, 1991). In addition, these signs and symptoms are also stress-producing for most patients.

The Pathophysiology of Stress and Crohn's Disease

The pathophysiology of stress and its relation to the clinical course of Crohn's disease is currently under investigation. Joachim (1983) stated that in the GI tract, the proinflammatory response that occurs during stress as a result of increased neuroendocrine activation, may be a cause

of GI disturbances and inflammatory conditions. One of the most potent immunosuppressive factors in the stress response is glucocorticoids. At the cellular level, glucocorticoids significantly inhibit functions of inflammatory cells and alter the interactions among these cells at inflammatory sites. Glucocorticoids also reduce the number of circulating lymphocytes and monocytes at inflammatory sites. Thus, glucocorticoids suppress the immune and inflammatory responses at a cellular level and perturbations in the communication between neuroendocrine and immune feedback systems may result in the development of inflammatory syndromes or alter the course of existing disorders (Sternberg, 1992).

Interestingly, many GI researchers are now focusing on the role of mediators of inflammation in the pathogenesis of Crohn's disease given the fact that most of the clinical manifestations of Crohn's disease are related to inflammation. These symptoms include abdominal pain, diarrhea, fever and hemorrhage (Zipser, 1988). Sternberg (1992) hypothesized that the hypofunctioning of the HPA axis is associated with susceptibility to inflammatory disease. However, it is unclear whether severe immunosuppression and damage to the normal inflammatory response as a result of stress is related to the pathogenesis and exacerbation of Crohn's disease.

Kirsner and Shorter (1982) as cited by Milne, Joachim and Niedhardt (1986) suggested that stress may act as a possible

inciting event or "insult" which can initiate the recurrence or alter the clinical course of Crohn's disease.

Researchers have frequently raised the question concerning the role that stress may play in the exacerbation of Crohn's disease and if a reduction in stress levels among patients would decrease symptoms. Collins and Croitoru (1993) stated that although the scientific evidence linking stress with symptom exacerbation in Crohn's disease has been inconclusive, it has been the experience of most patients and their physicians that such a relationship indeed exists. It is generally accepted among clinicians that chronic stress is harmful to the body's normal homeostatic mechanisms and this stress may aggravate the course of many chronic diseases, including Crohn's disease. The gastrointestinal tract has long been regarded as being particularly sensitive to stress and this has been observed in many healthy individuals who experience bowel symptoms after being exposed to stressful situation (Collins & Croitoru, 1993).

The brain-gut axis has recently been the focus of intense study as researchers believe that neuroendocrine factors play a major role in the relationship between the stress response, symptoms and Crohn's disease. Shanahan (1994) stated that although the evidence that stressful life events influence the clinical course of Crohn's disease is controversial at present, the resulting effects of the stress response and the neuroendocrine system on immunoinflammatory mechanisms are

well established. Researchers are currently investigating the effects of stress on the neuroimmune axis in Crohn's disease and attempting to link the bidirectional brain-GI Tract pathways as mediators of inflammation. Shanahan (1994) stated that it is still unclear whether these mechanisms contribute to the perpetuation of the inflammatory response or is an appropriate response to the inflammatory process. Sternberg (1992) suggested that any pathophysiologic abnormalities in the various neuroendocrine-immune system feedback loops, including those involved in the stress response, may result in the development of inflammatory disorders. The extent to which the brain-gut axis is involved in the pathogenesis/ exacerbation of Crohn's disease is unknown, as well as the role of stress in perpetuating these mechanisms.

Several research studies have investigated the effects of stressful life events on disease activity of patients with Crohn's disease.

Garrett, Brantley, Jones, and McKnight (1991) examined the relation between daily stress on symptoms in a group of ten patients with Crohn's disease. Over a period of 28 days, all participants monitored the occurrence of daily stress and recorded any signs and symptoms of Crohn's disease in several of these patients. These results were observed even after controlling for the effects of major life events. Small, negative correlations between stress and symptoms were observed among a few patients in this sample group. Patients

who reported high levels of stress also reported more signs and symptoms of the disease. Interestingly, the authors noted that daily stress appears to have the same impact on symptoms whether the person has experienced many or few major life events. The investigators concluded that the results of their study suggest that for at least some individuals with Crohn's disease, daily stress tends to be related to an exacerbation of the signs/symptoms of the disease. Despite these positive results, there were a few limitations in this study. The small sample size employed in this study limits the external validity of the results. Incidentally, the authors did note that statistical significance is difficult to achieve with such a small sample size and thus, future studies of this type need to use larger sample groups to achieve stronger correlations. The assessment period of 28 days was far too brief to make any definite conclusions regarding the effects of daily stress on Crohn's disease. A longer monitoring period may provide greater variability and provide a more accurate measure of subjects' daily stress patterns. As with other research studies in this area, this experiment found significant, although small associations between stress and Crohn's disease and not a true cause and effect relationship. A major problem that plagues these types of experiments is the individual variations of stress reactivity and disease activity, and thus, individual differences in Crohn's disease and stress must be accounted for in future studies. Despite

these limitations, the overall results from this study are encouraging and the research design is replicable, thus, warranting further investigation in this area.

Joachim (1983) conducted a pilot study to examine the effects of deep abdominal breathing and massage on feelings of well-being in 14 patients with Crohn's disease. The techniques were done over four weekly sessions and assessment of well-being and stress levels were done pre- and post-treatment. At post-treatment, all patients reported increased feelings of control over pain, increased ability to calm themselves and felt greater relaxation and more control over their stress levels following the sessions. Based on the results, the author stated that further investigation into the relationship between practising stress management techniques and their effects on well-being in patients with Crohn's disease appears warranted. In addition, it was noted that future studies should focus on stress prevention for Crohn's disease patients. Perhaps these and other stress management techniques could be employed before illness or exacerbation of symptoms occur. However, this study did not use a control group for comparison to the treatment group. Additional data using a control group would be essential for future studies of this type. A failure to monitor symptoms of subjects was also a major weakness of this experiment. Assessment of symptoms is essential to determine or infer a true relationship between stress management and the clinical course of Crohn's disease.

Milne, Joachim, and Neidhardt (1986) conducted an experiment designed to determine the effects of a stress management program on disease activity and psychosocial functioning in a group of 80 patients with Crohn's disease. Following a pre-intervention interview, where baseline data about symptoms and psychosocial variables were collected, all subjects were then randomly assigned to either a treatment group or control group. The treatment consisted of six classes on various stress management techniques and all subjects were assessed at 4-month intervals for one year. To measure disease activity and psychosocial status the authors used the Crohn's disease activity Index (Best, Becktel, Singleton, & Kern, 1976) and the Inflammatory Bowel Disease Stress Index (Joachim & Milne, 1987). A low score on both indices indicates greater health among participants. The authors found that at all assessment points, scores on both indices dropped significantly ($p > 0.05$) from baseline, indicating a decrease in disease activity in the treatment group. In contrast, there were no significant changes observed in the scores on either index in the control group. Incidently, these changes occurred even after controlling for adjustments in medications. Based on the results, Milne et al. (1986) suggested that stress management techniques may have positive therapeutic benefits for patients with Crohn's disease given that both disease activity and stress levels significantly decreased in the treatment group. What is

particularly encouraging about the results from this study is that the improvements in physical and psychosocial well-being observed in the experimental group were sustained over a one year period. This is very encouraging as patients with Crohn's disease may improve both their physical and psychosocial status as a result of participating in long term stress management programs. It would be quite interesting to see if exercise training would be an effective stress management technique for reducing stress levels and symptoms in these individuals. The authors noted that their results were obtained in a relatively healthy patient population and it is possible that the positive effects of stress management techniques may be even more significant in patients with more severe disease. There was only one major weakness in this otherwise excellent study. The researchers did not initially match the subjects for symptom severity at pre-treatment, so therefore, the improvement in the treated group may have represented a treatment effect or regression to the mean on the dependant variable (Schwartz & Blanchard, 1991). This potential confound would have to be addressed in future experiments of this type.

Schwartz and Blanchard (1991) recruited 21 adult patients with Crohn's disease and performed a randomized controlled trial to assess the effectiveness of psychological intervention techniques on symptom incidence/exacerbation. Eleven subjects were randomly assigned to a treatment group

and the remaining subjects served as controls. All subjects kept daily records of the major symptoms common to Crohn's disease and noted them on a five point scale (0 indicates not a problem, 5 would be a debilitating problem). Subjects in the experimental group received 12 treatment sessions consisting of several psychological modalities such as muscle relaxation training, biofeedback, coping strategies and an educational session relating to IBD symptoms. The IBD Stress Index (Joachim & Milne, 1987) was one of the instruments used to assess psychological well-being in all subjects. The authors found that the treatment group improved on five out of eight symptoms, with abdominal pain displaying a statistically significant reduction at post-treatment as compared to pre-treatment. The control group also improved on all eight symptoms. During the follow-up, patients in the experimental group tended to lose the treatment gains and as a whole, the controls showed greater improvement in symptoms than the treatment group. The overall IBD Stress Index Score decreased significantly in the treatment group (41.8 to 31.0) from pre- to post-treatment. Despite the somewhat surprising trends, the researchers emphasized that the results were generally positive, as the treatment group did perceive themselves as coping better and feeling less Crohn's disease-related stress and anxiety than did the controls. The symptom ratings in all subjects were generally positive with over 70% of the symptom ratings decreasing for the sample as a whole. The authors

could not explain why the combination of stress management techniques employed in this study were not as effective in reducing symptoms as demonstrated in previous research. However, a larger sample group would be useful for future replications of this study to determine if similar trends still occur. Larger sample groups will allow for more generalizability of the results and a more accurate test of the variables in question. Use of a randomized control that was one of the greatest strengths of this study.

In addition to the effects of stress on disease activity in Crohn's disease, several studies have also been done to determine the extent of patients well-being, overall perceived health status and quality of life related to Crohn's disease.

Drossman, Leserman, Mitchell, Li, Zagami and Patrick (1991) looked at health status and health care use in 671 randomly selected patients with Crohn's disease. Variables relating to physical, psychological and social functioning were measured in all patients over a 12-month period. Health care utilization and medication use were also assessed for all subjects. The authors found that although there were a high number of symptoms and complications among all patients, their overall psychological status was rated as good. However, the investigators emphasized that despite these encouraging results, the subjects with Crohn's disease reported poorer physical health, including more severe symptoms, greater disease activity, more steroid use, as well as a poorer

overall health perception. Patients also reported lower levels of general well-being and higher health care use. Drossman et al. (1991) concluded that patients with Crohn's disease may experience more psychosocial difficulties due to greater symptom severity and disease activity and thus, these individuals should be targeted for intervention to reduce these stressors. It is important to note that this is where exercise training may be effective as an intervention technique for reducing stress and increasing well-being in these individuals.

Conversely, North, Alpers, Helzer, Spitznagel, and Clouse (1991) discovered that stressful life events did not significantly precipitate exacerbations of symptoms of a sample of 24 patients with Crohn's disease. During a 2-year long prospective study, 24 patients from a university GI clinic completed a stressful life events and depression scale on a monthly basis. An inventory of intestinal symptoms was also completed monthly using items adapted from the Crohn's Disease Activity Index (Best et al., 1976). Using a time-lagged analysis, the authors found no evidence that depression or stressful life events precipitated exacerbation of the disease nor was a positive association with variations of symptoms observed in this sample group. Stressful life events were not associated with the gastrointestinal symptom scale at any point during this study. A mean of 2.2 exacerbations was observed per subject during the study period. Based on these

findings, the authors concluded that clinicians should be cautious in attributing any significant etiologic importance of stressful life events on disease activity in patients with Crohn's disease. Although there seems to be a mild association between stress and intestinal symptoms, it was noted that any hypotheses concerning the stress-symptom-exacerbation relationship in Crohn's disease can only be validated given carefully designed prospective research. However, any future replications of this experiment must employ a larger sample size to clearly establish a true cause and effect relationship among these variables.

Although many studies have suggested a stress-symptom relationship in Crohn's disease; the findings should be interpreted with caution. Causality between these variables has not been established, as a few researchers have found that stressful life events do not necessarily lead to exacerbations of established disease in various sample groups. North and Alpers (1994) stated that one of the major limitations in this area of research is that increasing complaints of symptoms during time of stress may be mistakenly assumed as a reflection of disease activity. The subjective symptoms of Crohn's disease may worsen under stress even though objective measures of disease activity do not represent an exacerbation. In addition, the large variance that is observed in both disease activity and response to stress among patients limits the validity of existing measures of stress and symptoms.

Garrett et al. (1991) suggested that prospective studies should be employed where the influence of stressful life events on both the signs and the symptoms of Crohn's disease can be more accurately measured.

Based on the current literature, the effects of negative life stress may or may not affect the health status of patients with Crohn's disease. The individualistic manner in the way patients respond to the stresses of having the disease and in their daily lives highly reflects the inconsistencies found in the literature regarding stress and Crohn's disease. However, many clinicians have observed a stress-illness relationship in many patients with the disease, thereby lending support for the promotion of stress management programs and therapeutic intervention for this population. Future research will be directed towards understanding the roles of the GI tract, the brain and the immune system in the mediation of the stress response and if there are any significant relationship between behavior and symptoms in Crohn's disease (Collins & Croitoru, 1993). If, in fact, stress affects the course of Crohn's disease, then clinicians must develop appropriate intervention techniques to help patients deal more effectively with stress and the demands of the disease (Garrett et al., 1991).

Although never formally researched until now, this investigator strongly believes that exercise intervention

should be an important part of the stress management regime for these patients.

Exercise and the Stress Response: Psychoneuroimmunology

In order to understand the hypothetical relationship between exercise training, stress and Crohn's disease, the interactions between exercise, the stress response and psychoneuroimmunology must be addressed. If, in fact, the signs and symptoms of Crohn's disease are exacerbated by negative life stress, and if exercise intervention can help alleviate the detrimental effects of these stressors, the physiological parameters that mediate these responses are an essential part of this complex puzzle.

A summary of selected health-related benefits associated with regular exercise training includes: a reduced risk for cardiovascular disease and hypertension, prevention and control of Type II diabetes and osteoporosis and stress relief (Rosato, 1990).

The field of exercise immunology is a fairly recent phenomenon, as researchers are attempting to isolate the effects of exercise training in reducing illness predilection for persons already susceptible to or afflicted by immune disease or dysfunction (Nash, 1994). Many fitness professionals now believe that moderate exercise training may provide resistance to infection and strengthen an individual's immunity to ward off illness or influence the course of previously diagnosed disease (The Canadian Fitness and

Lifestyle Research Institute, 1994). It appears that there is an optimal level of regular physical activity conducive to resistance to illness, although the specific type, frequency and intensity of exercise are unknown at this point (Traeger-Mackinnon, 1994). LaPerriere et al. (1994) have proposed regular exercise as an intervention technique for the treatment of a wide variety of illnesses and for the promotion of heath.

Psychoneuroimmunology (PNI) is a cross-disciplinary field that is rapidly becoming an essential link in the understanding of the interactions between exercise, neuroendocrine mechanisms and stress on immune system functioning. More specifically, psychoneuroimmunology is the study of the interrelationships among psychological, neuroendocrine and immunological parameters and is concerned with how these mechanisms may affect an individual's health (Traeger-Mackinnon, 1994). LaPerriere et al. (1994) have developed a psychoneuroimmunology model that conceptualizes the stress-related modulations that affect the immune, endocrine and nervous system functioning (Figures 4 and 5). The authors described the PNI model as a conceptualization of the stress-related effects on the autonomic nervous system, neuroendocrine mechanisms and neuropeptides, and the effects of these agents on the immune system of a compromised host. LaPerriere et al. (1994) hypothesized based on the PNI model that these physiological influences may have devastating

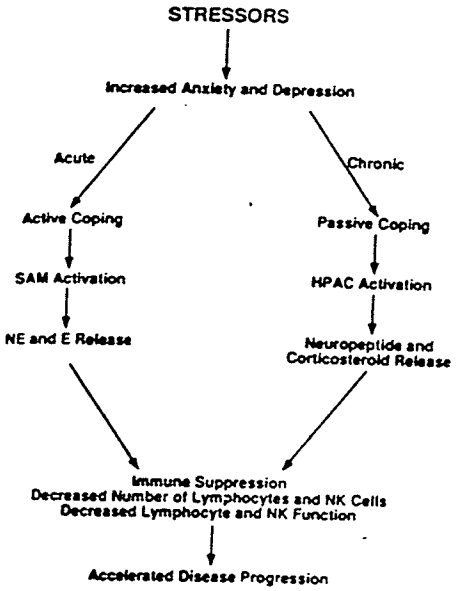


Figure 4

A suggested psychoneuro-immunologic model for stress-related immuno-modulator effects.

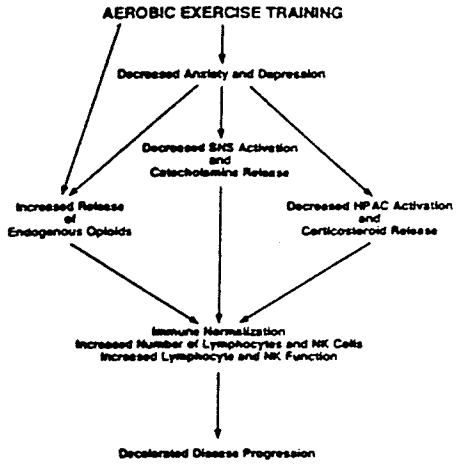


Figure 5

A heuristic "exercise and psychoneuroimmunology model

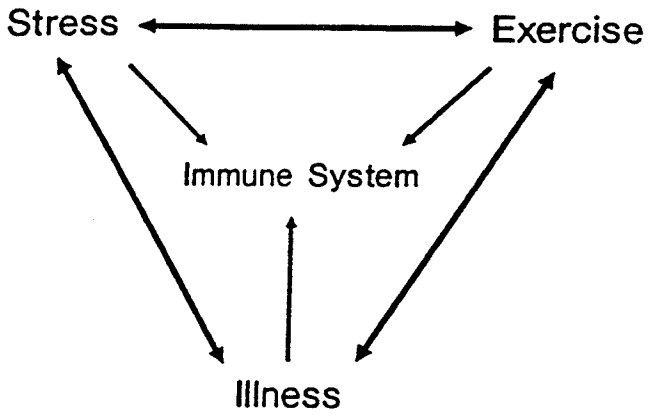
Redrawn from: LaPerriere, A., Ironson, G., Antoni, M. H., Schneiderman, N., Klimas, N., & Fletcher, M. A. (1994). Exercise and psychoneuroimmunology. Medicine and Science in Sports and Exercise, 26, 182-189.

consequences on the health status in those with chronic illnesses related to immunologic dysfunction and/or inflammation. What may be crucial is the understanding of the possible interactions between the PNI model and the etiopathogenesis/exacerbation of Crohn's disease and the possible mediating role exercise intervention may have in the prevention of these detrimental physiological effects from stress.

The relationship between exercise and psychoneuroimmunology is becoming more evident as clinicians are currently investigating the role of neuroendocrine factors in regulating the immune response to exercise, understanding the effects and specific type of moderate exercise for patients with diseases that involve the immune system and how exercise can modulate the stress response (Traeger-Mackinnon, 1994). Researchers have discovered that elevated levels of stress hormones, including cortisol, the catecholamines (adrenaline) and adrenocorticotropic hormone (ACTH) are associated with several immunosuppressive effects. These effects include an impairment or modification of T lymphocytes, macrophages and natural killer (NK) cell activity, cells that are an important part of the overall immune system response. These hormonal changes occur simultaneously with increased activation of the sympathetic nervous system and/or the hypothalamic-pituitary adrenocortical system (LaPerriere et al., 1994). These systems are primarily activated during "fight or flight"

arousal stage of the stress response (Rosato, 1990). Furthermore, Traeger-Mackinnon (1994) suggested that stress, exercise and illness can be observed as three points on a triangle, where exercise, stress and illness all have independent effects on immune function and they can all interact with each other (Figure 6). The author also stated that stress is a known contributing factor to illness and regular exercise training may reduce the detrimental physiological effects that occur when one is under stress. The exact physiological mechanisms that are responsible for the protective effects of exercise on stress are uncertain. However, several hypotheses have been proposed in the literature, including: a decreased heart rate from aerobic training; decreased B-adrenergic myocardial responses to physical and mental stressors; down-regulation of the sympathetic nervous system and increased parasympathetic control and the modulation of several of the stress hormones, particularly the catecholamines (adrenaline and noradrenaline) that are produced by the adrenal medulla during stress (LaPerriere et al., 1994).

The clinical implications of exercise-associated immune and neuroendocrine changes are not well understood. Research that has been conducted so far has focused mainly on the influence of physical fitness on stressful life events in various population groups.



—Theoretical model of the interrelationships between stress, exercise, illness, and the immune system.

Figure 6: Theoretical model of the interrelationships between stress, exercise, illness and the immune system.

Redrawn from: Traeger-Mackinnon, L. (1994). Current challenges and future expectations in exercise immunology: Back to the future. Medicine and Science In Sports and Exercise, 26, 171-174.

Roth and Holmes (1985) studied the effects of physical fitness (aerobic capacity) on stress levels and physical health in 112 subjects. Each subject first reported their stress levels for the preceding 12 months and had their fitness assessed with a submaximal bicycle ergometer test. For the following nine weeks, all subjects kept records concerning their physical health (illness, physician visits) and at the end of this period, each subject completed a questionnaire that measured psychologic symptoms (stress and anxiety). A multiple regression analysis revealed that a high level of life stress during the preceding 12-month period was related to poorer subsequent physical health for subjects with a low level of fitness. For subjects who had high fitness levels, reports of negative life stress seemed to have little impact on their overall health. The authors concluded that physical fitness may be a reliable moderator variable in the stress-illness relationship. Persons with high levels of cardiorespiratory fitness who experience high levels of stress still report fewer health problems than their less fit counterparts. Despite the encouraging results, there were a few limitations to this study. First, their sample group consisted of young, healthy adults so the extent to which the results of this study can be generalized to other populations is severely limited. It would have been interesting to see if groups with stress-related diseases would have experienced similar results on the effects of physical activity in

reducing life stress. Second, the authors failed to describe the initial fitness levels of all the subjects which may have skewed the results. Third, the subjects participated in this study as part of a psychology course requirement, which makes the motivation of the subjects and thus, external validity of the study questionable. Fourth, and most importantly, the underlying physiological mechanisms that are responsible for the results are unknown. Future research in this area should be directed towards finding out why these interactions occur and how we can apply these concepts to the general populations, those that are healthy and those with disease.

Brown (1991) studied the role of physical fitness as a moderator of life stress. One hundred and ten subjects (37 male and 73 female) documented physical health visits/illness over a one year period, stress levels from the preceding 12 months and self-report measures of physical activity were done on a weekly basis. A submaximal bicycle ergometer test was also used to determine subjects' aerobic capacity. The author found that life stress was significantly related to illness among those subjects with a low level of physical fitness and life stress had little impact among subjects with a high level of physical fitness. In addition, these interactions were observed even after variables of psychological distress were controlled for. Based on the results, Brown (1991) suggested that stressful life events were associated with deteriorating health status among subjects who exercised infrequently and

that moderate to high fitness levels may buffer the damaging physiological affects of life stress. It was hypothesized that exercise training may serve as a temporary outlet from life stress and may allow people to deal with stressful events more effectively. There were several limitations in this research study. Similar to Roth and Holmes (1985), the subjects used in this study were also young, relatively healthy college students. Not only are young people probably more healthy than older people, but the stressful events that college students encounter are different than those of the general population. The results may have been different if older or persons with disease were used and if subjects were randomly allocated from the general population rather than college campuses. Although the author used two direct methods of assessing fitness and health status (submaximal bicycle test and examining subjects' visits to a physician), self-reports of fitness and life stress were also used, thereby increasing the potential biases and confounds (i.e., forgetting) in this study. More objective measures of stress and fitness need to be used in future research to reduce these types of problems. Lastly, the author could not explain the physiological mechanisms that facilitate the positive influence of physical activity on decreasing stressful life events and enhancing health status. The clinical implications of exercise-associated changes in the stress response and on

general health are not well understood and have yet to be determined in the current literature.

King, Taylor, Haskell, and DeBurk (1989) performed a randomized, controlled trial looking at the effect of regular aerobic exercise on psychological health. One hundred and twenty subjects (60 male and 60 female) who were middle-aged and sedentary were randomly assigned to either a six month staff-monitored home-based aerobic exercise program or to an assessment-only control group. Physiological assessment (body weight, symptom-limited test) were done at baseline and at six months. Psychological measures (self-report stress questionnaire) were taken at baseline and bi-weekly through the six month period. The authors found that the exercise group reported less stress and anxiety than the controls and improved in functional capacity (VO_2 Max). King et al. (1989) noted that the findings in their study are especially encouraging due to the fact that they used a randomized control group and initially sedentary individuals, which eliminate the confounding effect due to selection factors. Many of the research studies in this area have been plagued with the problem of lack of randomization and control groups. In addition, this study used a six month training interval which is longer than that of other studies done in this area. The authors cited the American College of Sports Medicine (1991) who noted that such a training period provides an ample period of time for both physiological and psychological

effects from exercise training to occur. As with most studies in this area, self-report measures of physical activity and psychological well-being may limit the validity of the results. Subject characteristics like motivation, lying, forgetting and the Hawthorne effect may have confounded the data collected in this study. In addition, the subjects in the control group may have tried harder simply because they were in a control group. The external validity of this experiment is greater than in previous studies given that a middle-aged, sedentary population was used as a representative sample.

In terms of physiological comparisons, several studies have investigated the effects of cardiorespiratory conditioning on psychological stress.

Holmes and McGilley (1987) conducted an experiment to determine the influence of a brief aerobic training program on heart rate and subjective response to a psychological stressor. Sixty-seven female students were given a questionnaire to determine their initial fitness levels. Aerobic fitness was then assessed by a 12 minute walk/run test. Subjects were then classified into one of two groups, low-fit or high-fit. A no-training condition was also used. The aerobic training program consisted of an aerobic dance class that met for two 50 minute periods per week for 13 weeks. Subjects responses to a psychological stressor (completing a questionnaire to assess cognitive arousal

proceeded by a memory test) were assessed before and after the training/no training period. Heart rate was measured using an ECG monitor. The authors found that prior to fitness training, the low-fit subjects displayed greater heart rate and subjective responses to the stressor than did the high-fit subjects. Thus, the low-fit subjects were observed to be more sensitive to the effects of stressors. In addition, it was found that the aerobic training program was effective, compared to the no-training condition for reducing heart rate response of low-fit subjects to a psychological stressor. After training, these subjects showed moderate responses similar to those of the high-fit subjects. Based on the results, the authors concluded that aerobic training may be an effective way of helping low-fit individuals deal with psychological stressors. Despite the encouraging results, there were a few limitations in this study. First, subjects were young (17-20 years), healthy female students thus, limiting the external validity of the results. Male and older persons should have been included in this sample. Second, subjects were not randomly assigned to the training or no-training groups. Although the authors defended this by saying that there were not any systematic initial differences between subjects in these conditions, there still remains the possibility of many extraneous influences in the sample groups. Equivalency of groups cannot be assumed at baseline for these conditions. Third, the authors hypothesis that

aerobic training would be influential on the low-fit subjects' heart rate response would normally be expected because lower-fit persons tend to improve in aerobic fitness quickly and higher-fit persons do not have as much room for improvement in heart rate. Fourth, it is unclear whether an aerobic training program done only twice per week would make a significant difference over a longer assessment period in subjects' fitness levels. The authors should have used the American College of Sports Medicine (1991) guidelines for aerobic fitness, where the minimum frequency of training is three days per week.

Goldwater and Collis (1985) investigated the psychological effects of cardiovascular conditioning of 32 sedentary male subjects aged 19-30 years. Subjects were randomly assigned to either an experimental group (6 weeks of participation in strenuous endurance exercise, 5 days per week) or to a control group (2 weekly, 60 minute sessions of static stretching and games like badminton). Subjects were told of the existence of the two groups but their different status was not explained. Subjects were administered a number of psychologic scales as well as a general, subjective well-being questionnaire before and after the six week training period. Both groups were tested for cardiovascular fitness before and after the six week program. The authors found that the cardiovascular training group demonstrated a significantly greater improvement in cardiovascular fitness than the control

group and also showed a greater reduction in anxiety and stress. It was concluded that physical fitness conditioning may lead to an improvement in psychological functioning and a capacity to deal more effectively with life stress. As with previous studies in this area, subject characteristics were the major limitation in this study. Healthy, young male students were recruited to participate in this study, thus the external validity of this study is limited and the results cannot be generalized to the overall population at large. Subjects were also recruited based on the nature of the study "Work Out for Pay". Each subject received twenty-five dollars for completing the program. Motivation may have been a significant factor for subjects who volunteered for this study, and thus we have to question the validity of this study. Selection factors may have biased the overall results of this study. Also, six weeks of training may not be long enough to observe true changes in fitness and stress levels. Extraneous variables would likely have influenced subjects' responses during this short time period. The internal validity may be limited given the subject characteristics and reliance on self-report measures.

Interestingly, DeGeus, Van Doornen, de Visser and Orlebeke (1990) found that a short (7 week) cardiovascular training program did not significantly reduce stress-reactivity or recovery in subjects. A group of sedentary subjects were exposed to several laboratory tasks that are

known to increase blood pressure. The authors found that there are significant individual differences in aerobic fitness despite that all subjects reported low levels of activity. In addition, diastolic blood pressure reactivity was negatively related to the pre-existing differences in fitness and neither B-adrenergic cardiac reactivity or heart rate responses were related to fitness levels in these subjects. The authors concluded that seven weeks of training was not effective in changing stress reactivity among subjects and it was suggested that training of a longer duration is necessary to induce the psychological and physiological improvements related to exercise training to emerge. Consequently, nowhere in their study did the authors mention any subject characteristics in terms of sex, number of subjects used, health status and specific activity levels. This severely discredits the validity of this study as the reader does not know who participated in the study except for one statement: a homogenous, sedentary population. The results of this study are thereby severely limited given the vague description of the sample group.

Although current research suggests that exercise training may buffer the adverse effects of stressful life events, the investigations that have been done thus far do not provide us with any clear indication of whether we can effectively or practically change fitness levels sufficiently to alter the response to stressful situations (Holmes & McGilley, 1987).

To date, studies done in this area have not established a true cause and effect relationship between stress and exercise training and many of the physiological influences that mediate this relationship remain unclear. In addition, the extent to which the stress-exercise interaction predicts increases in illness over and above the variance already observed between initial and later levels of stress are unknown (Brown & Siegal, 1988). The major limitations of the research in this area are in the research design of the experiments. Lack of randomization and control groups, using healthy, young sample groups, short training programs, lack of controlling for the individualistic response to stress and the use of self-report measures may limit the significance of the results of these types of studies.

However, given the promising preliminary findings from the current literature that exercise training seems to lower stress levels and enhance health, further inquiries into these relationships appears to be warranted (Sinyor, Schwartz, Peronnet, Brisson, & Seraganian, 1983).

Exercise and the Immune System

The relationship between exercise and the immune system has been the subject of interest among researchers for many years. The current literature has suggested that there is a definite association between physical activity and immune function and many immunomodulations that occur as a result of exercise training have been isolated (Calabrese, 1992).

Recent research studies have suggested that moderate exercise training like walking for example, has immunomodulating effects while exhaustive, intense exercise may suppress immunity (Fitzgerald, 1991). Among the major immunological changes that occur with moderate exercise training are: a significant increase in natural killer (NK) cell activity and cell count; an increase in serum immunoglobulin levels and a moderate increase in T lymphocytes (Nieman & Nehlsen-Cannarella, 1991). Immunoglobulins have important antibody activity in the immune response.

A recent study by Nehlsen-Cannarella, Nieman, Balk-Lamberton, Markoff, Critton, Gusewitch and Lee (1991) reported a 57% increase in natural killer cell activity and a 20% increase in serum immunoglobulins in a group of middle-aged women who participated in a walking program at 60% heart rate reserve, 45 minutes per day, 5 days per week for 15 weeks. These changes were observed at six weeks and at 15 weeks of exercise. The authors were uncertain whether these adaptations would be similar using a longer, more intense training program. Similarly, Keast and Morton (1992) stated that moderate, long term exercise in the form of brisk walking has been shown to significantly enhance the levels of serum immunoglobulins in various sample groups.

A number of studies have reported interesting results regarding the effect of acute, intense exercise on the response of helper T and suppressor T cells.

Verde (1992) cited that in 12 male subjects who performed a maximal treadmill test, there was a significant increase in the percentage of suppressor T cells (32.7% to 36.4%) and a significant decrease in the overall ratio of helper/suppressor T cells, from 1.94 to 1.36. Murray, Irwin, Rearden, Ziegler, Motulsky and Maisel (1992) reported slightly different results from their study of 20 male subjects who performed an exhaustive exercise session on a treadmill. The authors observed a sharp rise in the suppressor T count and a modest increase in the percentage of helper T cells. These changes in the proportions of helper T cells and suppressor T cells after exercise appear to be transient in nature and highly dependant on the exercise intensity. At higher intensity levels (75% of VO_2 Max for 60 minutes), the greatest reductions in helper T cells have been observed, indicating that higher intensity training seems to have more detrimental effects on immune system functioning (Verde, 1992). However, whether these changes are transient in nature or appear with chronic training is still unknown.

Lin, Jan, and Chen (1993) investigated the effects of acute exercise training and immune response in rats. Rats were placed into three exercise groups, mild, moderate and severe and each group ran on a drum exerciser for ten minutes. The authors found that in the mild and moderate exercise groups (50-70% VO_2 Max), there was a significant enhancement of immune cell proliferation with less enhancement observed in

the severe exercise group (75%+ VO_2 Max). All of the exercise groups displayed an increase in interleukin-2 (IL-2) production and an enhanced spleen cell proliferation to T and B lymphocytes. Unfortunately, there was no sedentary control group in this study to compare the effects of exercise vs. no exercise on immune cell functioning. There may have been significant differences observed between these groups. Hoffman-Goetz (1986) as cited by Ferry, Weill, and Rieu (1990) found similar results as Lin et al. (1993) where T lymphocyte blastogenesis increased in a group of sedentary mice following 30 minutes of moderate exercise (60% VO_2 Max) on a treadmill.

Despite the well documented clinical evidence that moderate exercise training has a positive effect on the immune system functioning, the physiological mechanisms that are responsible for these changes are still hypothetical. Smith and Weidemann (1990) as cited by Traeger-Mackinnon (1994) proposed that moderate exercise training may enhance resistance to illness or infection by activating the release of various immunostimulatory factors like growth hormone and cytokines for example, into the circulation. Conversely, intense, chronic exercise may reverse these beneficial effects by increasing circulating immunosuppressive factors like glucocorticoids and ACTH into the bloodstream. The clinical implications of exercise-associated immune changes are not well understood as the specific type, frequency and intensity of exercise training needed to induce positive immunological

changes remain elusive. However, despite these challenges and limitations, the influence of well-prescribed physical activity on immune function has important implications for individual health as well as disease prevention and management (Nash, 1994). It seems probable that for diseases with a strong immunological component, like Crohn's disease for example, the immunomodulating effects of moderate exercise training would be beneficial for these individuals, who consequently, may have abnormal immune system functioning or are deficient in several immune cell parameters.

In summary, LaPerriere et al. (1994) have integrated all of the suggested physiological effects of exercise and have proposed an exercise and psychoneuroimmunology model. The authors designed this model as a demonstration of how moderate exercise training may prevent or reduce episodes of illness, enhance health status and decrease the progression of chronic disease, particularly those disorders that are immunosuppressive in nature. The relationship between exercise and psychoneuroimmunology is very complex as researchers are attempting to isolate the various immunodeficient diseases that may benefit from exercise intervention. The stress-illness association has been proposed as being a predominant factor in the exacerbation of many diseases, including Crohn's disease, and exercise has been shown to modify the detrimental effects of stress in various population groups. Although the underlying mechanisms

influencing the stress-reducing benefits of exercise are unclear, moderate exercise is associated with psychological and physiological benefits that enable participants to cope with stress more effectively (Berger, 1994). Waranch (1988) stated that there is persuasive evidence that psychological stress plays a significant role in the exacerbation of Crohn's disease and an estimated 60% of all gastrointestinal disorders are influenced somewhat by negative life stress. Therefore, given the current scientific evidence, it appears that there may be a significant relationship between Crohn's disease, exercise intervention and psychoneuroimmunology. The questions that remain unanswered by researchers are whether or not exercise intervention can modulate daily stress in patients with Crohn's disease. Thus, if stress levels are reduced as a result of exercise training, will there also be a simultaneous reduction in symptom incidence and exacerbation of these patients? These are important questions that need to be answered in the near future as exercise intervention could be an essential part of the therapeutic process for patients with Crohn's disease.

Exercise Intervention and Crohn's Disease

Current research in the field of psychoneuroimmunology has demonstrated that there are significant interactions between the neuroendocrine and immune systems and that lifestyle factors like stress, for example, may play a role in modulating the immune response. Researchers have attempted to

isolate the effects of exercise training on these parameters with the main focus being on identifying the role of neuroendocrine factors in regulating the immune response to exercise; understanding the effects and appropriate type of moderate exercise in patients with diseases that involve the immune system and the possible long term role of regular exercise training in preventing certain diseases (Traeger-Mackinnon, 1994). The underlying mechanisms that influence the stress-reducing benefits of exercise training are unclear. However, regular exercise training is associated with psychological and physiological benefits that allow participants to cope with life stress more effectively (Berger, 1994).

Although it has been shown that regular physical activity may prevent or modulate many chronic diseases including heart disease, diabetes and arthritis, the effects of exercise training on the prevention and treatment of Crohn's disease are less known. To date, there have been no studies done on the effect of exercise intervention on disease activity and stress levels of patients with Crohn's disease. In terms of exercise training as a preventative measure against the development of Crohn's disease, a few select studies have suggested that there is a protective effect.

Sonnenberg (1990) investigated the distribution of Inflammatory Bowel Disease (Crohn's & Ulcerative Colitis) among individual occupations. From 1982 to 1988, the author

assessed the occupations of 12,014 male and female subjects. The investigator discovered that in both sexes, the occurrence of IBD was low among workers with physically demanding jobs (construction, machinists, etc.) and high among those persons with sedentary occupations. It was concluded that physically demanding jobs are associated with a lower incidence of IBD. The physical activity seemed to elicit a protective effect among this sample group, although the reasons for this trend could not be explained. The author did report that there may have been several biases in this study that may have skewed the reported data. The occupational risks could have been associated with other factors like socio-economic status, less access to medical care, family history of the disease and the previous occupations of the subjects were not taken into consideration. Also, the author failed to stratify the sample group in terms of which subjects had Crohn's disease and which had Colitis. Therefore, it is difficult to say which group may have benefited more from a physically demanding occupation. This study did, however, have a large sample size which could act as an overall representation of the population with IBD. The elimination of the extraneous variables mentioned and the identification of subjects with Crohn's disease could allow a future replication of the study. The longitudinal nature of this study was the greatest strength of this research design.

Persson, Leijonmarck, Bernell, Hellers and Ahlbom (1993) investigated the association between physical activity and IBD in a case control study consisting of 184 subjects with Crohn's disease, 181 with Colitis and 305 controls. Information was collected using a postal questionnaire during the period from 1980 to 1984. Participation in physical activity was measured based on a daily, weekly or less often scale. The authors found that the relative risk (RR) of Crohn's disease was inversely related to regular physical activity participation based on activity reported over the past five year period and was estimated at 0.6 and 0.5 for weekly and daily exercise. In addition, for present activity levels, 20% of the patients versus 23% of the controls had decreased their physical activity during the last five years and 17% of the patients versus 16% of the controls had increased their activity levels. Based on the results, Persson et al. (1993) concluded that high physical activity levels among patients seemed to decrease the risk for Crohn's disease and this effect was significant even after adjusting for other risk factors like oral contraceptive use, smoking and dietary factors. Consequently, the authors emphasized that the specific mechanisms that may be responsible for this protective effect are unknown and require further investigation. One important flaw in this study was that the authors failed to specify which types of physical activity were reported by each subject. It is essential to know the

exact types of physical activity required to elicit these protective effects against the development of Crohn's disease.

Despite the positive results from these two studies, few other researchers have investigated the effects of exercise training on the etiopathogenesis and disease activity of Crohn's disease. Although the results have been fairly consistent that physical activity may provide a protective effect against the development of Crohn's disease, these types of studies need to be replicated in order to accept these hypotheses as scientifically valid. The Crohn's and Colitis Foundation of Canada (1993) suggested that patients with Crohn's disease should engage in regular physical activity to help reduce anxiety and life stress. They emphasized that physical activity can help produce a sense of well-being and being active will help patients to better cope with their disease and feel better about themselves. Although these recommendations did not include physical activity as a way to alleviate symptoms, exercise intervention may play an important role in reducing stress and increasing patients' quality of life which in turn, may reduce the incidence and exacerbation of symptoms. Future research in this area is essential to determine whether or not exercise training will have an enhancing effect on patients' overall health status.

Crohn's Disease and Low Bone Mineral Density

From a purely physiological standpoint, an important reason for individuals with Crohn's disease to participate in

regular physical activity is because they are at risk for low bone mineral density, which consequently may lead to osteoporosis or other skeletal disorders. Among the reasons for the increased risk for low bone mineral density in these patients are: reduced calcium intake, reduced physical activity, surgical resection of the intestine, malabsorption of vitamin D and corticosteroid therapy (Pigot, Roux, Caussade, Hardelin, Pelleter, Dupuy-Montbrun, Listrat, Dougados, Couturier, & Amor, 1992)

Pigot and colleagues (1992) studied the prevalence for low bone mineral density in 61 patients, 27 with Crohn's disease and 34 with Colitis. Bone mineral density was measured by dual energy x-ray absorptionetry at the spine and femoral regions. Dietary factors, hormonal status, physical activity, body weight and corticosteroid use were also assessed. The authors found that in 23% of the patients, all of them having received steroid therapy, their bone density at both regions were more than 2 SD below normal values. In 24% of the patients who did not receive steroid therapy, bone mineral density was not different from those subjects who had been on steroid therapy. Consequently, the authors noted that the patients with Crohn's disease received steroid therapy more often than the patients with Colitis. Incidently, individuals with Crohn's disease tend to be lower in body weight and intakes of calcium may be low due to disease activity, decreased appetite and malabsorption. Pigot et al.

(1992) concluded that bone mineral density is low in patients with Crohn's disease and this disease exposes them to a higher risk for bone fracture. The authors concluded that reduced physical activity in the past and during periods of active disease may explain in part the reduced bone density observed in this sample group. One weakness in this study was that the authors were not specific in terms of the type and frequency of physical activity reported by the subjects and overall physical activity participation was only assessed during the month before the study began. This does not allow a satisfactory explanation of how the pattern of participation in physical activity may have influenced the risk for bone loss in these subjects. A longer assessment period regarding the exact type and frequency of exercise would have been more beneficial for this study and would have allowed more definite conclusions regarding the effects of physical activity on bone loss of patients with Crohn's disease.

Abitol, Roux, Caussade, Guillemant, Kolta, Dougados, Couturier and Amor (1995) conducted a cross-sectional study by assessing bone metabolism in 84 patients with IBD. Thirty-four patients had Crohn's disease and 50 had Colitis. Clinical, dietary and spinal assessments were performed for all patients and bone metabolism was assessed by measuring the levels of regulating hormones. Physical activity levels were included in the clinical assessment. The authors found that bone turnover in these patients is characterized by low bone

formation in the presence of normal levels of calcium regulating hormones. Low serum osteocalcin levels were observed in 29% of the subjects. Based on the results, the authors suggested that patients with IBD that are at risk for low bone mineral density are those who have low osteocalcin levels, have high inflammatory syndrome (disease activity) and have a high corticosteroid intake. However, the authors failed to mention the effects of physical activity in the study and did not exemplify how they assessed levels of physical activity and did not include any of this data in the results of the study. It would have been interesting to see if physical activity had any significant effects on the metabolic bone assessment in this sample group. The potential differences in bone density among patients who exercise compared to those who do not would have been interesting and would have provided more insight into this area of research.

The role of regular exercise as both a preventative and therapeutic measure for patients with Crohn's disease who are at risk for low bone mineral density has not been given the attention or justification that it deserves in the current literature. Exercise intervention for these individuals should be studied more in depth as there seems to be based on the current research, a positive association between physical activity on the development, pathology and psychosocial mechanisms of Crohn's disease. Exercise may play a key role in the stress-illness relationship of Crohn's disease where

patients who regularly exercise may experience a reduction in symptoms as a result of decreased anxiety and other psychosocial stressors. The interaction between exercise, the immune system and neuroendocrine parameters may be relevant to patients with this disease given the current thinking that the etiopathogenesis and inflammatory mechanisms of Crohn's disease seem to be a result of immunological and neuroendocrine parameters. Perhaps exercise intervention will be able to modify these abnormal immunoneuroendocrine responses and thus, strengthen the patient's immunity and stress reactivity. Regular exercise training may also modify the detrimental stress response and thereby, symptoms may be reduced and quality of life and general well-being will be enhanced.

Future research will be able to answer these complex questions and perhaps exercise intervention will be used in conjunction with other therapeutic modalities to help alleviate the physiological and psychological stresses that patients with Crohn's disease encounter every day. The notion that stress, PNI, the brain-gut axis and exercise training may all be interrelated is exciting and hopefully this area will shape the future of GI research.

Exercise Training, Stress and Rheumatoid Arthritis

Given the lack of research concerning the effects of exercise intervention on disease exacerbation and perceived stress levels of patients with Crohn's disease, it is

necessary to analyze an alternative model to which similar hypotheses can be made. Rheumatoid arthritis (RA) seems to be one of the best examples of how exercise training may be beneficial for patients suffering from chronic, immuno-inflammatory disorders. Although the tissue damage/ inflammation that is characteristic of these diseases occur in different regions of the body, Rheumatoid arthritis and Crohn's disease may share similar clinical profiles and pathologies. Periods of remission and exacerbations are characteristic of both diseases; corticosteroid therapy is one of the main forms of treatment for both disorders and the immunoneuroendocrine pathways have been implicated as being both mediators of inflammation and an important part of the stress-illness relationship in both diseases. Considerable attention has been placed on the role of stressful life events in provoking flare-ups and disease progression in Rheumatoid arthritis and Crohn's disease. Although a true cause and effect relationship between stress and course of illness in patients has yet to be established, recent advances have been made in attempting to identify the specific neuroendocrine and immune parameters that likely mediate the effects of stress on disease activity (Zautra, Burleson, Matt, Roth, & Burrows, 1994).

The hypothalamic-pituitary-adrenal axis plays a crucial role in the stress response. During the "fight and flight" stage of the stress response, prolactin, ACTH and cortisol are

released into the bloodstream (Sternberg, 1992). In the healthy individual, cortisol suppresses cellular immune function and thus, inflammation is reduced, whereas prolactin stimulates the immune system. These opposing actions allow the body to maintain a normal homeostatic set point (Black, 1994). However, in diseases that have an abnormal immune component like Rheumatoid arthritis and Crohn's disease, the homeostatic mechanisms that normally regulate immunity and thereby, inflammation may not be fully functional (Dorian & Garfinkel, 1987). Researchers have suggested that dysregulation in these feedback systems may be hormonally responsive to stress, thereby increasing immune system activity and possible disease flare-ups (Zautra et al., 1994).

Zautra et al. (1994) examined the relationships among stressful life events, coping, depression and hormones (prolactin, cortisol and estradiol) in a sample of 33 women with RA. Measures of psychological status and physical health were assessed in all subjects as well as radioimmunoassay for hormone levels. In accordance with their hypothesis, the authors found that those patients with higher scores on depression and stressful life events showed higher levels of the stimulatory hormones. In addition, physician joint count and assessment of disease activity were positively correlated with higher levels of these hormones. The authors concluded that these results suggest that poor coping ability to stress may lead to an increase in immuno-stimulatory hormones and

this may activate mechanisms associated with increased inflammatory response leading to exacerbations of the disease. Although the results of this study do not reveal true causality given that immune cell parameters were not measured and a longer assessment period would be needed, this study represents important advances in the area of stress, neuroendocrine factors and disease exacerbation. Similar findings have also been observed in patients with Crohn's disease. The physiologic adaptations that occur in response to stress may be similar in these two disorders.

Interestingly, Swain and Maric (1994) stated that hyporesponsiveness of the hypothalamic-pituitary-adrenal axis (HPA) to stress is implicated in the development of immune-mediated arthritis in rats. This animal model seems to display a pronounced defect in corticotrophin-releasing hormone (CRH), a central nervous system mediator which plays a significant role in the activation of the HPA axis during stress. In addition, researchers are investigating the role of the neuropeptide Substance P in the pathogenesis of Rheumatoid arthritis. Substance P stimulates the production of various inflammatory mediators and has been shown to exacerbate disease activity in RA animal models (Wilder, 1992). However, the clinical relevance of these physiologic abnormalities have yet to be established in human experimental models.

It is interesting to note that these same immunoneuroendocrine factors have also been implicated in the pathogenesis and exacerbation of Crohn's disease. The underlying physiologic mechanisms that cause the uncontrolled inflammatory response in both of these disorders may be very similar in nature and thus, the clinical relevance of implementing similar therapeutic intervention techniques may be warranted.

Current research has indicated that exercise training may be beneficial in the prevention and rehabilitation of various chronic diseases (The Canadian Fitness and Lifestyle Research Institute, 1994). Investigators have observed that regular exercise training seems to decrease disease activity and reduce stress levels in patients with RA (Lyngberg, Harreby, Benton, Frost, & Samsoe-Danneskiold, 1994). The therapeutic value of exercise intervention for patients with Crohn's disease has received little attention in the literature. Exercise training has been overlooked as a potentially beneficial form of therapy for these individuals. Current research suggests that patients with RA are capable of sustaining functioning from physical activity without exacerbating disease activity. In fact, researchers are now concluding that exercise training is a healthier form of therapeutic intervention for patients rather than the commonly prescribed bed rest (Galloway & Jokl, 1993). Relatively few studies have investigated the effects of exercise intervention

on disease activity of patients with Crohn's disease. However, given the similar pathologies and clinical profiles of Crohn's disease and RA patients, it seems relevant to hypothesize that the exercise model for RA may also be applied to Crohn's disease.

Harkcom, Lampman, Figley-Banwell, and Castor (1985) investigated the therapeutic value of graded aerobic exercise training in 20 female patients (aged 27-68) with RA. All subjects were randomly assigned to one of three different aerobic exercise protocols: 15, 25 and 35 minutes of bicycle ergometer training, 3 times per week for 12 weeks. A non-training group served as controls. Assessment of joint count and psychological well-being were done before and after the 12-week period. The authors found that compared to the control group, all exercise groups improved their aerobic capacity, reported a significant decrease in disease activity and symptoms and described improvement in activities of daily living. It was concluded that exercise training up to 35 minutes, 3 times per week can be therapeutic for patients with RA in terms of improving functional capacity and reducing joint pain and activity. Low intensity aerobic exercise can be tolerated by these patients without exacerbating joint symptoms. However, a larger sample group would be necessary for future studies to increase the external validity of the results.

Lyngberg, Harreby, Bentzen, Frost and Samsoe-Danneskiold (1994) investigated the effects of physical activity on sedentary elderly patients with RA who were on low dose steroid treatment. Twenty-four patients were randomly assigned to either a treatment group receiving training (progressive interval training of bicycle exercise and step-climbing, twice weekly for 45 minutes) or to an untrained control group. The training took place over a 3-month period. Clinical assessment of disease activity was performed before and after the experiment. The authors found that disease activity (joint count) did not increase in the trained group and that fewer, although not significantly, swollen joints were observed in this group compared to the controls. In addition, a small reduction in morning stiffness occurred in the trained group but not in the control group. Fitness capacity of the trained group also improved significantly. Although most of the changes observed in the training group in this experiment were not statistically significant, the authors noted that the physical effects of training were beneficial for these patients as they all completed the program without an increase in disease activity and improved in functional capacity.

Interestingly, Minor, Hewett, Webel, Anderson, and Kay (1989) discovered that there were no significant differences between groups in the number of clinically active joints or morning stiffness among a group of 120 patients with RA who

were divided into either an aerobic exercise group or a control group. However, the subjects who participated in the 12-week exercise program displayed significant improvements in walking time, aerobic capacity and reported lower anxiety levels than did the controls. Furthermore, a follow-up assessment of the exercise group one year after baseline revealed that many of the subjects had maintained these improvements and continued to participate in physical activity programs. Based on these observations, the authors concluded that exercise training is beneficial for patients with RA and most patients can endure moderate training programs without exacerbation of symptoms.

Given these encouraging results, it seems that moderate exercise training in conjunction with other therapeutic modalities can play a positive role in the rehabilitation of patients with Rheumatoid arthritis. Exercise intervention is important in the management of RA patients as the current literature suggests that the benefits of regular aerobic exercise include increased bone density, promotes psychological well-being and may reduce joint pain and inflammation (Scott, 1992).

For individuals with Crohn's disease, stress reduction, enhanced well-being and reductions in symptoms would be the most important benefits from this model of therapeutic exercise intervention. The underlying physiologic mechanisms that are responsible for the etiopathogenesis and response to

stress are similar in both Crohn's disease and Rheumatoid arthritis, thereby lending support that exercise intervention may be as beneficial for patients with Crohn's disease as observed in patients with RA.

Literature Review Summary and Recommendations for Future Research

Exercise training plays an important role in the prevention and rehabilitation of many chronic diseases. Participation in regular physical activity is also associated with reductions in negative life stress and improvements in overall psychological health. Psychoneuroimmunology (PNI) is a new multidisciplinary field that encompasses the interactions between immune, neuroendocrine and psychologic parameters on an individual's health and how these mechanisms may leave one susceptible to illness and disease. Exercise training has been proposed as having positive effects on immune system functioning and has been shown to buffer the detrimental neuroendocrine mechanisms that occur during the stress response. A model of PNI, stress and exercise has been established, where exercise training may play a significant role in the stress-illness relationship and thereby, may influence the clinical course of immunologic related disease.

Crohn's disease is a chronic, inflammatory disease of the gastrointestinal tract characterized by periods of remission and exacerbations. The stress-symptom interaction has long

been regarded as being influential in the clinical course of Crohn's disease. Perturbations in the immunoneuroendocrine systems and the brain-gut axis have been implicated in the etiopathogenesis of Crohn's disease and may pose as exacerbators of the disease. The focus of attention is now directed towards implementing exercise training as a form of therapeutic intervention for individuals with Crohn's disease. Rheumatoid arthritis is one of the best models of how exercise training is beneficial for patients suffering from immuno-inflammatory disease. Given the positive associations between exercise, the immune system and stress reactivity, it seems relevant to incorporate this model as a way to reduce symptoms and perceived stress levels in patients with Crohn's disease.

As a result of this review, several questions remain to be answered and thus, suggestions for future research arise. The following is a list of possible future studies.

1. The high degree of individual variation between daily stress and the signs/symptoms of Crohn's disease must be validated and considered in future experiments (Garrett et al., 1991).
2. To determine whether chronic stress negatively affects the clinical course of Crohn's disease and the possible effectiveness of exercise intervention as a stress management technique in larger sample groups of Crohn's disease patients.

3. To incorporate a model of the immunopathogenesis and neuroendocrine modifying factors of the inflammatory response in Crohn's disease with psychoneuroimmunology and the exercise response.
4. Further study in the area of stress prevention - would exercise training buffer the detrimental effects of the stress response and thus, prevent symptom incidence/exacerbation from occurring? (Joachim, 1983).
5. To determine the appropriate types, intensity, and frequency of exercise that will be effective for reducing stress levels and enhancing physical well-being of individuals with Crohn's disease.

CHAPTER THREE

METHODS

Experimental Design

All participants were assigned to a treatment group consisting of a 12-week low intensity walking program. Prior to the exercise program, baseline measures of stress and symptoms were taken over a two-week period. The Harvey and Bradshaw (1980) Simple Index of Crohn's Disease Activity, the IBD-Q (Guyatt et al., 1989) and the Inflammatory Bowel Disease Stress Index (Joachim & Milne, 1987) were administered to all participants throughout a two-week period (at one week and immediately before intervention). The repeated baseline measurements were used to establish more reliable data for initial stress levels and symptoms of participants. In addition, this method helped control for extraneous variables such as extreme outliers (extreme high or low scores on questionnaires) and helped assume equivalency of all participants prior to intervention. The repeated baseline measures also served as the control for the study. This design helped increase confidence in the results, increased adherence, cooperation and enjoyment of the program. The major disadvantage of using this research design, which does not have a "true" control group, is that other variables other than the treatment (walking) may have caused differences in participants' scores. However, using the repeated baseline measures helped increase reliability of the scores prior to

intervention and this helped reduce measurement error and the influence of extraneous variables.

The CAFT Step Test was administered to all participants before the walking program to establish baseline measures of heart rate and predicted VO_2 Max. Body mass index was also calculated for all participants at pre- and post-study.

The Harvey and Bradshaw (1980) Simple Index, the IBD-Q (Guyatt et al., 1989), and the IBD Stress Index (Joachim & Milne, 1987) were then readministered to all participants following completion of the walking program. The Perceived Benefits of Walking Questionnaire was given to all participants following the 12-week program.

Subject Recruitment and Screening

The participants that were involved in this study were recruited on a volunteer basis through the Crohn's and Colitis Foundation of Manitoba and the Inflammatory Bowel Disease Clinic at the Health Sciences Centre. Sixteen participants originally volunteered, however, only 12 completed the walking program (ten female and two male). Two participants dropped out within the first week of the study due to lack of motivation, one dropped out due to an injury sustained just prior to the start of the program and one dropped out in the second week due to hospitalization for Crohn's disease. This person was unwell during the pre-test phase of the study.

All participants were ages 18 and over, diagnosed as having Crohn's disease and were relatively healthy to

facilitate completion of the program. Only sedentary or minimally active individuals who had not made recent changes in their activity level were included in this study. Persons on medications (prednisone, 5-ASA, etc.) were not excluded as this would have severely limited subject recruitment. Medication use was documented for each subject pre- and post-walking. Participants completed an informed consent form (Appendix A), The Canadian Standardized Test of Fitness Consent Form (Appendix B) and a Physical Activity Readiness Questionnaire (Appendix C) prior to intervention to determine whether walking was safe for each volunteer.

Instruments

Harvey and Bradshaw Simple Index of Crohn's Disease Activity

The Harvey and Bradshaw (1980) Simple Index of Crohn's Disease Activity (HBSI) is a numerical index of degree of illness or activity of Crohn's disease. It is one of the most widely accepted and clinically applicable indices in gastrointestinal research. It is also very valuable in assessing long-term progress of patients (Camilleri & Proano, 1989).

The HBSI designed by Harvey and Bradshaw (1980) is a modification of the Crohn's Disease Activity Index (CDAI) by Best, Becktel, Singleton and Kern (1976). The CDAI has eight clinical variables with various scores which are summed to yield a total symptom score indicative of inflammatory activity (Camilleri & Proano, 1989). A score less than 150

indicates low disease activity whereas a score between 150 and 450 indicates increasing severity of disease. However, the CDAI has been regarded as being particularly subjective and cumbersome to calculate as patients must log their symptoms for seven consecutive days.

Harvey and Bradshaw (1980) modified the CDAI by reducing the number of clinical variables to five, simplified the numerical calculation and shortened the period of clinical observation from seven to one day. Similar to the CDAI, a high score on the HBSI reflects greater disease activity. Researchers have stated that the total score may be skewed somewhat by the number of bowel movements the patient reports (Myren, Bouchier, Watkinson, Softley, Clamp, & de Dombal, 1984).

The five criteria that are measured in the assessment of disease activity on the Harvey and Bradshaw (1980) Simple Index are: pain, bowel habits, general well-being, complications and abdominal mass (Garrett & Drossman, 1990).

Harvey and Bradshaw (1980) compared their Simple Index to the CDAI with a sample group of 112 patients attending a gastrointestinal clinic. A correlation of 0.93 ($p < 0.001$) between the two indices was found, indicating that the Harvey and Bradshaw (1980) Simple Index is a very adequate measure of Crohn's disease activity. In addition, a moderate correlation (0.711) was found between the Simple Index and clinical diagnosis of Crohn's disease, lending support that this index

is fairly accurate in assessing inflammatory activity in patients with the disease (Harvey & Bradshaw, 1980). A positive correlation (0.756) was also found between the Harvey and Bradshaw (1980) Simple Index and the Oxford Crohn's Disease Severity Index (Myren et al., 1984).

Although many researchers believe that the current Crohn's disease indices are limited in practicality and objectivity and should be used in conjunction with other laboratory criteria, the Harvey and Bradshaw (1980) Simple Index of Crohn's Disease Activity is one of the preferred measurement tools of many clinical investigators in gastroenterology (Camilleri & Proano, 1989).

The Harvey and Bradshaw (1980) Simple Index of Crohn's Disease Activity is presented in Appendix D.

The Inflammatory Bowel Disease Stress Index

The Inflammatory Bowel Disease Stress Index (Joachim & Milne, 1987) is a questionnaire designed to measure the extent to which the stress of having Inflammatory Bowel Disease (Crohn's disease or ulcerative colitis) causes alterations in lifestyle, interpersonal relationships and self-image. The authors developed this index based on consultation with experts in behavioral medicine and the researchers' own clinical experience with IBD patients. IBD can significantly affect an individual's lifestyle.

Eight areas are addressed in this questionnaire: overall satisfaction, worry, relationships, school/employment,

recreation, sexuality, symptoms and body image. Changes in overall satisfaction, recreation, symptoms and body image are of particular interest to the investigator. Patients assign a numerical rating to each question on an ordinal scale ranging from 0 (no impact at all) to 3 (a great deal of impact) based on the extent to which IBD affects each variable. The maximum score on this index is 102.

Joachim and Milne (1987) tested the IBD Stress Index for face and content validity by sharing the questionnaire with clinicians and IBD patients for clarification of wording and comprehensibility of the questions. Field testing for reliability and validity of this index has not been done. However, the IBD Stress Index has been used in three research studies, two by the authors and one by Schwartz and Blanchard (1991) who used the IBD Stress Index as a measurement tool in their study of the evaluation of psychological treatment for IBD.

Milne, Joachim, and Niedhardt (1987) used the IBD Stress Index to assess the effects of a stress management program for patients with IBD. The authors found that at all assessment points (4 months, 8 months and 1 year follow-up), the IBD Stress Index scores decreased significantly from baseline in the treatment group. There were no significant changes in the scores of the control subjects who did not receive treatment.

Joachim and Milne (1987) used the IBD Stress Index to assess the effects of having IBD on patients' lifestyle.

Eighty patients with IBD completed the index. The authors found that although the impact of having IBD on most of the lifestyle variables was minimal, overall satisfaction with life was reduced as a result of having the disease. Forty-two percent of patients felt that their satisfaction was greatly reduced by having IBD.

Schwartz and Blanchard (1991) administered the IBD Stress Index as part of an overall psychological assessment of 21 patients with IBD. The index was used pre- and post-treatment and at post-control. Treatment consisted of biofeedback and relaxation techniques. The control group did not receive any intervention. The overall IBD Stress Index scores decreased significantly in the treatment group (41.8 to 31.0) from pre- to post-intervention. There were no changes in the scores of the control group.

Joachim and Milne (1987) stated that the major weaknesses of the IBD Stress Index include: the patient has to interpret what each question means; the questions may be too closed-ended; and a high or lower score on a single question may affect the cumulative overall score, thereby resulting in a somewhat false sense of dissatisfaction or satisfaction with the disease as a whole. However, despite these limitations, the IBD Stress Index is one of the few indices that directly measures overall life satisfaction with IBD and the subsequent stresses that are produced as a result of having the disease. This index continues to be a valuable measuring tool for

researchers who are interested in the effects of inflammatory bowel disease on life stress.

A sample IBD Stress Index is provided in Appendix E.

Inflammatory Bowel Disease Questionnaire

The Inflammatory Bowel Disease Questionnaire (IBD-Q) is a health-related quality of life measure that was developed for application in clinical trials of IBD to evaluate disease-related attitudes and dysfunction (Guyatt et al., 1989).

The IBD-Q is a 32-item questionnaire that evaluates general activities of daily living, symptoms, emotional status, personal interactions and social performance related to having IBD. Responses are graded on a 7 point scale, with 7 indicating no problem at all and 1 a very severe problem. A higher score on this index indicates better quality of life. The maximum score on this index is 224. The IBD-Q is divided into four major sections: bowel (i.e. loose stools, abdominal pain), systemic (fatigue, altered sleep patterns), social (work attendance, need to cancel social events), and emotional (angry, depressed, irritable) headings (Guyatt et al., 1989).

Validity, reliability and responsiveness of the IBD-Q were tested by Irvine et al. (1994) using 305 patients with stable Crohn's disease. IBD-Q scores were correlated with disease activity (Crohn's Disease Activity Index) ($r = -0.67$; $p < 0.0001$). The regression line slopes of IBD-Q scores were significantly different in patients who deteriorated from

those whose disease remained stable ($p < 0.0001$). Quality of life scores were lower in patients who required surgery.

Based on these results, the authors concluded that the IBD-Q is a valid and reliable assessment tool that reflects significant changes in the health status of patients with Inflammatory Bowel Disease.

The IBD-Q (1989) is presented in Appendix F.

Fitness Measures

CAFT Step Test

The Canadian Aerobic Fitness Step Test is a submaximal aerobic power test that was administered to each participant to assess fitness levels before and after the walking program. A predicted VO_2 Max value was determined at pre- and post-intervention.

The CAFT test consists of a series of stepping sequences performed on 20.3 cm steps to a six-count musical rhythm set by a cassette tape with progressive increase in tempo (The Canadian Association of Sports Sciences, 1987). Blood pressure and heart rate were monitored at the end of each three minute stepping session. Progression in stepping depended on participants' heart rate response. Predicted VO_2 Max was calculated following completion of the test.

This test is relatively simple for individuals to perform and the normative data available is based on a large random sampling of Canadian males and females between the ages of 17-69 years.

An original validation study by Jette, Campbell, Mongeon, & Routhier (1976) demonstrated a high correlation between the predictive equation and directly determined VO_2 Max values (r = 0.91) with a mean standard error of 11.3%. However, other researchers have reported much lower correlations between these variables (Shepherd, Cox, Carey, & Smyth, 1979; Leger & Gadovsky, 1989). The major limitation of the CAFT step test is that it tends to overestimate unfit people (up to 3.3 ml.-kg./min. for an actual VO_2 Max of 20 ml.-kg./min) and underestimate fit people (up to 2.6 ml.-kg./min. for a VO_2 Max value of 50 ml.-kg./ min) (The Canadian Society for Exercise Physiology, 1993). However, despite these limitations, this test is simple, practical and is similar in nature to the walking protocol. The CAFT heart rate and VO_2 Max calculation form is presented in Appendix G.

Anthropometric Measurements

BMI is a good indicator of total body composition in population based studies and is related to health outcomes. Significant increases in risk begin at a BMI of about 27.8 kg/m^2 for men and 27.3 kg/m^2 for women (ACSM, 1991). Each participant had their standing height and body weight taken. Body mass index (BMI) was then calculated for each participant using the formula: kg/m_2 (wt divided by ht). These measures were taken at baseline and following the 12-week walking program.

Data Collection

Prior to the start of the walking program, all participants attended an orientation meeting with the researcher at the University of Manitoba. Participants were given a full description of the study, signed all consent forms (Appendices A to C) and were given a brief tour of the walking track. At this meeting, the first baseline administration of stress and symptom questionnaires was done (The Harvey and Bradshaw (1980) Simple Index of Crohn's Disease Activity, The IBD Stress Index (Joachim & Milne, 1987) and the IBD-Q (Guyatt et al., 1989)). The following week, participants attended a fitness testing session at the University of Manitoba. The CAFT step test was administered to all participants and then participants filled out the same set of questionnaires to obtain second baseline scores. BMI was also obtained during this fitness testing session. A nurse was present at all of the pre-test meetings to determine participant scores for questions D and E from the HBSI. The researcher administered the CAFT test to all participants.

Immediately following the end of the 12 weeks of walking, the CAFT test and the same set of questionnaires were administered to all participants over a series of three evenings at the University of Manitoba. Post-walking BMI was calculated for all participants during these sessions. The study nurse was also present at all three sessions to determine participants' scores for questions D and E from the

HBSI. Three sessions were held to accommodate participants' time and availability constraints.

Description of the Exercise Intervention

Participants in this study were asked to walk three days per week for 12 weeks at an intensity of 60% of predicted heart rate reserve (Appendix H). The walking program started in April and ended at the end of June. Participants were encouraged to walk indoors at least once per week at a supervised session on an indoor track. Sessions were held at the Gritty Grotto track at the University of Manitoba. Walking sessions were offered four times per week (Monday, Tuesday and Wednesday evenings from 6:30 - 9:30 p.m., and Wednesday afternoon from 12:00 - 1:00 p.m.). The researcher attended each session over the 12-week period to supervise and monitor participants. Subjects were encouraged to walk progressively farther starting at 20 minutes per session and leading up to 35 minutes of walking. Warm-up, stretching and cool-down exercises were required of all participants during each walking session. Warm-up consisted of participants walking a few slow laps around the track followed by light stretches for the arms, waist and legs. Cool-down consisted of a few slow laps around the track and concluded with the same stretching routine as in the warm-up. Distance and intensity of walking were also progressive over the 12-week period.

To help control for noncompliance, participants were advised of the serious commitment they were making at the

onset of the program. The importance of accurately and honestly reporting perceived stress levels and symptoms was emphasized to each participant. Participants were also advised to accurately report all walking data during their unsupervised walking sessions.

Heart Rate Monitoring

Participants were taught how to measure their radial pulse to determine their training heart rate. Heart rate was taken halfway through each walking session (both unsupervised and supervised) and following the session. These heart rates were recorded in the log book for each session. Subjects were assigned a predicted target heart rate based on the Karvonen formula (Davis, 1975). Participants were also encouraged to use the Rating of Perceived Exertion (RPE) (Borg, 1973) to monitor their walking intensity. An intensity level of 60% was selected for this study due to the sedentary status of the participants.

The Karvonen formula is presented in Appendix H.

Log Book

All participants were given an individual log book where they recorded their walking. The log book had a record sheet to record frequency, distance and duration of walking, training heart rate and comments for general well-being. Each page covered a one week time period. Participants were required to accurately record all details of the walking sessions, especially those that were unsupervised. The log

books were checked on a weekly basis by the investigator before they were handed in and kept in the subject's file.

A sample log book page can be found in Appendix I.

Supervision/Motivational Techniques

The purposes of the supervised sessions were to monitor participants and confirm that they were following the program, to update log books and for socialization of participants. Participants handed in log book pages and were given the opportunity to discuss any concerns they had. They also met up with the other members of the group.

There were several ways the researcher tried to combat a possible lack of motivation among participants in the study. First, each participant was given their own personalized log book to document walking data and comments relating to psychological/physical well-being. Participants monitored their own progress while knowing that they were being monitored by the researcher. Second, having indoor supervised walking sessions four times per week was thought to be an effective motivational tool for monitoring participants, offering encouragement and a chance for socialization with other members of the walking group. Third, having predetermined goals in terms of frequency and duration (min.) of walking may have acted as a significant motivator for participants.

All participants were given a free 12-week pass to the facilities at the University of Manitoba so they could attend

the walking sessions and walk on their own if they so desired. Each participant was allowed to bring one guest to the walking sessions. Special walking t-shirts were given to all participants and many of them wore these t-shirts during the supervised walking sessions and fitness tests. Water bottles were also given to each participant. Not only were these a fitness related prize, but are very useful for patients with Crohn's disease who exercise, as dehydration can occur quickly in these persons. Six of the 12 participants participated in the 1996 Crohn's Disease Heel and Wheel-a-thon at St. Vital Park in June. It was a hot day but everyone had a lot of fun and socialized with the other members of the study.

One of the most significant incentives offered was that each participant would receive feedback and results regarding their personal progress in the study.

Perceived Benefits of Walking Questionnaire

Following completion of the program, each participant completed The Perceived Benefits of Walking Questionnaire. This instrument was designed by the researcher to assess the psychological and physical benefits of the 12-week walking program. It consisted of 10 open-ended questions about their personal experience in the walking program. Goals, perceived benefits (both physical and psychological), changes in stress levels and symptoms, barriers to future physical activity participation and recommendations for physical activity as a

part of the therapeutic process for patients with Crohn's disease were specifically addressed in this questionnaire.

The Perceived Benefits of Walking Questionnaire is presented in Appendix J.

Statistical Analysis

A paired t-test was employed to measure any changes between the pre- and post-test scores from the IBD Stress Index (Joachim & Milne, 1987), the IBD-Q (Guyatt et al., 1989) and the Harvey and Bradshaw (1980) Simple Index of Crohn's Disease Activity. A paired t-test was also used to measure any changes between the pre- and post-test scores for predicted VO_2 Max and BMI. Anova R was employed to establish reliability between the two baseline scores from the Harvey and Bradshaw (1980) Simple Index, the IBD Stress Index and the IBD-Q. Statistical analysis was done using the Data Desk statistical software for the Macintosh computer system.

Descriptive statistics (total, mean, standard deviation) were used to document rate of training progression (duration, frequency and distance of walking).

Qualitative Analysis

Qualitative analysis was done for the Perceived Benefits of Walking Questionnaire, participants' log books and experimenter observations.

CHAPTER 4

RESULTS

Introduction

The results of the investigation of a 12-week walking program on symptoms, perceived stress levels and aerobic fitness of patients with Crohn's disease are as follows.

Subject Characteristics

Twelve sedentary patients with Crohn's disease (10 female and 2 male) served as subjects in this study. Descriptive characteristics for each of the 12 subjects are presented in Table 1 followed by mean values, standard deviations and minimum and maximum values.

The participants ranged in age from 25.0 - 51.0 years with an average age of 38.3 years. The number of years with Crohn's disease ranged from 1.0 - 20.0 years with the average number of years being 9.0 years in this subject group. Ten participants in this study were on medication for their disease (prednisone, asacol and 6-mercaptopurine) and the remaining two subjects were drug-free. Seven participants had had previous surgery for their disease while the remaining five participants had never had surgery.

Initial predicted VO_2 Max values ranged from 20.8 - 37.2 ml-kg/min. with a mean value of 30.6 ml-kg/min. Initial BMI values ranged from 18.2 - 33.6 with a mean value of 24.25.

VO_2 Max and BMI values for all 12 participants are presented in Appendix K.

TABLE 1

DESCRIPTIVE CHARACTERISTICS OF SUBJECTS (n = 12)

SUBJECT	AGE (years)	HT. (cm)	WT. (kg)	YEARS WITH CROHN'S (#)
1	32	152	48.2	3.5
2	25	155	50.0	5.5
3	47	157	48.6	6.5
4	31	183	110.0	4.5
5	37	170	71.4	20.0
6	37	151	41.0	1.0
7	40	155	59.0	7.0
8	47	168	82.0	13.0
9	34	165	59.5	7.0
10	51	180	109.0	15.0
11	37	160	45.4	20.0
12	42	160	60.5	5.0
MEAN	38.3	163.0	65.8	9.0
SD	7.5	10.5	23.6	6.4
MINIMUM	25.0	151.0	41.0	1.0
MAXIMUM	51.0	183.0	110.0	20.0

All twelve participants were in fairly good health in terms of the status of their Crohn's disease. The Harvey and Bradshaw Simple Index is commonly used by clinicians to assess Crohn's disease activity in patients. A score of 5 or less indicates inactive disease (remission) whereas a score of greater than 5 indicates active disease. In this study, 6 patients had scores less than 5 and 6 had scores greater than 5 (Appendix K). One patient had a score of 19.5 as she had experienced a minor relapse of Crohn's disease just prior to the start of the walking program. One participant was recovering from a previous serious bout of illness several months prior to the study. A third participant experienced severe leg cramps as a result of prednisone use, however, this person was still able to walk.

Walking Program Data

Sessions Attended Over 12 Weeks

Total number of supervised and unsupervised sessions, total number of walking sessions and average walking sessions per week are presented in Table 2 for each subject.

The mean total number of supervised walking sessions attended by participants was 13.3. Seven participants attended at least one session per week (13-32 sessions), however, five participants attended less than eight sessions in total over the 12-week period. The lowest number of supervised sessions attended was four. The mean number of unsupervised sessions was 22.0, with the minimum being zero

sessions for one subject who attended every supervised session and the maximum being 33 (this person only attended a total of six supervised sessions over the 12-week period).

Table 3 presents the distance and duration walked for each of the 12 subjects.

Walking Distance

The average total distance of walking was 121.1 km for the 12-week period while the average distance per session was 3.5 km. Average distance (km) walked per session ranged from 1.1 km to 5.4 km.

Participants tended to walk greater distances during the supervised sessions at the indoor track rather than when they were walking outdoors on their own because they were able to calculate the exact distance.

Walking Duration

The prescribed walking duration (minutes) was between 20-35 minutes per session. Total average duration was 1194.3 minutes, with the maximum duration being 1518.5 minutes and the minimum 560.0 minutes. Average duration (minutes) per walking session was 32.6 minutes. The maximum duration per session was 42.5 minutes and the minimum 17.1 minutes. The person who walked 17.1 minutes walked in 10-15 minute intervals due to leg cramps she suffered as a result of prednisone use. Nine participants averaged over 30 minutes of walking per session, and two participants averaged 20.0 and 17.1 minutes respectively. These values are within the

TABLE 2

TOTAL NUMBER OF UNSUPERVISED/SUPERVISED WALKING SESSIONS

OVER 12 WEEKS

SUBJECT	TOTAL # SUPERVISED SESSIONS	TOTAL # UNSUPERVISED SESSIONS	TOTAL # OF SESSIONS	AVERAGE # OF SUPERVISED SESSIONS PER WEEK
1	20	16	36	1.7
2	4	33	37	0.3
3	16	24	40	1.3
4	22	11	33	1.8
5	6	33	39	0.5
6	7	25	32	0.6
7	6	21	27	0.5
8	12	26	38	1.0
9	5	31	36	0.4
10	13	22	35	1.1
11	32	0	32	2.7
12	17	19	36	1.4
MEAN	13.3	22.0	35.1	1.1
MINIMUM	4	0	27	0.3
MAXIMUM	32	33	40	2.7

TABLE 3
WALKING DISTANCE AND DURATION OVER 12 WEEKS (n = 12)

SUBJECT	TOTAL DISTANCE (km)	TOTAL DURATION (min)	AVERAGE DISTANCE (km)	AVERAGE DURATION (min)
1	150.7	1415	4.4	39.7
2	107.8	1040	3.0	27.5
3	172.5	1485	4.5	36.8
4	127.9	1174	4.0	31.2
5	106.3	1220	3.2	34.0
6	63.1	900	1.7	20.0
7	34.0	560	1.1	17.1
8	161.9	1518.5	4.3	42.5
9	90.4	1117.0	2.8	30.0
10	131.4	1263.0	3.4	35.2
11	171.3	1254.0	5.5	39.2
12	136.2	1385.0	3.8	37.4
MEAN	121.1	1194.3	3.5	32.6
SD	43.0	270.2	1.2	7.8
MINIMUM	34.0	560.0	1.1	17.1
MAXIMUM	172.5	1518.5	5.5	42.5

prescribed duration of walking for this study. Participants were encouraged to walk at a progressive pace throughout the study starting at 20 minutes and leading up to 35 minutes. Most participants walked 30 minutes or more within a few weeks after the study started.

Sample Walking Frequency Per Week Over 12 Weeks

The weekly frequencies for all subjects were combined to obtain average frequencies for the total sample for each week of the study (Table 4). The sample weekly frequencies remained fairly consistent throughout the 12-week period, with the highest frequencies being 3.0 times per week at weeks 3, 6 and 11. The lowest average frequency per week was 2.8, although this is very close to the prescribed frequency of three days per week of walking. Although the sample average is close to three times per week, there was a certain amount of variability among participants with some walking only once or twice during certain weeks, and others five times per week.

Walking Intensity

Participants walked close to their target heart rate approximately 6 weeks into the study. Participants also reached their target heart rate more often during the supervised sessions than when they walked on their own.

Measures of Crohn's Disease Symptoms and Stress

Repeated Baseline Measures

Participants completed the Harvey and Bradshaw (1980) Simple Index of Crohn's Disease, the IBD Stress Index (Joachim

TABLE 4

SAMPLE WALKING FREQUENCY PER WEEK OVER 12 WEEKS (n = 12)

WEEK	FREQUENCY (days)
1	2.9
2	3.0
3	3.1
4	2.8
5	2.8
6	3.1
7	3.0
8	2.9
9	2.8
10	2.8
11	3.1
12	2.8
MEAN	2.9
SD	0.1
MINIMUM	2.8
MAXIMUM	3.1

& Milne, 1987) and the IBD-Q (Guyatt et al., 1989) twice over a two-week period prior to starting the walking program. The average of the two scores was calculated and used as the pre-test score. An anova R was performed to determine the reliability between the two baseline measures. Reliability is the consistency of subjects on repeated measures of the same test, or repeatability of performance (Johnson & Nelson, 1986). Anova R is a statistical technique that determines the correlation between the same variable (Johnson & Nelson, 1986).

The results for each index are presented in Table 5 and summarized below.

Harvey and Bradshaw Simple Index

The anova R revealed a .97 measure of reliability between the two baseline scores from the Harvey and Bradshaw Index. Thus, the mean scores between baseline 1 and 2 were consistent.

Inflammatory Bowel Disease Stress Index

The reliability between the baseline scores from the IBD Stress Index (Joachim & Milne, 1987) was significant with an Anova R = .89.

Inflammatory Bowel Disease Questionnaire

Anova R revealed that the baseline scores from the IBD-Q were highly reliable at R = .91.

Differences in Total Index Scores from Pre- to Post-Test

Paired dependant t-tests were performed to determine if there were any differences between the pre- and post-test data of the three Crohn's disease indices. The results for each index are reported in Table 6 and summarized below.

Harvey and Bradshaw Simple Index of Crohn's Disease Activity

The difference between the pre- and post-test scores for the Harvey and Bradshaw Index (1980) was statistically significant ($p < 0.05$) with a t-value of 2.260 and $p = 0.02$. The mean symptom score decreased significantly from 5.87 at pre-test to 3.58 at the end of the program. These results are in accordance with the research hypothesis that subjects' symptoms of Crohn's disease would decrease following the 12-week walking program.

Inflammatory Bowel Disease Stress Index

There was a significant difference ($p < 0.05$) in the pre- and post-test scores from the IBD stress Index (Joachim & Milne, 1987) with a t-value of 4.458 and $p = 0.0005$. The mean score decreased from 29.16 at pre-test to 19.5 at the end of 12 weeks of walking. These results are also in accordance with the research hypothesis that subjects' stress levels would decrease following the 12-week walking program.

Inflammatory Bowel Disease Quality of Life Questionnaire

Pre- and post-walking is scores from the IBD-Q (Irvine et al., 1989) indicated a statistically significant difference

TABLE 5

ANOVA R VALUES

INSTRUMENT	BASELINE 1		BASELINE 2		F VALUE	R	PROB.
	Mean	SD	Mean	SD			
Harvey and Bradshaw	5.83	4.46	5.91	5.69	[1] 12.947 [2] 16.100	.97	[1]0.0042 [2]0.0216
IBD Stress Index	32.66	17.80	25.58	13.61	[1] 40.39 [2] 42.373	.89	[1]<0.0001 [2]<0.0001
IBD-Q	170.75	24.69	172.83	31.39	[1]573.87 [2]363.62	.91	[1]<0.0001 [2]<0.0001

TABLE 6

CHANGES IN PRE- AND POST-TEST INDEX SCORES (n = 12)

INSTRUMENT	PRE Mean	PRE SD	POST Mean	POST SD	T-VALUE	PROB.
Harvey and Bradshaw Symptom Index	5.87	5.03	3.58	3.11	2.260	0.02*
IBD Stress Index	29.16	15.41	19.5	10.83	4.458	0.0005*
IBD-Q	171.83	27.03	189.08	11.92	-2.552	0.0135*
VO_2 Max (ml. kg/min)	30.60	4.70	32.43	4.79	-3.869	0.0013*
BMI	24.25	5.28	23.94	5.33	1.609	0.068

* Statistically significant $p < 0.05$

($p < 0.05$) with a t-value of -2.552 and $p = 0.0135$. Quality of life related to having Crohn's disease significantly increased from a mean score of 171.83 at pre=test to 189.08 at 12 weeks.

Participants' pre- and post-test scores on all three indices are presented in Appendix K.

Participants' Scores for Individual Index Items

A summary of the changes in participants' scores for each index item is presented in Appendix L.

Harvey and Bradshaw Simple Index

The Harvey and Bradshaw (1980) Simple Index of Crohn's Disease Activity is designed to measure the major signs and symptoms of Crohn's disease. This questionnaire is based on five different items. Participant responses are as follows:

a) General Well-Being

Six participants (50%) reported that their general well-being had improved from pre- to post-study. The remaining six participants (50%) reported no change in their general well-being from pre- to post-test.

b) Abdominal Pain

Three participants (25%) reported feeling less abdominal pain following the walking program as compared to when they started. Eight participants (67%) reported no change in abdominal pain. One participant (8%) reported feeling slightly more abdominal pain following the walking program.

This person's score went from 0 = none to 1 = mild at post-test.

c) Number of Liquid Stools Per Day

Two participants (17%) reported that the number of liquid stools per day decreased at post-study as compared to pre-study. Ten participants (83%) reported no change in the number of liquid stools per day from pre- to post-study.

d) Abdominal Mass

One participant (8%) went from 2 = definite abdominal mass at pre-test to 0 = none at post-test. Ten participants (83%) reported no change in abdominal mass from pre- to post-study. One participant (8%) went from 0 = none abdominal mass at pre-test to 1 = dubious mass. This person did have a minor relapse of her disease just prior to the start of the walking program.

e) Complications

Five participants (42%) reported a decrease in extra intestinal complications of Crohn's disease following the walking program. All five of these participants reported having no complications at post-study as compared to one or two at post-study. Five participants (42%) reported no change in the frequency of extra intestinal complications. Of these five persons, four did not experience any complications from pre- to post-study. Two participants (17%) experienced increased complications at post-study as compared to pre-study.

IBD Stress Index

The IBD Stress Index (Joachim & Milne, 1987) was designed to measure the patient's perception of the extent to which IBD had caused alterations in lifestyle. Although eight areas of lifestyle are addressed in this questionnaire, only 5 areas - overall life satisfaction, worry, recreation, symptoms and body image, are of particular relevance to this study. Participants' responses to each of these five areas are outlined below.

a) Overall Life Satisfaction

Seven of the 12 participants (58%) in this study reported that their life satisfaction had increased as compared to before they started the walking program. Five subjects (47%) reported that their life satisfaction remained the same following the program.

b) Worry

Two of the 12 participants (17%) reported that they spent less time worrying about their illness and the changes that it has made to their lifestyles. The remaining 10 participants (83%) all reported that they spent the same amount of time worrying about their illness from pre- to post-test.

c) Recreation (only question "a" of this section)

Five participants (47%) reported that their illness was less of a factor in their not taking part in sports than before the walking program started. Seven participants (58%) reported that the extent to which their illness prevented them

from taking part in sports remained the same from pre- to post-study.

d) Psychosomatic/Symptoms

Ten of the 12 participants (83%) reported feeling less psychosomatic/ physical symptoms relating to Crohn's disease following the walking study as compared to before it began.

Nine out of 12 participants (75%) reported that their illness was not as prominent a factor in feeling low on energy/fatigued as compared to when the study began. Three subjects (25%) rated their illness as having the same effect on their energy levels from pre- to post-study.

Three out of 12 participants (25%) felt that their illness had less of an impact on feeling hopeless for the future as compared to before they started the study. Nine participants (75%) reported no change in this variable from pre- to post-study.

Six participants (50%) reported that they felt less downhearted/depressed as a result of their illness at post-study. The remaining six participants (50%) reported no change in the effect of their illness on depression levels.

Six participants (50%) reported that they had less trouble sleeping as a result of their illness at post-study. Five participants (42%) reported no change in their sleeping habits. One participant reported having more trouble sleeping at post-test as compared to pre-test (0 = never to 1 = sometimes).

Five out of twelve participants (42%) reported feeling less nervous inside as a result of their illness following the walking program. The remaining seven participants (58%) reported no change in feeling nervous from pre- to post-study.

e) Body Image

Seven participants (58%) reported more positive feelings towards their body image following the walking program. Four participants (33%) reported no change in their body image from pre- to post-study. One participant (80%) reported a higher score in this section (1 = sometimes to 3 = a great deal. This person felt that her illness made her feel unattractive. This participant was experiencing severe facial acne as a result of long term prednisone use and this occurred throughout the study period.

All 12 participants experienced some positive changes in these five items. Two participants reported a negative change in body image (unattractiveness) and trouble sleeping.

IBD-Q Questionnaire

The Quality of Life in Inflammatory Bowel Disease Questionnaire (Guyatt et al., 1989) is designed to find out how patients have been feeling during the last two weeks prior to completing the questionnaire. This questionnaire asks several questions concerning disease related attitudes and dysfunction in patients. The questions that are of particular relevance to the hypothesis of this study relate to patients' energy levels, symptoms, and stress levels.

The results of individual items are presented below.

a) Energy Levels

Question #2 asks about patients' energy levels. Nine out of twelve participants (75%) reported that fatigue was less of a problem at post-study as compared to before they started walking. Two participants reported no change in how often they felt fatigued from pre- to post-study (no change means that participants felt neither more positive or negative at post-test in comparison to their pre-test response). The remaining participant reported that they felt slightly more fatigued during the last two weeks of the study.

b) Symptoms

Bowel symptoms. Questions 5, 12, 24 and 8 ask about patients' bowel symptoms. Five participants (42%) reported less frequent loose bowel movements following the study as compared to when they first started. Five participants (42%) reported no change in the frequency of loose bowel movements from pre- to post-study. Two participants (17%) reported slightly higher frequency in loose bowel movements during the last two weeks of the study.

Five participants (42%) reported less difficulty from participation in sports or leisure activities as a result of bowel symptoms. Six participants (50%) reported no change in the degree of difficulty regarding sports participation as a result of bowel symptoms. Only one participant (8%) reported

slightly more difficulty in doing sports/leisure activities as a result of bowel problems.

Four of the participants (33%) reported that they felt less troubled by the urgency of having to go to the washroom following the study. The remaining eight participants (67%) reported no change in the urgency to have to go to the washroom.

Two participants (17%) reported that delaying a social engagement as a result of bowel symptoms was less of a problem at post-study. Nine participants (75%) reported no change in delaying social engagements as a result of bowel problems. One participant (8%) reported that they had to delay social engagements more often during the post-test assessment as compared to the beginning of the study.

Abdominal symptoms. Questions #9, 20, 29, and 10 pertain to patients' abdominal symptoms. Four participants (33%) reported that abdominal cramps occurred less frequently at post-test as compared to the pre-test assessment. Five participants (42%) reported no change in the frequency of abdominal cramps. Three participants (25%) felt that abdominal cramps occurred more frequently at post-test then at pre-test.

Six participants (50%) reported that abdominal bloating had been less frequent following the walking program. Four participants (33%) reported no change in the feeling of abdominal bloating. Two participants (17%) reported an

increase in the occurrence of abdominal bloating in the two-week period prior to completion of the walking study.

Six participants (50%) reported that the feeling of being sick to their stomach occurred less frequently. Four participants (33%) reported no change in the frequency of feeling sick to their stomach. Two participants (17%) reported that feeling sick to their stomach occurred more often during the last two weeks of the study as compared to two weeks before it started.

Eight participants (67%) reported that the feeling of being generally unwell occurred less often following the walking program. Two participants (17%) reported no change in the occurrence of feeling unwell. Two participants (17%) reported feeling generally unwell slightly more often at post-study.

Stress Levels

Questions #3, 15, 19, 21, 25, 27, 30 and 32 pertain to patients' moods, attitudes and overall life satisfaction.

Five participants (42%) reported feeling less frustrated or restless following completion of the study. Three participants (25%) reported no change in the frequency of feeling frustrated or restless. Four participants (33%) reported feeling frustrated or restless more often following the walking program as compared to before they started.

Six participants (50%) reported feeling less depressed or discouraged following completion of the program. Four

participants (33%) reported no change in depression levels. Two participants (17%) felt slightly more depressed/ discouraged during the last two weeks of the study.

Six participants (50%) reported feeling less anxious or worried in relation to their illness. The remaining six (50%) reported no change in illness-related worries.

Six participants (50%) felt more relaxed and free of tension following the walking program. Three participants (25%) reported no change in relaxation levels. Three participants (25%) reported feeling relaxed and free of tension less often during the last two weeks of the study than at the beginning.

Six participants (50%) reported feeling less tearful or upset following the walking program. Four participants (33%) reported no change in the frequency of feeling tearful or upset. Two participants (17%) reported feeling slightly more tearful or upset at post-test as compared to pre-test.

Five participants (42%) reported feeling angry as a result of their bowel problem less often following the walking program. Six participants (50%) reported no change in anger levels following the program. One participant reported feeling angry as a result of their bowel problem more often.

Six participants (50%) reported feeling less irritable following the walking program. Two participants (17%) reported no change in irritability levels. Four participants

(33%) felt slightly more irritable during the last two weeks of the study as compared to the beginning.

Seven participants (58%) reported feeling happy with their personal life following the walking study. Three participants (25%) reported no change in satisfaction with their personal lives. Two participants (17%) reported feeling somewhat less happier or satisfied with their personal lives from pre- to post-study.

All 12 subjects experienced some positive changes in the various questionnaire items. No one group of patients accounted for all of these improvements. Participants' responses were varied on the questionnaire items.

Fitness Measures

Predicted VO_2 Max

The subjects demonstrated a significant increase ($p < 0.05$) in predicted VO_2 Max (expressed as ml. kg/min) as measured by the CAFT, following 12 weeks of walking (t-value of -3.869 and $p = 0.0013$). The mean score for predicted VO_2 Max increased from 30.6 at pre-test to 32.43 post-walking. Predicted VO_2 Max values ranged from 22.2 to 37.9 ml-kg/min at post-walking. These values correspond to below average to average scores for age and gender for the general population (Canadian Association of Sport Sciences, 1987). The significant difference in mean predicted VO_2 Max score from pre- to post-test supports the research hypothesis that

participants' fitness level would change following 12 weeks of walking.

Body Mass Index

Participants' BMI did not significantly change ($p < 0.05$) following 12 weeks of walking (t-value of 1.609 and $p = 0.068$). The mean BMI score decreased, however, not significantly, from 24.25 at pre-test to 23.94 at post-test. Pre-test BMI's were slightly low to average for the female patients in this study as compared to the general population. The two male patients in this study had high pre-test BMI's (> 27.8 kg/m^2) at 32.6 and 33.6.

Participants' pre- and post-test scores for predicted VO_2 Max and BMI are presented in Appendix K.

Qualitative Measures

Perceived Benefits of Walking Questionnaire

Following completion of the 12-week walking program, participants answered ten open-ended questions based on their personal experience in the walking program. Goals, perceived benefits (both physical and psychological), changes in stress levels and symptoms, and recommendations for future physical activity participation were specifically addressed in this questionnaire. A breakdown of participants' responses are outlined below:

Goals

The most common response from participants concerning the main goal or reason for participating in this walking program

was to become more fit and gain stamina and strength. Most participants felt that this program gave them the motivation they needed to start a physical activity program. The second most common goal among participants was to feel better physically (in terms of both their illness and for everyday life). One of the most compelling answers by one of the participants concerning why she wanted to participate in this walking program was that she was feeling very ill and hopeless and she thought this study would help her feel better and give her a better perspective concerning her illness. One other interesting answer given by a participant was that this person believed that participating in a research study is important in order to gain positive outcomes in illness management. This subject group was very motivated to try new experiences to gain more knowledge about their disease.

All participants stated that their personal goals had been achieved following completion of the 12-week study.

Benefits

Participants experienced a range of physical and psychological benefits from this walking study.

The most common physical benefits cited by participants were: a significant increase in energy and stamina (participants said they were not as tired as they used to be and felt rejuvenated following the walking sessions); felt physically fitter (in terms of increased endurance and flexibility which incidently made everyday activities easier

to do); weight loss (one participant was so happy that she lost 10 pounds during the study, most others did not lose weight but felt more toned). Two participants reported that the Crohn's disease related joint pain they had been experiencing for years had significantly diminished or disappeared over the 12-week program. This is a significant finding given that joint pain affects many patients with Crohn's disease and perhaps exercise therapy may be the best way to alleviate these symptoms.

The most common psychological benefits that participants experienced were: decreased daily stress and more able to deal with stressful life events in a more positive manner; increased self-esteem (especially for those who experienced side-effects from prednisone (weight-gain, facial acne); happier with life in general; felt more motivated to keep in an exercise program and to a certain extent, felt that they helped contribute in the fight against Crohn's disease.

Barriers to Future Participation

Nine out of twelve participants in this study cited lack of time, motivation and family obligations as the most significant barriers for future participation in physical activity programs. These are similar responses also cited by the general population for barriers to participation. Only three participants cited that fatigue, pain or symptoms relating to Crohn's disease would impair their future physical activity participation. Of these three participants, one did

say that she could not keep up on a regular basis and would only be able to exercise on the days she had energy. This participant did experience some fatigue throughout the study and only walked intermittently (10 minutes at a time) as she experienced severe leg cramps (a side effect from Prednisone use). However, this participant ceased her Prednisone medication prior to completing the study so this problem may diminish in the future and she may be able to exercise on a more continuous basis.

Participation in Future Physical Activity Programs

Eleven out of the twelve participants reported that illness permitting, they would regularly participate in physical activity programs in the future. Only one participant cited maybe they would not participate in the future. This person did not say why they answered this way, however, this is the same person who experienced leg cramps and had difficulty walking in a continuous manner. She may be unsure of her physical capabilities for the future.

Lifestyle Change

Participants reported various ways in which their lifestyle changed by walking three days per week. Increased energy was a common response, as was getting into a regular routine to exercise. Participants became more conscious of their personal health and fitness (i.e., eating better). Getting friends and family involved in the walking program was an important factor for participants.

Illness

Seven out of the twelve participants reported that their Crohn's disease did not interfere or conflict with their enjoyment/participation in the walking program. One participant said that the few symptoms that she did experience decreased after the walking sessions and one other said she experienced a steady improvement in her disease status during this walking program. One participant reported that although she felt fatigued prior to walking, she would always feel rejuvenated after her walking session. Three participants reported that they experienced symptoms (i.e., joint pain and leg cramps) at the beginning of the study, but as the program progressed, the symptoms decreased or disappeared altogether. The remaining two participants cited that their illness interfered sometimes with their enjoyment of the program. Fatigue and abdominal bloating were the symptoms reported by these individuals.

Coping with Illness

Nine out of twelve participants reported that they were able to cope more effectively with their illness as a result of the walking program. These persons felt that they were more aware of their disease and how to deal with their personal discomforts as a result of the walking. By improving their overall health, they felt that they will be able to deal with their illness more effectively. Having more energy and

exercising with a group were also cited as being important factors in being able to cope better with their illness.

One participant reported that her joint pain had almost completely disappeared, her medication use had ceased and Crohn's-related abdominal pain had also decreased as a result of the walking program. The participant who experienced severe leg cramps (a side effect of Prednisone) and fatigue, reported that when she was able to walk, she felt rejuvenated and the program as a whole gave her a sense of purpose and well-being.

Three participants said that they did not feel any different in terms of coping with their illness. These individuals stated that they felt well before the walking program started and did not feel much different physically after it was over. One person did say, however, that she did have more energy following the program as compared to when it started.

Stress Levels

Participants reported a wide range of answers concerning how the walking program affected their daily stress levels. Ten participants stated that the walking program definitely helped decrease their daily stress levels and allowed them to deal more effectively with stresses when they occurred. The most common responses from these participants included: increased energy levels allowed them to get daily tasks done faster which was stress reducing; being able to relax more and

sleep better at night; the feeling of accomplishment helped to tackle daily routines more easily; many participants used the walk as a break from their work schedule or used it as a time for relaxation and "family time". The issue of weight control was causing one participant stress and now that she had lost 10 pounds during the program, she felt much happier with life in general.

One participant felt more positive about her illness because despite how awful she felt at times (prednisone use, leg cramps) she felt proud that she could walk about 2 km. twice per week. For this participant, the feeling of accomplishment and not letting her illness get in the way of her goals helped decrease a lot of stress in her life. One other participant had an extremely stressful life (young children, marital difficulties, job responsibilities, part-time student). This person reported that on the days she went for a walk feeling overwhelmed from life stress, she left feeling calm and believing she had the ability to cope with everything in her life. These ten participants felt that the 12-week walking program was a positive influence on the rest of their daily lives.

One participant reported that she experienced a combination of stress levels throughout the program. Sometimes she felt invigorated yet at other times she would be worried about fatigue and would then have difficulty making it through her regular schedule. However, this same person also

reported that her illness had made a steady improvement throughout the walking program, so she just had to learn to deal more effectively when she felt fatigued.

The remaining subject in this group reported that the walking program did not help decrease her stress levels. She stated that having to bank time at work in order to attend the walking sessions was a stressor in itself. The somewhat limited days of scheduled walking sessions and family obligations was the reason this person had to walk on work time.

Negative Factors

All twelve participants unanimously reported that there were no negative factors that may have affected their participation in this walking program. Two subjects mentioned that the long drive to the University was somewhat difficult at times, however, it did not affect their enjoyment or participation in this study. One participant reported that her only regret from the study was that she was not able to walk with the rest of the group more often given her family obligations.

Physical Activity as Part of the Therapy Process

Based on their experience, all twelve participants unanimously agreed that regular physical activity should be recognized as an important part of the overall therapy process for patients with Crohn's disease.

Among the most common responses by participants were: the reduction of stress is a significant reason for integrating exercise into the care plan for persons with Crohn's disease; the feeling of accomplishment (even when you are not well) from the commitment to exercise makes you feel more positive about your illness and cope more effectively when symptoms do occur; and having more energy and feeling stronger and more agile made dealing with daily tasks easier.

Other significant findings include: arthritis, being a major side effect of Crohn's disease, had been a major problem for two participants and since the walking, this problem has significantly improved; one participant stated that exercise therapy is definitely better than medication use as many of her physiological complaints she had related to her illness have disappeared since she started walking. One participant stated that physical activity should be encouraged to help improve: strength, stamina, positive self-image, decrease stress, increase energy levels and possibly an improvement in the disease process.

Three participants were either just recovering from a previous bout with Crohn's or had a minor relapse just prior to the start of the walking program. These participants were very depressed concerning their physical condition (heavy medication use, pain, etc.) at the beginning of the study. However, they remained motivated and as the weeks went on, they felt happier physically and psychologically, decreased

and/or completely stopped their medication use and were among the top walkers of the group. These participants found that physical activity diminished many negative factors (both physical and psychological) that frequently occur in Crohn's disease patients. It must be noted, however, that participants' responses may have been based on the Hawthorne effect, where their positive attitudes towards physical activity may have been only because they were participating in a study involving physical fitness. They may not feel as motivated to continue after the study is over.

Walking Log Books

Every week for 12 weeks, each participant monitored their walking (distance, duration and heart rate) and made comments relating to their psychological and physical well-being in their own personal log book. Each page covered a week and was handed into the researcher at the end of each week. All log books were kept in a well-organized manner and all pages were collected from participants (12 pages from each person).

Most participants were consistent in writing down comments relating to how they felt each week, however, others were not as specific and only commented on an infrequent basis. The importance of these comments represents how participants felt and how these feelings may have changed (positive or negative) as the 12 weeks of walking progressed.

One important trend that was observed among all twelve participants was that comments tended to get more positive as

the weeks went by. Many of the participants reported similar feelings, therefore, the most common responses will be discussed. These comments include: increased energy levels and stamina; participants felt fatigued at times, however, everyone reported that after the walk they felt rejuvenated; felt physically stronger and more agile and decreased stress levels, especially for those who walked after a particularly stressful day. Some aches and pains were reported. One person experienced leg cramps during the walking and this occurred throughout the study, although during the last few weeks they began to subside as this person ceased her prednisone use at this time. One other person reported muscle stiffness and minor joint pain, however, this was only at the beginning of the study. These problems subsided as the weeks went by.

Surprisingly, few gastrointestinal problems were reported. One person said she felt bloated occasionally, however, this did not interfere with her walking. Others stated that symptoms decreased after the walks and incidently, symptoms were at their worst when they were not walking. One person stated that since she started walking, she has gone off all her medications and feels great without them! Two other participants steadily decreased their medication use, particularly prednisone, and felt that this was a great accomplishment for themselves.

A few participants reported that they were depressed during the first week of the study as one had a minor relapse and was back on prednisone and one other was unsure whether she would be able to complete the program as she was just recovering from a serious bout with Crohn's disease six months prior to the study. However, their comments quickly became very positive (more energy, increased self-image, more strength and symptoms less severe). At the end of the 12 weeks, these two participants felt physically and psychologically stronger and one had her prednisone at its lowest dose yet. They reported that they were able to cope better with their illness and felt better now than they had in a long time. Incidently, these persons were among the top three walkers of the group in terms of frequency, distance and duration of walking.

Medication Use

Prior to the start of the study, 10 of the 12 participants were using medication(s). Two subjects were not on any type of medication. Following completion of the walking program, the same two participants remained drug-free, two persons went completely off all their medications, and the remaining eight participants either stayed at the same dosage or decreased their medication use. One participant significantly decreased their prednisone dosage (an anti-inflammatory corticosteroid) from 20 mg at pre-study to 7.5 mg per day at post-study. However, her 6-MP (6-mercaptopurine)

dose increased from 1 1/2 to 2 pills per day to help her successfully wean off prednisone. It must be noted, however, that it is unclear of the extent to which this increase in 6-MP accounted for this patient's improvement in symptoms as compared to the exercise program itself. One participant went from 30 mg of prednisone per day to nothing a few weeks before the study ended. One participant decreased her Asacol dosage from 8 pills to 4 pills per day and one other went from 12 pills to none at post-study. These values are presented in Appendix K.

Interestingly, two participants in this study were using herbal remedies in addition to their prescribed medications. Dosages of these remedies remained the same throughout the 12-week study.

Researcher Observations

Walking sessions were held four times per week (one afternoon and three evening sessions) at the University of Manitoba. Most subjects attended these sessions at least once per week. During these sessions, the experimenter made observations regarding subjects' attitudes, behaviors and overall well-being over the 12-week period. This heterogeneous subject group allowed for many significant observations to be made.

First and foremost, this was a group of people who demonstrated how important physical activity is for persons with chronic disease. One participant started the first week

very depressed because she had a minor relapse just prior to starting the program and was back on prednisone. After the second week, this person gained more confidence and was determined to finish the 12-week program. Each walking session got better for her in terms of the distance she walked and she would always leave each session full of energy and with a smile on her face. As the weeks progressed, her energy increased, stress decreased and her attitude towards her illness became more positive and accepting. She knew she was doing all she could to stay healthy. By the end of the program, this person was one of the top walkers of the group and her illness did not get any worse at any time during the 12 weeks.

Another participant was just recovering from a previous bout of Crohn's and was weaning off Prednisone. She was hesitant to start the program, however, she knew this was something she needed to do for her health. As the weeks went by, she experienced significant increases in energy and stamina, she looked stronger physically and her self-image was more positive. Her Crohn's symptoms decreased and she experienced a steady decline in her prednisone dosage. This participant also displayed a significant increase in her fitness level as observed during the post-walking CAFT test.

Yet another participant experienced severe leg cramps as a result of prednisone use which affected her walking. She felt hopeless at the beginning of the study because of this

problem, however, she did not give up. She walked in 10-15 minute intervals and managed to walk an average of 2 km twice per week throughout the program. The walking program gave her a sense of purpose and the feeling of accomplishment was what was very noticeable in this person's attitude at the end of the study. For 12 weeks, this person worked around her physiological limitation and successfully completed a physical activity program that seemed to be an impossible task 12 weeks earlier.

One participant was in good health, however, she lived a very stressful life. She found the walking program a diversion from her regular life. She came out to each walking session and used this time for relaxation and stress relief. This person was the top walker of the group for distance, duration and frequency of walking.

Training progression was noticeable for most participants throughout the 12-week period. Distance, duration and intensity progressively increased for most participants. Most participants were walking at or close to their target heart-rate at about six weeks. No participant relapsed or experienced more severe symptoms at any time during the walking program.

Psychological benefits were especially noticeable in all participants in terms of increased self-concept, a more positive attitude towards their life in general, more positive

coping with their disease and the strong commitment they showed in trying to improve their health.

The socialization aspect of the walking program was also an important part of the overall change in participants. Many of the participants either walked together or tried to keep pace with each other during the indoor walking sessions. Many participants brought family members or friends to the sessions and everyone got to know one another as the weeks went by. The walking sessions provided an important atmosphere for social support as participants got the opportunity to talk with other patients with Crohn's, thus receiving support and encouragement from persons who had similar goals for health and fitness.

Following completion of the walking program, many participants looked happier, were more motivated, more confident in themselves and knew how to cope with their disease. Most subjects felt more energetic, experienced a decrease in stress and experienced fewer symptoms than when they first started the program. Participants also looked more confident in terms of their fitness levels during the post-test CAFT test.

No injuries were sustained during fitness testing or at any point in the walking program and no subjects were lost due to injury from the program.

CHAPTER 5

DISCUSSION

Introduction

The beneficial effects of physical activity on fitness and lifestyle are well established (Fox & Matthews, 1981; Shephard, 1986). Substantial evidence indicates that exercise is associated with improvements in mental health, neuroendocrine and immune system functioning (LaPerriere et al., 1994). Physical activity has also been proposed as being a significant modulator in the stress-illness relationship of chronic disease. Although the benefits of physical activity for persons with chronic disease are becoming increasingly recognized, the effects of exercise training on patients with Crohn's disease are relatively unknown. The effects of physical activity on stress and symptoms of patients with this disease has never been addressed.

The research problem was formulated in order to provide insight into the potential benefits of low intensity physical activity on stress levels and health status of patients with Crohn's disease. Guidelines for future exercise prescription in this population will be discussed.

The main hypotheses of this study focused on whether there are positive changes in stress levels, symptoms and aerobic fitness levels following a 12-week low intensity walking program. In addition, qualitative factors such as

subjects' perceived benefits of walking, log books and experimenter observations were used in drawing conclusions.

Effects of Exercise on Symptoms of Crohn's Disease

The results of this study clearly indicate that symptoms of Crohn's disease are significantly reduced following participation in a 12-week walking program.

Overall mean scores on the Harvey and Bradshaw (1980) Simple Index of Crohn's Disease Activity significantly decreased from 5.87 at pre-test to 3.58 at post-walking. In terms of individual scores, eight participants decreased their overall score on this index from pre- to post-study, one participant's score remained the same and three participants had slightly higher scores at post-test. However, this index is highly dominated by bowel habit (Myren et al., 1983) so even though these participants reported feeling fine, an increased number of bowel movements would have significantly influenced the overall score. Two of the three persons with higher post-test scores reported more complications related to Crohn's disease that raised their overall score. One person had a new fistula and experienced arthralgia (joint pain), and the other had minor aphthous ulcers (mouth lesions). These two participants were still on prednisone at the end of the study which may have influenced these scores.

One case that is of particular importance is the participant who decreased her overall Harvey and Bradshaw Score by more than half from pre- to post-test (19.5 to 7.0).

After experiencing a minor relapse of Crohn's disease just prior to the beginning of the study. She decreased her score (a lower score is better) on general well-being from very poor to very well; abdominal pain decreased from moderate to mild; and number of liquid stools per day decreased from 10-12 per day to 3 at post-test. This person reported that participating in the walking program made her feel physically and psychologically stronger. She increased her energy and stamina levels and felt less stress relating to her disease. The feeling of accomplishment made this person feel more confident and in more control of her disease. Although this person did report many positive changes in terms of her physical health from the walking program, it must be emphasized that this person was on prednisone and was taking several herbal remedies throughout the study which may also have contributed to decreased symptoms. It can be noted, however, that she was quite depressed about going on prednisone again at the start of the study, yet as the program progressed, this person was happier and more accepting of her disease. Therefore, the walking program did have direct positive effects on this person's psychological health which in turn may have affected her physical health. What is particularly encouraging about these results is that participants did not experience any exacerbations of symptoms or have relapses of their disease at any time during the walking program. This is similar to studies done by Harkcom

et al. (1985) and Lyngberg et al. (1994) who found that low intensity aerobic exercise can be tolerated by patients with rheumatoid arthritis without exacerbating joint symptoms. All subjects in the present study completed a fitness program without an increase in disease activity and improved in functional capacity. Based on these results, it could be concluded that participation in physical activity programs is possible for persons recovering from or experiencing mild symptoms of illness.

Qualitative analysis of the Perceiving Benefits of Walking Questionnaire also strongly supports the hypothesis that physical activity has positive therapeutic benefits for patients with Crohn's disease. Following the walking program, participants reported higher energy/stamina levels and an overall improvement in their illness. One participant reported that her symptoms decreased following the walking sessions and when she wasn't walking, her symptoms were more pronounced. Two participants reported that joint problems related to Crohn's disease that had plagued them in the past almost completely disappeared during the walking program. These results are similar to Harkcom et al. (1985) who found that in 20 patients with rheumatoid arthritis, who participated in bicycle ergometer training 3 times per week for 12 weeks, reported significant decreases in disease activity and symptoms. Lyngberg et al. (1994) found that a group of 24 patients with rheumatoid arthritis reported fewer

swollen joints and a reduction in morning stiffness of joints following a twice weekly routine of stair climbing and bicycle exercise. Noredemar (1981) found that aerobic capacity improved without joint exacerbations following long-term aerobic exercise in 23 patients with rheumatoid arthritis.

Two participants went off their medications while many others decreased the dosages of their current medications.

Following the program, many participants reported feeling more in control of their illness and felt they could cope more effectively when their symptoms did occur. One person did emphasize that because she felt better, her symptoms seemed fewer and less pronounced. Interestingly, three persons reported that the walking program did not make them feel much different in terms of their disease status. However, these persons still reported that they increased their energy levels and experienced less stress as compared to before they started the program. Patients subjectively felt better as a result of the walking program. Therefore, even if physical activity does not affect symptoms in some patients with Crohn's disease, decreasing stress levels and increasing energy and stamina remain very important reasons for these persons to remain physically active.

Although no physiological data is currently available to explain why symptoms decreased following the 12-week walking program, it is probable that the immuno-modulating effects of moderate exercise training may have played a significant role.

Sonnenberg (1990) found that subjects who had physically demanding jobs had a lower incidence of IBD when compared to those with sedentary occupations. Persson et al. (1993) reported that the risk of Crohn's disease was inversely related to regular physical activity participation in a group of 184 subjects with Crohn's disease. The authors concluded that high physical activity levels among these patients seemed to decrease the risk of Crohn's disease. The influence of well-prescribed physical activity on immune function has important implications for individual health as well as disease prevention and management (Nash, 1994).

Recent research studies have suggested that moderate physical activity like walking for example, has immuno-modulating effects (Fitzgerald, 1991). Nehlsen-Cannarella et al., (1991) reported a 57% increase in natural killer cell activity and 20% increase in serum immunoglobulins in a group of middle-aged women who participated in a walking program at 60% heart rate reserve, 45 minutes per day, 5 days per week for 15 weeks. These changes were observed at six weeks and at 15 weeks of exercise. Similarly, Keast and Morton (1992) stated that moderate, long-term exercise in the form of brisk walking has been shown to significantly enhance the levels of serum immunoglobulins in various sample groups. Lin et al., (1993) found that in a group of rats who exercised at a mild to moderate pace (50 - 70% VO_2 max), there was a significant enhancement of immune cell proliferation.

Based on the current research, it seems possible that for diseases with a strong immunological component like Crohn's disease, the immuno-modulating effects of moderate exercise training would be beneficial for these individuals who consequently may have abnormal immune system functioning. Future research should be directed towards the immunological effects of physical activity in patients with Crohn's disease.

Effects of Exercise on Stress

This 12-week study set a predetermined goal of 3 walking sessions per week 20-35 minutes per session at 60% of heart rate reserve for each subject. This frequency, duration and intensity of walking is within the exercise prescription guidelines for cardiorespiratory fitness benefits (ACSM, 1991).

The results of this study strongly support the hypotheses that participation in regular physical activity can significantly improve mental health and decrease life stress. Two indices were used in this study to measure stress (the IBD Stress Index and the IBD-Q). The average score on the IBD Stress Index (Joachim & Milne, 1987) decreased significantly from 29.2 at pretest to 19.5 post-walking. One participant who experienced a minor relapse of Crohn's prior to the study had a pretest score of 57.5 (the highest score of the group) and at post-walking, decreased her IBD Stress Index Score to 33, a significant difference in stress for this person. Another participant significantly reduced her IBD Stress Index

Score from 30.5 to 15.0 following the walking program. This person was in good health, however, she led an extremely stressful life. This is a significant finding as the walking program helped this person deal more effectively with her daily stressors. This person attended every supervised walking session and used this time for relaxation. This strongly supports the hypotheses that participation in regular physical activity can help alleviate feelings of distress and enhance well-being.

The overall average score on the IBD-Q increased significantly from 171.8 at pre-test to 189.1 at post-test. A higher score on the IBD-Q indicates greater quality of life. Thus, participants would want higher scores on this index. Quality of life related to Crohn's disease (as measured from the IBD-Q) increased significantly in this subject group. Only three of the twelve participants had slightly lower scores on the IBD-Q. However, these differences were not enough to deter from the overall positive group results. The same subject who had the relapse at the beginning of the study significantly increased her IBD-Q score from 110 at pre-test to 184 at post-test. Another significant finding was that one participant who despite having leg cramps that frequently affected her walking, increased her IBD-Q score from 159.5 to 204.0. This was the second highest post-test score of the 12 subjects on this index. Moderate physical activity had a positive influence on the quality of life related to Crohn's

disease for these participants. Physical activity appeared to reduce the patients' stressors related to the disease process and give them a more positive outlook regarding their health.

Qualitative analysis of the Perceived Benefits of Walking Questionnaire, participant log books and experimenter observations also strongly supported the hypotheses that exercise can help alleviate feelings of distress and mild depression (ACSM, 1990). Participants either stated that the walking was a direct outlet for stress (time for relaxation and peace) or other factors like having more energy and stamina and feeling physically stronger made daily tasks less stressful. Physical activity should be emphasized to all patients with Crohn's disease as fatigue and general malaise are stress producing symptoms of the disease. Participants in this study felt more energetic and physically stronger, therefore, reducing the stress of daily life. In addition, being able to socialize with the other members of the group helped alleviate some disease-related worries and concerns. The group atmosphere of the walking sessions may also have been a significant stress reducer for some participants.

Finally, participants were asked to record comments related to their physical and psychological well-being following each walking session. Comments relating to energy levels, stress, self-image, symptoms and day-to-day living were documented by the walkers. The log books may have helped participants cope better with life stress as they were able to

write down how they were feeling throughout the study (positive and negative). Documenting their progress may have influenced their enjoyment in the study.

The results of this study are encouraging given that previous research has suggested that stress may affect the course of disease in already diagnosed patients with Crohn's disease by leading to an exacerbation of the primary symptoms of the disease (Garrett et al., 1991). Exercise training may modulate the detrimental effects of stress (both physical and psychological) while enhancing the health status and strengthening the immune response (Traeger-Mackinnon, 1994).

Although no studies have been done on the effects of physical activity on stress related to Crohn's disease, several other studies have shown the positive benefits of physical activity on stress. Brown (1991) found that people who are physically fit are less vulnerable to the adverse effects of life stress than those who are less fit. Roth and Holmes (1985) reported that higher levels of life stress were related to poorer physical health for subjects with a low level of fitness. For subjects who had high cardiorespiratory fitness, reports of negative life stress seemed to have little impact on their overall health. King et al. (1989) also found that subjects reported less stress and anxiety and improved in functional capacity following a six month home-based aerobic program. Goldwater and Collis (1985) reported that subjects demonstrated a significant improvement in cardiorespiratory

fitness and also showed a substantial reduction in anxiety and stress following a 6-week aerobic exercise program. Similar to the results of this study, Minor et al. (1989) found that 120 patients with rheumatoid arthritis experienced lower anxiety levels following a 12-week exercise program.

It can be hypothesized that exercise training may serve as a temporary outlet from life stress and may allow people to deal with stressful events more effectively. This was true for the participants in this study who decreased their overall stress levels and found more effective ways to cope with life stress, particularly that related to Crohn's disease, as a result of the walking program. The Canadian Foundation for Crohn's and Colitis (1993) suggested that patients with Crohn's disease should engage in regular physical activity to help reduce anxiety, tension and other stressors and an active lifestyle will help patients to cope with the disease and feel better about themselves. The results of this study strongly support this statement. This study did show that moderate physical activity can be an effective stress management technique for patients with Crohn's disease. Participants reduced their stress levels and felt subjectively better about themselves following the 12-week walking program.

The results of this study suggest that exercise training may be an effective stress management technique for reducing stress levels and enhancing psychological well-being in patients with Crohn's disease. Life stress has been shown to

affect the clinical course of Crohn's disease, therefore clinicians must develop appropriate intervention techniques such as exercise training, to help patients deal more effectively with stress and the demands of the disease (Garrett et al., 1991). Physical fitness may be a reliable moderating variable in the stress-illness relationship of Crohn's disease.

The promising preliminary findings from the results of this study suggest that exercise training seems to lower stress levels in patients with Crohn's disease. Therefore, further inquiries into these relationships appears to be highly warranted.

The Stress-Symptom Interaction

The stress-illness relationship has been proposed as being a predominant factor in the exacerbation of many diseases, including Crohn's disease. Waranch (1988) stated that there is pervasive evidence that psychological stress plays a significant role in the exacerbation of GI disorders, including Crohn's disease, and an estimated 60% of GI disorders are influenced somewhat by psychological stress. Stress is not the primary cause of Crohn's disease, however, stress may affect the course of already diagnosed disease by leading to an exacerbation of symptoms. It has been the experience of most patients with Crohn's disease and their physicians that the stress-illness relationship indeed exists (Collins & Croitoru, 1993). Therefore, establishing effective

stress management techniques for patients with Crohn's disease is of extreme importance. Duffy et al. (1991) reported that in a group of 77 patients with Crohn's disease, those subjects who were exposed to stress demonstrated an increased risk of clinical episodes of disease when compared to unexposed subjects. Turnbull and Vallis (1995) found that greater psychological distress and disease activity predicted more systemic symptoms in a group of 16 patients with Crohn's disease.

The results of this study clearly indicate that participation in moderate physical activity can significantly reduce stress levels and symptoms in patients with Crohn's disease. Although physiological measures were not utilized in this study, there can be several reasons hypothesized why patients' symptoms decreased: enhanced psychological well-being and reduced reactivity to stress, or as the participants became fitter, their immune system became stronger. Lechin et al. (1994) found that in a group of 88 patients with various chronic diseases (rheumatoid arthritis, asthma, ulcerative colitis, Crohn's disease etc.), neurochemical and hormonal plasma profiles were significantly different during exacerbation and remission periods from that of normal controls. The author suggested that an uncontrolled stress mechanism underlies the diseases of these patients. Therefore, reducing stress levels of these patients may have a

positive influence on the immune response and thus may reduce symptoms of their disease.

Several research studies have investigated the effects of stressful life events on disease activity of patients with Crohn's disease.

Garrett et al. (1991) found that in a group of 10 subjects with Crohn's disease who monitored stress and symptoms over 28 days, those persons who reported high levels of stress also reported more signs and symptoms of the disease. The investigators concluded that the results of their study suggest that for at least some individuals with Crohn's disease, daily stress tends to be related to an exacerbation of the signs and symptoms of Crohn's disease.

Similar to the results of this study, Milne et al. (1986) found that scores on the Crohn's Disease Activity Index (Best et al., 1976) decreased significantly from baseline to post-test in a group of 80 patients who practised various stress management techniques over a 12-month period. Schwartz and Blanchard (1991) reported that 11 patients with Crohn's disease who received biofeedback, muscle relaxation training, coping strategies and educational sessions related to IBD symptoms improved on five out of eight symptoms, with abdominal pain displaying a statistically significant reduction at post-treatment. In addition, these participants did perceive themselves as coping better and feeling less Crohn's disease-related stress and anxiety. Similarly, the

participants in the present study also reported feeling less Crohn's disease-related stress and were able to cope more effectively with their disease following the 12-week walking program. These participants reported that they felt more positive about their illness because being in the walking program made them feel that despite their illness, they were doing everything possible to be otherwise healthy.

The results of this study are very encouraging even though no physiological measures were utilized. Self-report measures and qualitative analysis revealed significant decreases in stress and symptoms of Crohn's disease in 12 patients with Crohn's disease following a 12-week walking program. These preliminary findings will enable researchers to further investigate the effects of physical activity on stress and symptoms of patients with Crohn's disease. Swain (1995) cited that among the positive effects of participating in a regular physical activity program is the possible decreased incidence of Crohn's disease and colonic cancers. Future research is essential in determining the extent to which exercise has a positive influence on the gastrointestinal tract. The results of this study clearly indicate that physical activity should be an important part of the overall therapeutic process for patients with Crohn's disease given the positive effects on well-being and physical health observed in these 12 patients. Exercise may play an

important role in the stress-illness relationship of Crohn's disease.

One of the most challenging issues facing researchers is whether behavioral or psychotherapeutic interventions like physical activity, for example, can directly enhance immune function and thereby prevent the onset or alter the course of disease involving the immune system (Pelletier, 1992). The answer to this question will no doubt change the face of disease prevention and management for the future.

Evaluation of the Exercise Program

Use of Log Books to Record Training Data

Participants in this study recorded the frequency, distance (km) and duration (min) of walking and target heart rate for each walking session in a personally assigned log book. The importance of recording accurate heart rate values, especially in the unsupervised walking sessions was emphasized to each participant. All log books were kept in order and were found to be well documented after the 12-week program. All data in the log books were complete for all 12 participants. The use of log books for this walking study was therefore an effective mode of documenting training progression over a 12-week period.

Many of the participants were detailed in their comments and were very consistent in these comments throughout the 12-week period. Only a few participants were generally nonspecific in their comments. Given that decreasing stress

levels of participants was one of the hypotheses of this study, use of the log book may have served as an important motivational tool, thus, allowing participants to monitor their progress on a weekly basis. Recording comments may also have been an additional motivating factor. Participants may have felt more positive about themselves by writing down how they felt both psychologically and physically following each session. As illustrated in the results, there was a general consensus among all participants on their improved psychological and physical health with relation to energy levels, symptoms, self-esteem, stress levels and general health. The comments became more positive throughout the 12-week period. Research has shown that personal log books are not only an effective way to document training progression, but also serve as a motivational tool for participants who know they are being monitored (Klesges, Eck, Mellon Fulliton, Somes & Hanson, 1989). In addition, looking back at the record and observing the gains that have been made can be a source of motivation when one becomes discouraged (Rosato, 1990). This is particularly true with the participants in this study because as they monitored their progress throughout the program they found it easier to deal with disease related problems such as side effects from medication, fatigue and stress.

Effect of Supervision

The supervised walking sessions served as a motivational tool as participants were encouraged to walk to the best of their ability. Many participants liked the sessions because they tried to set new walking goals by trying to keep up with the other walkers.

The average attendance over 12 weeks for participants was 13.4 sessions so most attended approximately one session per week. One participant attended 32 sessions in total (2-3 times per week), however, five participants only attended a total of 4 or 5 sessions in total (Table 2). Some of the participants found it difficult to attend the sessions at the University due to driving time and family obligations. Two participants couldn't attend the sessions due to job conflicts. They walked outside and at the indoor track at their places of work. One participant was frequently out of town for her job so she walked on her own time and came every two weeks to the walking sessions. Two other participants worked shift work so they could not attend the walking sessions on a regular basis. These persons attended the sessions about once every two weeks. Job conflicts and family obligations were a major reason why these five people had such poor attendance rates for the supervised walking sessions. These participants were, however, committed to the study and walked the required three days per week. They also kept their log books up to date and filled in all of the required walking

data for these unsupervised walking sessions. A few participants did not come as frequently during the last few weeks of the study due to the nice weather outside. The researcher made weekly follow-up telephone calls to these participants to monitor their walking progress.

Although all data from each walking session were complete, data from the supervised sessions may have been more accurate than for the non-supervised sessions. Exact distance could be calculated as opposed to calculating distances in other locations. Most participants demonstrated larger increases in distance and duration of walking and heart rate was closer to target range during the supervised sessions. However, even though the mean attendance rate was only 13.4 for the 12 weeks, this does not mean that the participants were not walking. This is supported by the average frequency data of 2.92 times per week over the 12-week period. The minimum frequency per week for this group was 2.8, very close to the prescribed 3.0 times per week of walking. Many participants preferred to stick to their own individual walking routes even though they were all encouraged to attend the supervised sessions.

Perhaps the most significant residual effect of the supervised walking sessions, other than monitoring subjects' progress, was the aspect of socialization. Participating with a group has been shown to increase adherence to exercise. Massie and Shephard (1971) as cited by Rosato (1990) compared

Cooper's individualized aerobics program to the group approach and found that after 28 weeks only 47% of those in the individualized program continued to participate compared to 82% in the group system. Exercising within a group setting provides reinforcement, camaraderie, and an element of competition as well as a spirit of cooperation. In the early days of exercise, allegiance to a group enhances compliance. One's commitment to the group is not as easily dissolved as a commitment to oneself. A person is more likely to stay committed to a group exercise program as compared to if they exercised on their own. However, when the individual becomes more committed to a regular physical activity program, the need for group support will probably decrease and the program can be continued without it (Rosato, 1990). Incidently, one of the participants in this study felt that walking with the other members of the study group was very therapeutic and provided stress relief. In addition, one other participant stated that the only negative factor she experienced during the study was that she regretted that she was not able to attend more of the group walking sessions due to family obligations. However, it should be noted that the beneficial effects of group therapy cannot be separated out from the exercise program itself. Participants in the study may have felt better simply because they were exercising among a group of other patients with Crohn's disease.

The results of this study certainly support the notion that physical activity can have pronounced psychological benefits on participants, especially when performed in a group setting. The socialization aspect of group exercise is very important, especially for persons with Crohn's disease. The effect of supervision and group exercise is a significant topic that requires further research.

Exercise Program Adherence

Motivation is a crucial element in adherence to participation in regular physical activity. Motivation played a key role in this study due to its length and the vigorous amount of walking required. McAuley and Jacobson (1991) emphasized that high levels of motivation are required to sustain a physical activity program since exercise behaviors may be somewhat resistant to change.

Overall, subject retention in this study was fairly good considering the length of the program, the amount of walking required, and the sedentary status of the participants. However, it is difficult to estimate how good subject retention would have been if this study had been longer than three months. Twelve of the initial sixteen subjects (75%) completed the 12-week walking program, the fitness tests and questionnaires. Two subjects dropped out within the first week of the study due to lack of motivation, one dropped out a few days before the walking started due to injury, and one person dropped the program due to hospitalization for her

Crohn's disease. However, this person only walked a total of three times during the two weeks she was in the program and had been unwell during the pre-test phase.

As stated in the results, nine out of the 12 participants in this study cited lack of time, motivation and family obligations as the most significant barriers for future participation in physical activity programs. Three participants cited that fatigue, pain or symptoms relating to Crohn's would impair their future physical activity participation. Although most of the participants agreed that this study provided the motivation to get started in a physical fitness program again, they stated that keeping motivated for the future would be a challenge. Given that this study did emphasize group participation and the researcher did attend every walking session, the notion of going back to individualized exercise was difficult for a few participants. This is where future group exercise sessions for patients with Crohn's disease would be an asset.

Eleven out of 12 participants reported that illness permitting, they would regularly participate in future physical activity programs. Only one participant said "maybe" to future physical activity participation due to bouts of fatigue and side effects of medication.

The time of the year of the study may have played a major role in participants' adherence. The walking program went from April to June, thus, participants may have enjoyed the

program more simply because it was held during the spring and summer. In addition, a few participants stated that they had always felt better during this time than during the winter.

Keeping participants motivated was an important part of the walking program. Instructor enthusiasm and support may have significantly influenced participants' motivation in this study. The instructor provided considerable information regarding progress or improvement which potentially influenced self-esteem and confidence of participants. Having predetermined goals in terms of frequency and duration of walking may have acted as a significant motivator for participants. This predetermined amount may also have served as a goal for the participant to work towards. This may help explain the high average frequency of 2.9 times per week for the 12-week period.

Offering incentives for participants may also have served as a motivational factor. Rosato (1990) stated that extrinsic rewards are often a necessary stimulus for people to continue in an exercise program during those early critical months. The incentives offered in this study were: a 12-week free pass to the facilities at the University of Manitoba, special walking t-shirts and water bottles, six participants attended a Crohn's sponsored walk-a-thon and feedback was given to each participant regarding their progress in the study. All of the participants were truly interested in how they were progressing in terms of their fitness level and in relation to

their disease. This was very positive as many of the participants became better educated about their health and learned how to deal more effectively with their Crohn's disease.

Although these extrinsic rewards were offered to participants to help facilitate adherence to the program, by the end of the study, it was evident that all participants internalized the feelings of well-being as the prime motivators of exercise (Rosato, 1990). Achieving greater health status and quality of life were the most significant rewards for participants in this study.

A six month telephone follow-up (in December) was conducted to determine if participants were still exercising following the study. Six participants were continuing to exercise between two and six days per week (aerobics, walking, aquacise and cycling were the most common activities cited), four participants were not exercising on a regular basis, and two participants had continued to walk up to four months after the study, but they both had to discontinue this activity as one became severely ill (infection in her GI tract) and another had a relapse of her Crohn's disease. Incidentally, this is the same person who experienced a relapse at the start of the walking program and was well during the program. Therefore, at six months, 50% (6 of 12) of the original study group continued to exercise. The four participants who did not continue to exercise following the

study cited lack of time and job and family obligations as the major reasons for quitting exercise.

Effects of Exercise on Fitness Parameters

Walking Frequency

This study set a predetermined goal of 3 walking sessions per week, for 12 weeks. Subjects were advised to first increase their frequency, then duration followed by intensity. The amount is well within the prescription for cardiorespiratory fitness benefits (ACSM, 1991).

Based on the results, it appears that walking three days per week was a reasonable and attainable goal for all participants in this study. Participants were able to walk three days per week while not having to alter their lifestyles a great deal. One of the participants in the study was able to achieve these goals despite suffering from leg cramps as a result of prednisone use. Also, there were no injuries reported by participants relating to the walking program.

A frequency of three days per week was not sufficient enough for changes in BMI ($p = 0.068$). The mean pre-test BMI was 24.3 compared to 23.9 at post-test. However, dietary status of participants was not monitored and anthropometric measures were not taken (besides BMI) pre- and post-study. These factors may have made a significant difference in body composition changes of participants. One participant did lose 10 pounds during the study and others reported that they were

more toned in their waist, hips and legs following the program even though they did not lose any weight.

The ACSM (1991) guidelines recommend a frequency of 3-5 days per week of exercise. The three day per week frequency prescribed in this study was sufficient enough to decrease stress levels, decrease symptoms related to Crohn's disease, increase predicted VO_2 Max and improve quality of life in 12 patients with Crohn's disease. Rosato (1990) stated that low intensity exercise of moderate duration (20-40 minutes) can be pursued every day without producing physiological or orthopaedic problems.

ACSM (1991) emphasized that exercise prescription for persons with chronic disease requires individualization and flexibility due to fluctuating clinical status of patients. The results of this study will enable fitness professionals to have a greater insight when prescribing exercise for persons with Crohn's disease.

Walking Duration

The prescribed walking duration (minutes) was between 20-35 minutes per session.

All subjects met the ACSM (1991) prescription guidelines for 15-60 minutes of continuous or discontinuous aerobic activity. Given the sedentary status of the participants, 20-35 minutes of walking for 12 weeks was enough to elicit significant health and fitness benefits. For people who exercise for health enhancement, as the participants did in

this study, it is best to sacrifice some degree of intensity for duration (Rosato, 1990). Duration of exercise for patients with Crohn's disease will highly depend on disease activity, medication use, and nutritional status. Every patient with Crohn's disease will need an individualized exercise program based on these factors.

Walking Distance

Distance of walking depended on participants' energy levels, medication use and general well-being.

Average distance walked per session was 3.5 km with the minimum being 1.1 km and the maximum 5.4 km per session. Participants tended to walk greater distances during the sessions at the indoor track as they were able to calculate the exact distance of walking.

Walking Intensity

The prescribed walking intensity for this study was 60% of heart rate reserve. This falls within the intensity prescription guidelines of 55-90% of maximum heart rate recommended by ACSM (1991). The intensity of exercise for this study was selected at the lower limits of maximum heart rate due to the sedentary status of the participants and because they have a chronic disease.

Seals, Hagberg, Hurley, Ehsani & Holloszy (1984) documented a significant increase in $V0_2$ Max with an exercise frequency of three times per week. In addition, ACSM (1991) stated that the amount of improvement in VO_2 Max tends to

plateau when frequency of training is increased about three days per week. Mean predicted $V0_2$ Max at pre-test was 30.6 compared to 32.4 at post-walking.

Intensity of exercise for patients with Crohn's disease must be prescribed on an individualized basis. It would be recommended that these persons exercise at a lower intensity, as the intensity prescribed for this study (60% of heart rate reserve) seemed safe and effective for participants. Increases in functional capacity (VO_2 Max) were evident following this low intensity 12-week walking program. Also, exercising at a lower intensity may provide important health benefits and result in increased fitness in some people, especially those who are sedentary or have a low level of fitness (ACSM, 1991). Patients with Crohn's disease should also use the Rating of Perceived Exertion as it is an effective tool for evaluating normal discomfort and for regulating intensity of exercise (ACSM, 1991).

Exercise Guidelines for Crohn's Disease

Although the benefits of exercise training for patients with various chronic diseases are becoming increasingly recognized, there are no existing programs or guidelines for patients with Crohn's disease. The results of this study have revealed several important and valuable sources of information regarding the effects of exercise training on the health status of patients with Crohn's disease.

ACSM (1991) stated that the goals of exercise training for persons with chronic disease are:

1) to counteract the detrimental physiological effects of bed rest and/or previous sedentary living patterns, and

2) to optimize the patients' functional capacity within the physiological limitations of the disease.

In addition, exercise training may also be beneficial as a stress management technique capable of reducing the impact of unmanageable stressful life events on psychological and physiological health of persons with chronic disease (LaPerriere et al., 1994).

Overall, the results of this study indicated that patients with Crohn's disease can tolerate physical activity programs without an increase in disease activity. A 12-week low intensity walking program reduced stress levels, decreased symptoms, increased VO_2 Max and increased overall quality of life and perceived energy levels of 12 patients with Crohn's disease. Given that this is the first study to investigate the effects of exercise training in patients with Crohn's disease, these findings will provide essential information regarding exercise prescription and guidelines. The psychological and physical benefits of regular physical activity should be emphasized to persons with Crohn's disease as they tend to report significant psychosocial distress which appears to be related to greater symptom severity. They also report overall poorer health and well-being (Drossman,

Leserman, Mitchell, Li, Zagami, & Patrick, 1991). It is evident that regular physical activity should be included in the overall therapeutic regime for these patients.

Although exercise guidelines for patients with Crohn's disease were non-existent prior to this study, there are general considerations for exercise that are applicable to various chronic disease, including Crohn's disease. The ACSM (1991) has put forward the following guidelines when administering an exercise program for patients with chronic disease.

1) Patients may experience temporary set-backs and many will have a progressively worsening course. Any significant change in medical status requires reassessment of the exercise goals and the risks associated with exercise.

When a patient experiences an acute flare-up in Crohn's disease, it would be wise to suspend exercise until the flare-up is under control. When exercise is resumed, the original goals and prescription may have to be modified.

2) Pain and chronic fatigue are conditions that are common to many chronic disease states. RPE is a good tool for evaluating normal discomfort and should be used for regulating intensity in these patients.

3) For obvious reasons, exercise should only be initiated when the patient is clinically stable.

4) Exercise prescription should be developed with careful consideration of individual health history, risk

factor profile, behavioral characteristics and personal goals and preferences.

Thus, the guidelines set by ACSM (1991) regarding quantity and quality of exercise may have to be modified according to the individual.

The ACSM (1991) emphasized that regular physical activity should be considered a part of the medical therapy for patients with chronic disease because it provides a unique opportunity for surveillance and because it is a valuable source of information that may assist the physician in the ongoing treatment of patients. In addition, in some cases, the response to medical therapy becomes more evident during exercise training.

The results of this study are encouraging given the proposed stress-illness relationship in Crohn's disease and the role of physical activity as a stress management technique. Future research in this area should be directed towards both the psychological and physiological aspects of exercise training on stress and symptoms in patients with Crohn's disease.

Summary and Conclusions

Twelve sedentary patients with Crohn's disease (10 female and 2 male) aged 25.0 - 51.0 years (mean age of 38.3 years) participated in a 12-week low intensity walking program. Participants were encouraged to work towards a pre-determined goal of walking 3 times per week, between 20-35 minutes per

session at 60% of heart rate reserve. Participants were asked to begin at a gradual and comfortable walking pace and then first increase their frequency of walking, followed by duration and intensity.

Participants completed self-report measures of stress and symptoms of Crohn's disease at baseline and following the walking program. The Perceived Benefits of Walking Questionnaire was also administered to each participant post-walking. Daily walking data (frequency, distance, duration, target heart rate and comments relating to psychological and physical well-being) were recorded in individual log book pages which were handed into the researcher on a weekly basis. The CAFT aerobic test and BMI were also administered to each participant pre- and post-study.

The overall symptom score from the Harvey and Bradshaw (1980) Simple Index of Crohn's Disease Activity decreased significantly ($p = 0.02$) from 5.87 at pre-test to 3.58 at post-test. This is in accordance with the research hypothesis that symptoms of Crohn's disease would decrease following the 12-week walking program. Two participants went completely off their medications, two remained drug-free and four participants decreased the dosages of their medications. Only one patient increased her dosage of 6-MP to counteract her decreased dosage of prednisone. The remaining participants stayed at the same medication dosage throughout the study.

The overall stress score from the Inflammatory Bowel Disease Stress Index (Joachim & Milne, 1987) decreased significantly ($p = 0.0005$) from 29.2 at pre-test to 19.5 at post-walking. This is also in accordance with the research hypothesis that participants' stress levels would decrease following the 12-week walking study.

Quality of life related to having Crohn's disease as measured by the IBD-Q significantly increased from a mean score of 171.8 at pre-test to 189.1 at the end of the study ($p = 0.0135$).

Participants demonstrated a significant increase in predicted VO_2 Max (a measure of cardiovascular fitness) following 12 weeks of walking ($p = 0.0013$). Mean values for VO_2 Max increased from 30.6 at pre-test to 32.4 at post-walking.

Participants' Body Mass Index (BMI) did not significantly change following 12 weeks of walking ($p = 0.068$). The mean BMI value decreased, although not significantly, from 24.25 to 23.94 at post-study.

Qualitative analysis of the Perceived Benefits of Walking Questionnaire, participants' log books and experimenter observations revealed many positive benefits of the walking program. Participants reported that the walking program gave them more energy and stamina, which helped them accomplish daily tasks more easily, they felt less affected by stress (both Crohn's-related and in their daily lives), symptoms

seemed fewer because they felt physically and psychologically better, their self-concept increased (especially for those who were on prednisone) and two participants reported that their Crohn's-related joint pain had diminished or completely disappeared as a result of the walking. Many participants also reported that the walking program gave them a feeling of accomplishment in that they felt more positive and aware of their disease and because they were making a major contribution to their overall health by being active. The walking program gave many of the participants the motivation to continue with physical activity for the future. They saw the positive changes that occurred in themselves over the 12-week period and agreed that participation in physical activity would be important. All twelve participants agreed that physical activity should be part of the overall therapeutic process for patients with Crohn's disease.

This study set a predetermined goal of three walking sessions per week for 12 weeks. The minimum average frequency for the total sample was 2.80 and the maximum 3.10.

The prescribed walking duration (min.) was between 20-35 minutes per session. Average duration per walking session was 32.6 minutes. Most participants walked 30 minutes or more within a few weeks after the study started.

Average distance walked per session was 3.5 km with the minimum being 1.1 km to a maximum of 5.4 km per session. Participants tended to walk greater distances during the

sessions at the indoor track as they were able to calculate the exact distance of walking.

The prescribed intensity of walking was 60% of heart rate reserve. Target heart rate was determined for each participant using the Karvonen formula (Davis, 1975). Heart rate was taken at halfway and following each walking session. Participants walked at or close to their target heart rate approximately six weeks into the study. Participants also reached their target heart rate more often during the supervised sessions than when they walked on their own.

The results of this study provide useful information which can be used to develop exercise prescription guidelines to achieve health and fitness benefits for patients with Crohn's disease. Physical activity should be emphasized as a crucial part of the therapeutic process for patients with Crohn's disease given that 12 weeks of moderate physical activity lowered both stress levels and symptoms in this group of patients.

Recommendations

Exercise training plays an important role in the prevention and rehabilitation of many chronic diseases. Participation in regular physical activity is also associated with reductions in negative life stress and improvements in psychological health. This study was the first of its kind to investigate the effects of exercise training on stress and symptoms of patients with Crohn's disease. The results of

this study are very encouraging as it seems that moderate physical activity may act as a modulating factor in the stress-illness relationship of Crohn's disease. In addition, this study has provided the framework for exercise prescription guidelines for this population.

Based on the results of this study, there are several recommendations that can be made for future exercise programs for patients with Crohn's disease.

Low intensity activity of moderate duration was enough to elicit improvements in fitness (predicted VO_2 Max) and decrease stress and Crohn's disease symptoms of patients. Therefore, patients should participate in low intensity activities like walking, exercising at a progressive pace (20-30 minutes to start) at about 60% of heart rate reserve. Recording their training progression in a log book may be a significant motivator for this population group. Supervised exercise programs would be beneficial for patients with Crohn's disease as this study group liked the socialization aspect of the walking sessions. Being able to socialize with other patients with Crohn's disease would highly complement the exercise program itself. Patients may adhere to group programs better than individualized exercise programs.

Exercise prescription for this population should be highly individualized as all patients will have different medical histories, illness severity and medications. Prescription will be significantly different for a patient who

has fluctuating clinical status or who is experiencing severe side-effects from medication(s) as compared to someone who is in complete remission and is not on medication(s). The results of this study did show that patients with Crohn's disease can tolerate a low intensity exercise program of moderate duration without experiencing an exacerbation of symptoms. The fitness professional may prescribe exercise programs for patients based on this protocol.

Education is an important part of the therapeutic process for patients with Crohn's disease. This population needs to be aware of how exercise can have a positive influence on their disease process and how regular physical activity may play a key role in minimizing stress and symptoms.

As a result of this study, several questions remain to be answered and thus, recommendations for future research arise. The following recommendations are made for future research on the effects of exercise training on patients with Crohn's disease:

1) A larger sample group must be employed to achieve greater representation of the population with Crohn's disease.

2) Group exercise sessions should be compared to individualized exercise. The psychological effects of group exercise may be different to that of individual exercise in patients with Crohn's disease.

3) Future replication of this study should use a longer training period. It would be useful to determine if six

months or a year of exercise would produce more significant physiological and psychological changes in participants.

4) Different exercise protocols (i.e. strength training) should be used in future studies to determine the appropriate types, intensity and frequency of exercise that will be the most effective for reducing stress levels and enhancing physical well-being of patients with Crohn's disease.

5) A replication of this study should be done using a comparison to other chronic disease groups or to a normal control group.

6) Lifestyle factors such as diet, smoking and use of herbal remedies should be monitored in future studies.

REFERENCES

Abitol, V., Roux, C., Caussade, S., Guillemant, S., Kolta, S., Dougados, M., Couturier, D., & Amor, B. (1995). Metabolic bone assessment in patients with inflammatory bowel disease. Gastroenterology, 108, 417-422.

Ader, R. (1992). On the clinical relevance of psychoneuroimmunology. Clinical Immunology and Immunopathology, 64, 6-8.

Ader, R., & Cohen, N. (1993). Psychoneuroimmunology: Conditioning and stress. Annual Review of Psychology, 44, 53-85.

American College of Sports Medicine. (1991). Guidelines for exercise testing and prescription (4th ed.). Philadelphia: Lea and Febiger.

Berger, B. G. (1994). Coping with stress: The effectiveness of exercise and other techniques. Quest, 46, 100-119.

Berne, R. M., & Levy, M. N. (1993). Physiology (3rd ed.). St. Louis: Mosby Year Book.

Best, W.R., Becktel, J. M., Singleton, J. W., & Kern, F. (1976). Development of a Crohn's disease activity index. Gastroenterology, 70, 439-444.

Black, P. H. (1994). Central nervous system-immune system interactions: Psychoneuroendocrinology of stress and its immune consequences. Antimicrobial Agents and Chemotherapy, 38, 1-5.

Booth, R. J., & Ashbridge, K. R. (1992). Implications of psychoimmunology for models of the immune system. In A. J. Husband (Ed.), Behavior and immunity (pp. 13-23). Boca Raton: CRC Press.

Borg, G. A. (1973). Perceived exertion: A note on history and methods. Medicine and Science in Sports and Exercise, 5, 19.

Brantley, P. J., Dietz, L. S., McKnight, G. T., Jones, G. N., & Tulley, R. (1988). Convergence between the daily stress inventory and endocrine measures of stress. Journal of Consulting and Clinical Psychology, 56, 549-551.

Brown, J. D. (1991). Staying fit and staying well: Physical fitness as a moderator of life stress. Journal of Personality and Social Psychology, 60, 555-561.

Brown, J. D., & Siegal, J. M. (1988). Exercise as a buffer of life stress: A prospective study of adolescent health. Health Psychology, 7, 341-353.

Cacioppo, J. T. (1993). Social neuroscience: Autonomic, neuroendocrine and immune responses to stress. Psychophysiology, 31, 113-128.

Calabrese, L. H. (1992). Exercise, immunity, cancer and infection. In C. Bouchard, R. J. Shephard, T. Stephens, J. R. Sutton, & B. D. McPherson (Eds.), Exercise, fitness and health: A consensus of current knowledge (pp. 568-579). Champaign: Human Kinetics Publishers.

Camilleri, M., & Proano, M. (1989). Advances in the assessment of disease activity in inflammatory bowel disease. Mayo Clinic Protocol, 64, 800-807.

Canadian Fitness and Lifestyle Research Institute. (1994). The research file: Exercise and the immune system. Ottawa.

Canadian Society for Exercise Physiology. (1993). Certified fitness appraiser resource manual. Ottawa.

Canadian Association of Sport Sciences. Canadian Standardized Test of Fitness. (1987). Operations manual (3rd ed.).

Crohn's and Colitis Foundation of Canada. (1993). Psychological aspects of inflammatory bowel disease, 3-10.

Collins, S. M., & Croitoru, K. (1993). What will research tell us about the future of inflammatory bowel disease. Canadian Journal of Gastroenterology, 7, 51-54.

Davis, J. A. (1975). A comparison of heart rate methods for predicting endurance training intensity. Medicine and Science in Sports and Exercise, 7, 295.

DeGeus, E. J. C., Van Doornen, L. J. P., de Visser, D. C., & Orlebecke, J. F. (1990). Existing and training induced differences in aerobic fitness: Their relationship to physiological response patterns during different types of stress. Psychophysiology, 27, 457-475.

Dorian, B., & Garfinkel, P. E. (1987). Stress, immunity and illness: A review. Psychological Medicine, 17, 393-407.

Drossman, D. A., Leserman, J., Mitchell, C. M., Li, Z., Zagami, E. A., & Patrick, D. L. (1991). Health status and health care use in persons with inflammatory bowel disease: A national sample. Digestive Diseases and Sciences, 36, 1746-1755.

Duffy, L. C., Zielczny, M. A., Marshall, J. R., Byers, T. E., Weiser, M. M., Phillips, J. F., Calkins, B. M., Ogra, P. L., & Graham, S. (1991). Relevance of major stress events as an indication of disease activity prevalence in inflammatory bowel disease. Behavioral Medicine, 17, 101-110.

Elson, C. O. (1988). The immunology of inflammatory bowel disease. In J. B. Kirsner & R. G. Shorter (Eds.), Inflammatory bowel disease (pp. 97-165). Philadelphia: Lea and Febiger.

Ferry, A., Weill, B. L., & Rieu, M. (1990). Immunomodulations induced in rats by exercise on a treadmill. Journal of Applied Physiology, 69, 1912-1915.

Fitzgerald, L. (1991). Overtraining increases the susceptibility to infection. International Journal of Sports Medicine, 12, 55-58.

Franks, B. D. (1994). What is stress? Quest, 46, 1-7.

Galloway, M. T., & Jokl, P. (1993). The role of exercise in the treatment of inflammatory arthritis. Bulletin on the Rheumatic Diseases, 42, 1-4.

Garrett, J. W., & Drossman, D. A. (1990). Health status in inflammatory bowel disease: Biological and behavioral considerations. Gastroenterology, 99, 90-96.

Garrett, V. C., Brantley, P. J., Jones, G. N., & McKnight, G. I. (1991). The relation between daily stress and Crohn's disease. Journal of Behavioral Medicine, 14, 87-96.

Glass, D. C. (1989). Psychology and health: Obstacles and opportunities. Journal of Applied Social Psychology, 19, 1145-1163.

Goldwater, B. C., & Collis, M. L. (1985). Psychologic effects of a cardiovascular conditioning: A controlled experiment. Psychosomatic Medicine, 47, 174-180.

Guyatt, G. H., Mitchell, A., Irvine, E. J., Singer, J., Williams, N., Goodacre, R. & Tompkins, C. (1989). A new measure of health status for clinical trials in IBD. Gastroenterology, 96, 804-810.

Harkcom, T. M., Lampman, R. M., Figley-Banwell, B., & Castor, C. W. (1985). Therapeutic value of graded aerobic exercise training in rheumatoid arthritis. Arthritis and Rheumatism, 28, 32-38.

Harvey, R. F., & Bradshaw, J. M. (1980). A simple index of Crohn's disease activity. Lancet, 60, 514.

Holmes, D. S., & McGilley, B. M. (1987). Influence of a brief aerobic training program on heart rate and subjective response to a psychologic stressor. Psychosomatic Medicine, 49, 366-374.

Irvine, E. J., Feagan, B., Rochon, J., Archambault, A., Fedorak, R. H., Groll, A., Kinnear, D., Saibil, F., & McDonald, J. W. D., (1994). Quality of life: A valid and reliable measure of therapeutic efficacy in the treatment of inflammatory bowel disease. Gastroenterology, 106, 287-296.

Jette, M., Campbell, J., Mongeon, J., & Routhier, R. (1976). The Canadian home fitness test as a predictor of aerobic capacity. Canadian Medical Association Journal, 114, 680-682.

Joachim, G. (1983). The effects of two stress management techniques on feelings of well-being in patients with inflammatory bowel disease. Nursing Papers, 15, 5-18.

Joachim, G. S., & Milne, B. (1987). Inflammatory bowel disease: Effects on lifestyle. Journal of Advanced Nursing, 12, 483-487.

Johnson, B. L., & Nelson, J. K. (1986). Practical measurements for evaluation in physical education (4th ed.) New York: Macmillan Publishing.

Keast, D., & Morton, A. R. (1992). Long-term exercise and immune functions. In R. R. Watson & M. Eisinger (Eds.), Exercise and disease (pp. 89-109). Boca Raton: CRC Press.

Kiecott-Glaser, J. K., & Glaser, R. (1992). Psychoneuroimmunology: Can psychological interventions modulate immunity? Journal of Consulting and Clinical Psychology, 60, 569-575.

King, A. C., Taylor, C. B., Haskell, W. L., & DeBurk, R. F. (1989). Influence of regular aerobic exercise on psychological health: A randomized controlled trial of healthy middle-aged adults. Health Psychology, 8, 305-324.

Kirsner, J. (1991). Inflammatory bowel disease part 1: Nature and pathogenesis. Disease-a-Month, 37, 610-643.

Klesges, R., Eck, L., Mellon, M., Fulliton, W., Somes, G., & Hanson, C. (1989). The accuracy of self reports of physical activity. Medicine and Science in Sports and Exercise, 22, 690-696.

Kropiunigg, U. (1993). Basics in psychoneuroimmunology. Annals of Medicine, 25,473-479.

LaPerriere, A., Ironson, G., Antoni, M.H., Schneiderman, N., Klimas, N., & Fletcher, M. A. (1994). Exercise and psychoneuroimmunology. Medicine and Science in Sports and Exercise, 26, 182-189.

Lechin, F., Vander Dijis, B., Lechin, A., Orozco, B., Lechin, M., Baez, S., Rada, I., Leon, G., & Acosta, E. (1994). Plasma neurotransmitters and cortivol in chronic illness: role of stress. Journal of Medicine, 25, 181-192.

Leger, L., & Gadoury, C. (1989). Validity of the 20 m shuttle run test with 1 min. stages to predict VO_2 Max in adults. Canadian Journal of Sports Sciences, 14, 21-26.

Lin, Y. S., Jan, M. S., & Chen, H. I. (1993). The effect of chronic and acute exercise on immunity in rats. International Journal of Sports Medicine, 14, 86-92.

Lyngberg, K. K., Harreby, M., Bentzen, H., Frost, B., & Samsoe-Danneskiold, B. (1994). Elderly rheumatoid arthritis patients on steroid treatment tolerate physical training without an increase in disease activity. Archives of Physical Medicine and Rehabilitation, 75, 1189-1194.

MacDermott, R. P. (1994). Alterations in the mucosal immune system in ulcerative colitis and Crohn's disease. Medical Clinics of North America, 78, 1207-1225.

Matsuura, T., West, G. A., Youngman, K. R., Klein, J. S., & Fiocchi, C. (1993). Immune activation genes in inflammatory bowel disease. Gastroenterology, 104, 448-458.

Mayer, M. A., Raybould, H., & Koelbel, C. (1988). Neuropeptides: Inflammation and motility. Digestive Diseases and Sciences, 33, 715-775.

McAuley, E., & Jacobson, L. (1991). Self-efficacy and exercise participation in sedentary adult females. American Journal of Health Promotion, 5, 185-191.

Milne, B., Joachim, G., & Niedhardt, J. (1986). A stress management program for inflammatory bowel disease patients. Journal of Advanced Nursing, 11, 561-567.

Minor, M. A., Hewett, J. E., Webel, R. R., Anderson, S. K., & Kay, D. R. (1989). Efficacy of physical conditioning exercise in patients with rheumatoid arthritis and osteoarthritis. Arthritis and Rheumatism, 32, 1396-1404.

Murray, D. R., Irwin, M., Rearden, C. A., Ziegler, M., Motulsky, H., & Maisel, A. S. (1992). Sympathetic and immune interactions during dynamic exercise: Mediation via a B_2-adrenergic-dependent mechanism. Circulation, 86, 203-212.

Myren, J., Bouchier, A. D., Watkinson, G., Softley, A., Clamp, S. E., & deDombal, F. T. (1984). The O.M.G.E. multinational inflammatory bowel disease survey 1976-1982: A further report on 2,657 cases. Scandinavian Journal of Gastroenterology, 19, 1-27.

Naliboff, B. C., Benton, D., Soloman, G. F., Morely, J. E., Fahey, J. L., Bloom, E. T., Makinodan, T., & Gilmore, S. L. (1991). Immunological changes in young and old adults during brief laboratory stress. Psychosomatic Medicine, 53, 121-132.

Nash, M. S. (1994). Exercise and immunology. Medicine and Science in Sports and Exercise, 26, 125-127.

Nehlsen-Cannarella, S. L., Nieman, D. C., Balk-Lamberton, A. J., Markoff, P. A., Critton, D. B., Gusewitch, G., & Lee, J. W. (1991). The effects of moderate exercise training on immune response. Medicine and Science in Sports and Exercise, 23, 64-70.

Nieman, D. C., & Nehlsen-Cannarella, S. L. (1991). The effects of acute and chronic exercise on immunoglobulins. Sports Medicine, 11, 183-201.

Noredemar, R. (1981). Physical training in rheumatoid arthritis: a controlled long-term study II. Functional capacity and general attitudes. Scandinavian Journal of Rheumatology, 10, 25-30.

North, C. S., & Alpers, D. H. (1994). A review of studies of psychiatric factors in Crohn's disease: Etiologic implications. Annals of Clinical Psychiatry, 6, 117-123.

North, C. S., Alpers, D. H., Helzer, J. E., Spitznagel, E. L., & Clouse, R. E. (1991). Do life events or depression exacerbate inflammatory bowel disease: A prospective study. Annals of Internal Medicine, 114, 381-386.

O'Leary, A. (1990). Stress, emotion and human immune function. Psychological Bulletin, 108, 363-382.

Pelletier, K. R. (1992). Mind-body health: Research, clinical and policy applications. American Journal of Health Promotion, 6, 345-358.

Persson, P. G., Leijonmarck, C. E., Bernell, O., Hellers, G., & Ahlbom, A. (1993). Risk indicators for inflammatory bowel disease. International Journal of Epidemiology, 22, 268-272.

Pigot, F., Roux, C., Caussade, S., Hardelin, D., Pelleter, O., DuPuy-Montbrun, T., Listrat, V., Dougados, M., Couturier, D., & Amor, B. (1992). Low bone mineral density in patients with inflammatory bowel disease. Digestive Diseases and Sciences, 37, 1396-1403.

Plowman, S. A. (1994). Stress, hyperreactivity and health. Quest, 46, 78-99.

Podolsky, D. K. (1991). Inflammatory bowel disease. The New England Journal of Medicine, 70, 928-935.

Rabkin, J. G., & Struening, E. L. (1976). Life events, stress and illness. Science, 194, 1013-1020.

Rosato, F. D. (1990). Fitness and wellness: The physical connection. St. Paul: West Publishing Company.

Roth, D. L., & Holmes, D. S. (1985). Influence of physical fitness in determining the impact of stressful life events on physical and psychologic health. Psychosomatic Medicine, 47, 164-172.

Schauf, C., Moffett, D., & Moffett, S. (1990). Human physiology: Foundations and frontiers. St. Louis: Mosby College Publishing.

Schedlowski, M., Jacobs, R., Fluge, T., Aiker, J., Prohl, F., Stratmann, G., Richter, S., Hadicke, A., Wagner, T.O.F., Schmidt, R. E., & Tewes, U. (1993). Parachuting stress: Effects on endocrine and immune functions. In A. J. Husband (Ed.), Psychoimmunology: CNS-immune interactions (pp. 97-106). Boca Raton: CRC Press.

Schwartz, S. P., & Blanchard, E. B. (1991). Evaluation of a psychological treatment for inflammatory bowel disease. Behavioral Research Therapy, 2, 167-177.

Scott, D. L. (1992). Rest or exercise in inflammatory arthritis? British Journal of Hospital Medicine, 48, 446-447.

Seals, D., Hagberg, J., Hurley, B., Ehsani, A., & Holloszy, J. (1984). Endurance training in older men and women: cardiovascular responses to exercise. Journal of Applied Physiology, 40, 1024-1029.

Shanahan, F. (1994). Current concepts of the pathogenesis of inflammatory bowel disease. Irish Journal of Medical Science, 12, 544-549.

Shanahan, F., & Anton, P. (1988). Neuroendocrine modulation of the immune system: Possible implications for inflammatory bowel disease. Digestive Diseases and Sciences, 33, 415-495.

Shephard, R. J., Cox, M., Carey, P., & Smyth, R. (1979). Some factors affecting the accuracy of the Canadian Home Fitness Test scores. Canadian Journal of Applied Sport Sciences, 4, 205-209.

Sheridan, J. F., Dobbs, C., Brown, D., & Zwilling, B. (1994). Psychoneuroimmunology: Stress effects on pathogenesis and immunity during infection. Clinical Microbiology Reviews, 7, 200-212.

Sinyor, D., Schwartz, S. G., Peronnet, F., Brisson, G., & Seraganian, P. (1983). Aerobic fitness level and reactivity to psychosocial stress: Physiological, biochemical and subjective measures. Psychosomatic Medicine, 45, 205-215.

Sonnenberg, A. (1990). Occupational distribution of inflammatory bowel disease among German employees. Gut, 31, 1037-1040.

Sternberg, E. M. (1992). The stress response and the regulation of inflammatory disease. Annals of Internal Medicine, 117, 854-866.

Strober, W., & James, S. P. (1986). The immunologic basis of inflammatory bowel disease. Journal of Clinical Immunology, 6, 415-429.

Swain, M. G., & Maric, M. (1994). Prevention of immune-mediated arthritis in cholestatic rats: Involvement of endogenous glucocorticoids. Gastroenterology, 107, 1469-1474.

Swain, R. A. (1995). Exercise and the gastrointestinal tract. Medicine, Exercise, Nutrition and Health, 4, 93-100.

Synder, B. K., Roghmann, R. J., & Siegal, L. H. (1993). Stress and psychosocial factors: Effects on primary cellular immune response. Journal of Behavioral Medicine, 16, 143-158.

Traeger-Mackinnon, L. (1994). Current challenges and future expectations in exercise immunology: Back to the future. Medicine and Science in Sports and Exercise, 26, 191-194.

Turnbull, G. K., & Vallis, T. M. (1995). Quality of life in inflammatory bowel disease: the interaction of disease activity with psychosocial function. American Journal of Gastroenterology, 90, 1450-1454.

Verde, T. J. (1992). Short-term exercise and immune function. In R. R. Watson & M. Eisinger (Eds.), Exercise and disease (pp. 71-85). Boca Raton: CRC Press.

Vollhardt, L. T. (1991). Psychoneuroimmunology: A literature review. American Journal of Orthopsychiatry, 61, 35-45.

Waranch, H. R. (1988). Relaxation therapy. In T. M. Bayless (Ed.), Current management of inflammatory bowel disease (pp. 345-346). Philadelphia: B.C. Decker Inc.

Wilder, R. L. (1992). Neurobiology and inflammatory arthritis. Bulletin on the Rheumatic Diseases, 41, 1-3.

Zautra, A. J., Burleson, M. H., Matt, K. S., Roth, S., & Burrows, L. (1994). Interpersonal stress, depression and disease activity in rheumatoid arthritis and osteoarthritis patients. Health Psychology, 13, 139-148.

Zipser, R. D. (1988). Mediators of inflammation in inflammatory bowel disease. Digestive Diseases and Sciences, 33, 45-55.

APPENDIX A

INFORMED CONSENT FORM

The Faculty of Physical Education and Recreation Studies
University of Manitoba

Consent Form

The Effects of Exercise Intervention on Symptomology and Perceived Stress Levels of Patients with Crohns Disease

I have read the description of the study and understand the measurement procedures involved.

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 investigators will be made aware of any data collected during the study on my symptomology and stress levels as well as my exercise behaviour and fitness assessment results, but such data will not be made known to any others.

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 any damage or injury (including death) that I may suffer during my participation in the research study.

_____ _____
Date Participant

_____ _____
Date Witness

Investigators: C.P. Loudon, B.P.E., Principal investigator; Faculty of Physical Education and Recreation Studies.
C.N. Bernstein, M.D., FRCPC; Faculty of Medicine.

APPENDIX B

CANADIAN STANDARDIZED TEST OF FITNESS CONSENT FORM

Appendix C (2)

Adult Consent and Release Form for the Canadian Standardized Test of Fitness

I, the undersigned, do hereby acknowledge:

- my consent to perform a fitness test consisting of stepping on double 20 cm steps at speeds appropriate for my age and gender, measurements of standing height, weight, girths and skinfolds and tests of grip strength, push-ups, trunk forward flexion and sit-ups, the results of which will assist in determining the type and amount of physical activity most appropriate for my 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 Canadian Standardized Test of Fitness. I understand that the interpretation of results is limited to providing a comparison with percentile-based norms and information on various aspects of fitness;

- 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 assume willfully 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 read, understood, and completed the Physical Activity Readiness Questionnaire (Reference: PAR-Q Validation Report, British Columbia Ministry of Health, 1978) and the answers to all the questions were negative;

- that I hereby release _____
NAME OF ORGANIZATION ADMINISTERING THE TEST
its 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 Canadian Standardized Test of Fitness except where the damage or injury is caused by the negligence of

_____
NAME OF ORGANIZATION ADMINISTERING THE TEST
or its agents, officers and employees acting within the scope of their duties.

NOTE:
This form must be witnessed at the time of signing and the witness must be of the age of majority

_____ _____
SIGNATURE DATE

_____ _____
WITNESS DATE

APPENDIX C – PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PGS. 207 & 208)

do not film

APPENDIX C

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE

Physical Activity Readiness Questionnaire - PAR-Q (revised 1994)

PAR - Q & YOU

(A Questionnaire for People Aged 15 to 69)

208

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO		
☐	☐	1.	Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
☐	☐	2.	Do you feel pain in your chest when you do physical activity?
☐	☐	3.	In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4.	Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	5.	Do you have a bone or joint problem that could be made worse by a change in your physical activity?
☐	☐	6.	Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
☐	☐	7.	Do you know of any other reason why you should not do physical activity?

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- if you are or may be pregnant — talk to your doctor before you start becoming more active.

Please note: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

You are encouraged to copy the PAR-Q but only if you use the entire form

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction.

NAME _____

SIGNATURE _____ DATE _____

SIGNATURE OF PARENT _____ WITNESS _____
or GUARDIAN (for participants under the age of majority)

continued on other side...

Supported by: Health Canada Santé Canada

APPENDIX D

HARVEY AND BRADSHAW SIMPLE INDEX OF CROHN'S DISEASE ACTIVITY

UNIVERSITY OF MANITOBA

SIGNS AND SYMPTOMS OF CROHNS DISEASE SURVEY

Introduction

This survey is designed to measure the major signs and symptoms of Crohns disease. Questions A, B, and C can be answered by the participant. A nurse will be needed to determine the scores for questions D and E. Please fill out the following survey as carefully as possible. Your responses will be kept strictly confidential. You are free to withdraw from the study at any time.

This survey is based on five items; Please circle the appropriate answer.

A. General Well-being (0= very well, 1= slightly below par, 2= poor, 3= very poor, 4= terrible).

B. Abdominal pain (0= none, 1= mild, 2= moderate, 3= severe).

C. Number of liquid stools per day _____

D. Abdominal mass (0= none, 1= dubious, 2= definite, 3= definite and tender).

E. Complications: arthalgia, uveitis, erythema nodosum, aphthous ulcers, pyoderma gangrenosum, anal fissure, new fistula, abscess (score 1 per item).

THANK YOU FOR YOUR COOPERATION

APPENDIX E

INFLAMMATORY BOWEL DISEASE

STRESS INDEX

UNIVERSITY OF MANITOBA

STRESSFUL LIFE EVENTS OF CROHNS DISEASE

The following questions look at the impact of having IBD on your lifestyle and relationships. Using the following scale below, please circle the appropriate number for each question.

	Never	Sometimes	Fairly Often	A Great Deal
Overall life satisfaction:				
1) In general, to what degree is your satisfaction with life affected by your illness?	0	1	2	3
Worry:				
2) How much time do you devote to worrying about your illness and the changes that it has made to your lifestyle?	0	1	2	3
Relationships:				
3) To what extent does your illness interfere with you getting along with:				
a) your mate and immediate family?	0	1	2	3
b) other meaningful people in your life?	0	1	2	3
School and Employment:				
5) To what extent does your illness interfere with your taking on new courses or responsibilities, job performance or grade level?	0	1	2	3
6) How often do you miss work/school because of your illness?	0	1	2	3

Please continue on the next page...

	Never	Sometimes	Fairly Often	A Great Deal
Recreation:				
7) To what extent does your illness prevent you from taking part in:				
a) sports	0	1	2	3
b) social functions	0	1	2	3
c) charity or community work	0	1	2	3
Sexuality:				
8) How much does your illness interfere with:				
a) sexual desires	0	1	2	3
b) sexual activity	0	1	2	3
c) ability to perform sexually	0	1	2	3
d) ability to experience pleasure	0	1	2	3
Symptoms:				
9) To what extent does your illness contribute to your experiencing the following feelings or symptoms:				
a) trouble remembering things	0	1	2	3
b) trouble sleeping	0	1	2	3
c) feeling like crying	0	1	2	3
d) getting angry over unimportant things	0	1	2	3
e) feeling critical of others	0	1	2	3
f) feeling nervous inside	0	1	2	3
g) difficulty making decisions	0	1	2	3
h) loss of temper	0	1	2	3
i) feeling low on energy, fatigued	0	1	2	3

Please continue on the next page...

	Never	Sometimes	Fairly Often	A Great Deal
j) feeling downhearted/depressed	0	1	2	3
k) boredom, little interest in things	0	1	2	3
1) trouble concentrating	0	1	2	3
m) feeling hopeless about the future	0	1	2	3

Body image:

10) To what extent does your illness contribute to the following feelings about your body and yourself:

a) powerless	0	1	2	3
b) ashamed	0	1	2	3
c) guilty	0	1	2	3
d) scared	0	1	2	3
e) dirty	0	1	2	3
f) unattractive	0	1	2	3
g) angry	0	1	2	3
h) not a full man or woman	0	1	2	3

THANK YOU FOR YOUR COOPERATION

APPENDIX F

INFLAMMATORY BOWEL DISEASE

QUESTIONNAIRE

ID#_____ 216

TO BE COMPLETED BY THE PATIENT

QUALITY OF LIFE IN INFLAMMATORY BOWEL DISEASE QUESTIONNAIRE (Q-IBD) (Part I)

This questionnaire is designed to find out how you have been feeling during the last two weeks. You will be asked about symptoms you have been having as a result of your Crohn's Disease, the way you have been feeling in general, and how your mood has been. Please indicate your answer by placing an "X" in the appropriate box.

1. How frequent have your bowel movements been during the last two weeks in comparison to when your disease is stable?

Bowel movements more frequent than they have ever been	Extremely frequent	Very frequent	Moderate increase in frequency of bowel movements	Some increase in frequency of bowel movements	Slight increase in frequency of bowel movements	No increase in frequency of bowel movements

2. How often has the feeling of fatigue or of being tired and worn out been a problem for you during the last two weeks?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

3. How often during the last two weeks have you felt frustrated, impatient or restless?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

4. How often during the last two weeks have you been unable to attend school or work or unable to do your work at home because of your bowel problem?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

5. How much of the time during the last two weeks have your bowel movements been loose?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

6. How much energy have you had during the last two weeks?

No energy at all	Very little energy	A little energy	Some energy	A moderate amount of energy	A lot of energy	Full of energy

TO BE COMPLETED BY THE PATIENT

QUALITY OF LIFE IN INFLAMMATORY BOWEL DISEASE QUESTIONNAIRE (Q-IBD) (Part I) (cont'd)

7. How often during the last two weeks did you feel worried about the possibility of needing surgery because of your bowel problem?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

8. How often during the last two weeks have you had to delay or cancel a social engagement because of your bowel problem?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

9. How often during the last two weeks have you been troubled by cramps in your abdomen?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

10. How often during the last two weeks have you felt generally unwell?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

(Part II)

11. How often during the last two weeks have you been troubled because of fear of not finding a washroom?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

12. How much difficulty have you had, as a result of your bowel problems, doing leisure or sports activities you would have liked to have done during the last two weeks?

A great deal of difficulty, activities made impossible	A lot of difficulty	A fair bit of difficulty	Some difficulty	A little difficulty	Hardly any difficulty	No difficulty, the bowel problem did not limit sports or leisure activities

TO BE COMPLETED BY THE PATIENT

QUALITY OF LIFE IN INFLAMMATORY BOWEL DISEASE QUESTIONNAIRE (Q-IBD) (Part II) (cont'd)

13. How often during the last two weeks have you been troubled by pain in the abdomen?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

14. How often during the last two weeks have you had problems getting a good night's sleep, or been troubled by waking up during the night?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

15. How often during the last two weeks have you felt depressed or discouraged?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

16. How often during the last two weeks have you had to avoid attending events where there was no washroom close at hand?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

17. Overall, in the last two weeks, how much of a problem have you had with passing large amounts of gas?

A severe problem	A major problem	A moderate problem	Some trouble	A little trouble	Hardly any trouble	No trouble

18. Sometimes people with inflammatory bowel disease have problems getting to the weight they would like to be, and maintaining that weight. How much of a problem has this been for you over the last two weeks?

A severe problem	A major problem	A moderate problem	Some trouble	A little trouble	Hardly any trouble	No trouble

19. Many patients with I.B.D. often have worries and anxieties related to their illness. These include worries about never feeling any better, about having a relapse and about getting cancer. In general, how often during the last two weeks have you felt worried or anxious?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

TO BE COMPLETED BY THE PATIENT

QUALITY OF LIFE IN INFLAMMATORY BOWEL DISEASE QUESTIONNAIRE (Q-IBD) (Part II) (cont'd)

20. How much of the time during the last two weeks have you been troubled by a feeling of abdominal bloating?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

21. How often during the last two weeks have you felt relaxed and free of tension?

None of the time	Hardly any of the time	A little of the time	Some of the time	A good bit of the time	Most of the time	All of the time

22. How much of the time during the last two weeks have you had rectal bleeding with your bowel movements?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

23. How much of the time during the last two weeks have you felt embarassed as a result of your bowel problems?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

24. How much of the time during the last two weeks have you been troubled by a feeling of having to go to the bathroom even though nothing comes out?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

25. How much of the time during the last two weeks have you felt tearful or upset?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

26. During the last two weeks, how much of a problem has accidental soiling of your underpants been?

A severe problem	A major problem	A moderate problem	Some trouble	A little trouble	Hardly any trouble	No trouble

TO BE COMPLETED BY THE PATIENT

QUALITY OF LIFE IN INFLAMMATORY BOWEL DISEASE QUESTIONNAIRE (Q-IBD) (Part II) (cont'd)

27. How much of the time during the last two weeks have you felt angry as a result of your bowel problem?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

28. To what extent has your I.B.D. limited sexual activity during the last two weeks?

No sex as a result of I.B.D.	Major limitation as a result of I.B.D.	Moderate limitation as a result of I.B.D.	Some limitation as a result of I.B.D.	A little limitation as a result of I.B.D.	Hardly any limitation as a result of I.B.D.	No limitation as a result of I.B.D.

29. How much of the time during the last two weeks have you been troubled by feeling sick to your stomach?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

30. How much of the time during the last two weeks have you felt irritable?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

31. How often during the last two weeks have you felt lack of understanding from others?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	Hardly any of the time	None of the time

32. How satisfied, happy or pleased have you been with your personal life during the past two weeks?

Very dissatisfied, unhappy most of the time	Generally dissatisfied, unhappy	Somewhat dissatisfied, unhappy	Generally satisfied, pleased	Satisfied most of the time, happy	Very satisfied most of the time, happy	Extremely satisfied could not have been more happy or pleased

APPENDIX G

CALCULATION OF PREDICTED VO_2 MAX

Appendix C

Calculating Aerobic Fitness (Predicted VO_2 MAX)

(from results of Canadian Aerobic Fitness Test)

Name of Participant _____

Date _____

1 Factor 1
Select factor 1 from LAST STEPPING STAGE COMPLETED (see below)

Stage	1	2	3	4	5	6	7
Male	61.4	64.9	69.5	72.8	75.8	81.4	88.4
Female	58.1	59.9	64.4	67.3	69.5	72.2	—

Factor 1 _____

2 Factor 2
Determine factor 2 from participant's NEAREST BODY WEIGHT AND AGE from table below

Factor 2 _____

3 Factor 3
SUBTRACT factor 2 from factor 1

Factor 3 _____

4 Factor 4
Select factor 4 from POST-EXERCISE HEART RATE for last stepping stage completed (see below)

Factor 4 _____

Post-Ex HR	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Factor 4	12.2	13.0	13.7	14.4	15.1	15.8	16.6	17.3	18.0	18.7	19.4	20.2	20.9	21.6	22.3	23.0	23.8	24.5	25.2

5 SUBTRACT factor 4 from factor 3 to get PREDICTED VO_2 MAX. ($ml \cdot kg^{-1} \cdot min^{-1}$)

VO_2 MAX _____

6 Determine ranking from NORMS AND PERCENTILES FOR PREDICTED VO_2 MAX. (see Operations Manual, pg. 34)

Percentile _____

7. Aerobic fitness may also be determined directly from NORMS AND PERCENTILES FOR HEART RATE FINAL SCORES (see Operations Manual, pg. 35)

Percentile _____

Factor 2

Body Wt	Kgs	45.5	47.7	50.0	52.3	54.5	56.8	59.1	61.4	63.6	65.9	68.2	70.5	72.7	75.0	77.3	79.5	81.8	84.1	86.4	88.6	90.9	93.2	95.5	9
	Lbs	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	2
	69	22.0	22.3	22.6	22.9	23.1	23.4	23.7	24.0	24.2	24.5	24.8	25.1	25.3	25.6	25.9	26.2	26.4	26.7	27.0	27.2	27.5	27.8	28.1	28
	67	21.5	21.8	22.1	22.4	22.6	22.9	23.2	23.5	23.7	24.0	24.3	24.5	24.8	25.1	25.4	25.6	25.9	26.2	26.5	26.7	27.0	27.3	27.5	2
	65	21.1	21.3	21.6	21.9	22.1	22.4	22.7	23.0	23.2	23.5	23.8	24.1	24.3	24.6	24.9	25.2	25.4	25.7	26.0	26.2	26.5	26.8	27.1	27
	63	20.5	20.8	21.1	21.4	21.6	21.9	22.2	22.5	22.7	23.0	23.3	23.5	23.8	24.1	24.4	24.6	24.9	25.2	25.5	25.7	26.0	26.3	26.5	2
	61	20.1	20.4	20.6	20.9	21.2	21.5	21.7	22.0	22.3	22.6	22.8	23.1	23.4	23.6	23.9	24.2	24.5	24.7	25.0	25.3	25.6	25.8	26.1	26
	59	19.6	19.9	20.2	20.4	20.7	21.0	21.3	21.5	21.8	22.1	22.3	22.6	22.9	23.2	23.4	23.7	24.0	24.3	24.5	24.8	25.1	25.3	25.6	2
	57	19.1	19.4	19.6	19.9	20.2	20.5	20.7	21.0	21.3	21.6	21.8	22.1	22.4	22.6	22.9	23.2	23.5	23.7	24.0	24.3	24.6	24.8	25.1	25
	55	18.7	18.9	19.2	19.5	19.8	20.0	20.3	20.6	20.8	21.1	21.4	21.7	21.9	22.2	22.5	22.7	23.0	23.3	23.6	23.8	24.1	24.4	24.7	24
	53	18.2	18.4	18.7	19.0	19.3	19.5	19.8	20.1	20.4	20.6	20.9	21.2	21.4	21.7	22.0	22.3	22.5	22.8	23.1	23.4	23.6	23.9	24.2	24
	51	17.7	18.0	18.2	18.5	18.8	19.1	19.3	19.6	19.9	20.2	20.4	20.7	21.0	21.2	21.5	21.8	22.1	22.3	22.6	22.9	23.2	23.4	23.7	24
	49	17.2	17.5	17.8	18.1	18.3	18.6	18.9	19.2	19.4	19.7	20.0	20.2	20.5	20.8	21.1	21.3	21.6	21.9	22.2	22.4	22.7	23.0	23.2	23
	47	16.7	17.0	17.3	17.6	17.8	18.1	18.4	18.7	18.9	19.2	19.5	19.7	20.0	20.3	20.6	20.8	21.1	21.4	21.7	21.9	22.2	22.5	22.7	23
	45	16.3	16.5	16.8	17.1	17.4	17.6	17.9	18.2	18.4	18.7	19.0	19.3	19.5	19.8	20.1	20.3	20.6	20.9	21.2	21.4	21.7	22.0	22.3	22
	43	15.7	16.0	16.3	16.6	16.8	17.1	17.4	17.7	17.9	18.2	18.5	18.7	19.0	19.3	19.6	19.8	20.1	20.4	20.7	20.9	21.2	21.5	21.7	22
Age	41	15.3	15.6	15.9	16.2	16.4	16.7	17.0	17.3	17.5	17.8	18.1	18.3	18.6	18.9	19.2	19.4	19.7	20.0	20.3	20.5	20.8	21.1	21.3	21
	39	14.8	15.1	15.4	15.7	15.9	16.2	16.5	16.8	17.0	17.3	17.6	17.8	18.1	18.3	18.6	18.9	19.2	19.4	19.7	20.0	20.3	20.6	20.8	21
	37	14.3	14.6	14.9	15.2	15.4	15.7	16.0	16.3	16.5	16.8	17.0	17.3	17.6	17.9	18.2	18.4	18.7	19.0	19.3	19.5	19.8	20.1	20.3	20
	35	13.9	14.1	14.4	14.7	15.0	15.2	15.5	15.8	16.0	16.3	16.6	16.9	17.0	17.4	17.7	17.9	18.2	18.5	18.8	19.0	19.3	19.6	19.9	2
	33	13.4	13.6	13.9	14.2	14.5	14.7	15.0	15.3	15.6	15.8	16.1	16.4	16.6	16.9	17.2	17.5	17.7	18.0	18.3	18.6	18.8	19.1	19.4	19
	31	12.9	13.2	13.4	13.7	14.0	14.3	14.5	14.8	15.1	15.4	15.6	15.9	16.2	16.4	16.7	17.0	17.3	17.5	17.8	18.1	18.4	18.6	18.9	19
	29	12.4	12.7	13.0	13.2	13.5	13.8	14.1	14.3	14.6	14.9	15.1	15.4	15.7	16.0	16.2	16.5	16.8	17.1	17.3	17.6	17.9	18.1	18.4	18
	27	11.9	12.2	12.5	12.8	13.0	13.3	13.6	13.9	14.1	14.4	14.7	14.9	15.2	15.5	15.8	16.1	16.4	16.6	16.9	17.1	17.4	17.7	17.9	18
	25	11.5	11.7	12.0	12.3	12.6	12.8	13.1	13.4	13.6	13.9	14.2	14.5	14.7	15.0	15.3	15.5	15.8	16.1	16.4	16.6	16.9	17.2	17.5	17
	23	11.0	11.2	11.5	11.8	12.1	12.3	12.6	12.9	13.2	13.4	13.7	14.0	14.2	14.5	14.8	15.1	15.3	15.6	15.9	16.2	16.4	16.7	17.0	17
	21	10.5	10.8	11.0	11.3	11.6	11.9	12.1	12.4	12.7	13.0	13.2	13.5	13.8	14.0	14.3	14.6	14.9	15.1	15.4	15.7	16.0	16.2	16.5	16
	19	10.0	10.3	10.6	10.8	11.1	11.4	11.7	11.9	12.2	12.5	12.7	13.0	13.3	13.6	13.8	14.1	14.4	14.7	14.9	15.2	15.5	15.7	16.0	16
	17	9.5	9.8	10.1	10.4	10.6	10.9	11.2	11.5	11.7	12.0	12.3	12.5	12.8	13.1	13.4	13.6	13.9	14.2	14.5	14.7	15.0	15.3	15.5	15
	15	9.1	9.3	9.6	9.9	10.2	10.4	10.7	11.0	11.2	11.5	11.8	12.1	12.3	12.6	12.9	13.1	13.4	13.7	14.0	14.2	14.5	14.8	15.1	15

APPENDIX H

KARVONEN FORMULA

The Karvonen Formula

*THR = (MHR - RHR) x Training Intensity (%) + RHR

where:

THR = Training Heart Rate

MHR = Maximum Heart Rate

RHR = Resting Heart Rate

Predicted Maximum Heart Rate:

*220 - age

For this study, the Karvonen Formula was calculated as follows:

*THR = (MHR - RHR) X 60% + RHR

where:

60% = participants' training intensity

APPENDIX I

LOG BOOK SAMPLE PAGE

Weekly Exercise Log Book Form

Name: _____ Phone: _____

Week of: ____ to ____ Fitness Leader's Signature: _____

	Distance	Time	HeartRate	Location	Comments
M			/		
T			/		
W			/		
T			/		
F			/		
S			/		
S			/		

APPENDIX J

PERCEIVED BENEFITS OF WALKING QUESTIONNAIRE

WALKING STUDY QUESTIONNAIRE

Please answer the following questions based on your experience in this 12-week walking study. Please be as honest and accurate as possible when answering these questions.

1) What was the main reason or goal for you wanting to participate in this walking program? Did you achieve this goal(s)? Explain.

_____

_____

_____

2) Please list the most significant benefits (both psychological and physical) you received from participating in this walking program.

_____

_____

3) What was (or will be in the future) the most significant hurdle or barrier that would make it difficult for you to participate in a regular physical activity program? Explain.

_____

_____

4) Do you think (illness permitting) that you will regularly participate in physical fitness activities in the future?

a) yes b) no

5) How did your lifestyle change by walking 3 days per week?

_____

_____

6) Did your illness interfere or conflict with your enjoyment or participation in this walking program? If yes, explain.

_____

_____

_____

7) Do you feel that you are able to cope more effectively with your illness (symptoms, medication use, etc.) as a result of the walking program? If yes, why, if no, why not?

_____

_____

_____

8) Do you think that the walking program helped to decrease your daily stress levels or helped you cope more effectively with these day to day stresses? If yes, explain why, if no, why not?

_____

_____

_____

9) Were there any negative factors that affected your participation in this walking program? If so, do you have any suggestions for future programs of this type?

_____

_____

_____

_____

10) Based on your experience, do you think that regular physical activity (ie-walking) should be recognized as an important part of the overall therapy process for patients with Crohns disease? Please explain.

_____

_____

_____

_____

_____

_____

THANK YOU FOR YOUR PARTICIPATION

STAY FIT AND STAY WELL!!

APPENDIX K

SUMMARY TABLE OF PARTICIPANTS' SCORES

Subject	Pre/Post Questionnaire Scores		BMI		VO_2 (ml-kg/min)		Medication Use
1	Pre	Post	Pre	Post	Pre	Post	Prednisone ↓ 20 to 7.5 mg 6 - MP ↑ to 2 mg/day coming off a bad year of illness
	HBSI - 1	2					
	IBD-St - 35.5	30.0	20.6	20.7	32.5	36.1	
	IBD-Q - 181	187					
2	HBSI - 6	3					Drug-Free Health O.K.
	IBD-St - 2.5	0	19.9	20.8	36.9	37.3	
	IBD-Q - 211	204					
3	HBSI - 19.5	7					6-MP - same (1 pill) Asacol ↓ 8 to 4 pills [*relapse prior to study] prednisone same (10 mg)
	IBD-St - 57.5	33	20.3	19.7	29.6	33.7	
	IBD-Q - 110	184					
4	HBSI - 10	2					Pentasa - same (500 mg) Health O.K.
	IBD-St - 11	3	32.6	32.8	37.7	37.9	
	IBD-Q - 190	207					
5	HBSI - 3	2					
	IBD-St - 23	20	26.3	24.6	27.8	29.8	Omeprazole - <u>off</u> (from 20 mg) Health O.K.
	IBD-Q - 170	173					
6	HBSI - 3.5	1					Pentasa - same (6 x 500 mg) Codine - same (1 pill)
	IBD-St - 52	31	18.2	18.2	34.3	37.9	
	IBD-Q - 154.5	171					
7	HBSI - 4	1					6-MP ↓ - 200 to 50 mg Prednisone ↓ - 30 mg to <u>none</u>
	IBD-St - 20.5	11	25.5	24.6	28.4	28.0	
	IBD-Q - 159.5	204					
8	HBSI - 1	0					Asacol - same (4800 mg) Health O.K.
	IBD-St - 21.5	18	29.1	29.1	20.8	22.2	
	IBD-Q - 196	194					
9	HBSI - 7	7					Drug-free Health O.K.
	IBD-St - 34.5	21	22.5	21.8	32.6	33.6	
	IBD-Q - 170.5	180					
10	HBSI - 7	10					Prednisone - same (5 mg) 6-MP - same (50 mg) 5-ASA - same (1,000)
	IBD-St - 30	22	33.6	33.6	28.0	28.2	
	IBD-Q - 162	187					
11	HBSI - 5.5	6					Asacol ↓ - 4 pills x 3 to none Health O.K.
	IBD-St - 30.5	15	18.5	17.8	31.8	33.6	
	IBD-Q - 156	183					
12	HBSI - 3	2					6-MP - same (50 mg) Health O.K.
	IBD-St - 31.5	30	23.9	23.6	29.9	30.9	
	IBD-Q - 201.5	195					

APPENDIX L

CHANGES IN PARTICIPANTS' SCORES FOR CROHN'S DISEASE INDEX ITEMS

	+ Change	No Change	- Change
HBSI			
Total Score	8	1	3
a. General well-being	6	6	0
b. Abdominal pain	3	8	1
c. # of liquid stools/day	2	10	0
d. Abdominal mass	1	10	1
e. Complications	5	5	2
IBD Stress Index			
Total Score	12	0	0
a. Overall life satisfaction	7	5	0
b. Worry	2	10	0
c. Recreation	5	7	0
d. Psychosomatic/symptoms	10	2	0
- energy levels	9	3	0
- hopelessness	3	9	0
- depression	6	6	0
- nervous	5	7	0
- trouble sleeping	6	5	1
e. Body image	7	4	1
IBD-Q			
Total Score	9	0	3
a. Energy levels	9	2	1
b. Bowel movements			
- # of bowel movements	5	5	2
- participation in leisure activities	5	6	1
- urgency to use washroom	4	8	0
- social engagements	2	9	1
c. Abdominal symptoms			
- frequency of abdominal cramps	4	5	3
- abdominal bloating	6	4	2

	+ Change	No Change	- Change
- feeling sick to stomach	6	4	2
- general well-being	8	2	1
d. Feeling frustrated/ restless (stress)	5	3	4
- depressed/discouraged	6	4	2
- anxious/worried in relation to IBD	6	6	0
- relaxation/tension	6	3	3
- tearful or upset	6	4	2
- angry as a result of IBD	5	6	1
- irritability	6	2	4
- happiness in personal lives	7	3	2