

CHAPTER 1

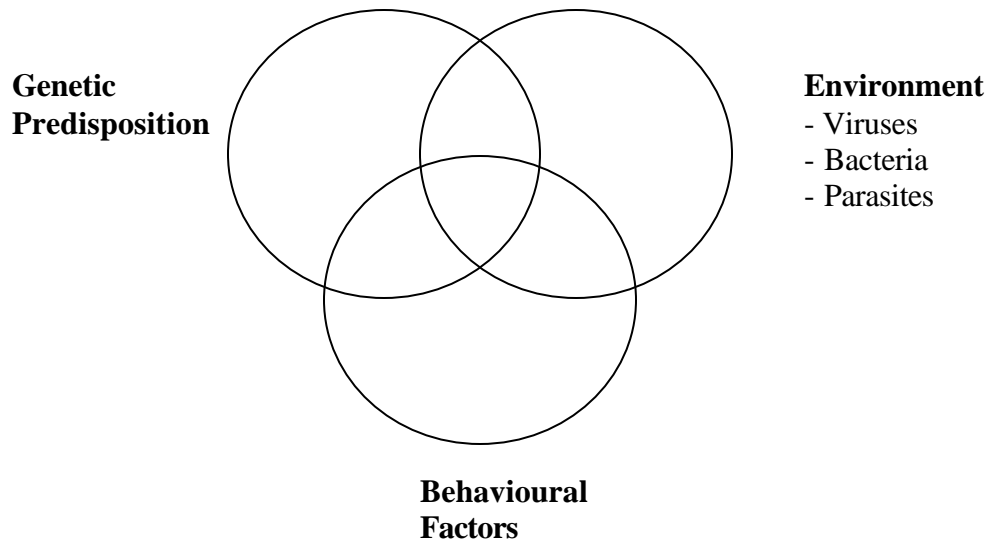
INTRODUCTION

The theory that most diseases have a primary biological cause has guided approaches to the treatment and prevention of physical illness for the last few centuries. This viewpoint, which has considerable empirical support, is a defining characteristic of the traditional biomedical model of disease (Stroebe, 2000). However, it is becoming increasingly evident that a one-dimensional approach to physical illness may be too simplistic. Specifically, a substantial body of research suggests that the disease process may be influenced by a complex interaction of biological, psychological and social factors (Stroebe, 2000).

As an alternative to the biomedical approach, Borysenko (1984) has formulated a tripartite model of disease susceptibility which reflects the idea that physical illness is a function of a variety of influences. According to this model, which is illustrated in Figure 1.1, biological and behavioural variables may independently or in combination affect the risk of physical disorders. For example, behavioural factors may be the primary cause of gastrointestinal problems and certain types of headaches. In addition, behavioural variables may interact with hereditary predispositions and environmental agents to influence disease onset and progression. For instance, factors such as stress may reduce host resistance to pathogens and thereby increase the risk of infectious illness. Behavioural variables may also trigger inherited weaknesses in certain bodily tissues or organs, leading to the onset of disease.

FIGURE 1.1: BORYSENKO'S TRIPARTITE MODEL OF DISEASE

SUSCEPTIBILITY (adapted from Borysenko, 1984)



THE RESEARCH PROBLEM

An enhanced understanding of the role of psychosocial factors in disease susceptibility may have important implications for the prevention and treatment of various disorders. Knowledge of this sort may have special application in areas where healthiness appears to be of primary importance. A case in point is endurance sports performance. In support of this, several studies have shown that infections such as the common cold and influenza can impair various measures of aerobic exercise capacity, thus influencing the athlete's ability to train and compete (Weidner & Sevier, 1996).

When elite athletes are unable to perform at a required standard, they stand to lose valuable earnings and sponsorships, along with status and opportunities for recognition. Moreover, health problems may increase anxiety and depression, as well as lower self esteem in these individuals (May, Veach, Reed & Griffey, 1985). It follows that illness and injury may also have adverse psychological effects on recreational athletes who are motivated by performance concerns.

In recent years, several researchers in different domains have sought to identify the factors that are related to the risk of physical illness in endurance athletes. It appears that much of this research has focused on the role of exercise behaviour in susceptibility to upper respiratory tract infections. The findings of these studies suggest that regular, moderate aerobic exercise training is associated with enhanced resistance to the common cold and influenza. In contrast, there is evidence that the risk of viral infections is increased during periods of high-volume endurance training and following participation in a marathon-type event (Nieman, 2000).

However, it seems that further research may be needed before any definite conclusions can be drawn from these empirical findings. For example, little is known about the role of repeated bouts of competition in the risk of infection, or about the relationship between infectious disease susceptibility and measures of training duration, frequency and intensity.

Consequently, one of the objectives of the present study was to assess further the association between exercise behaviour and the risk of upper respiratory tract infections in an endurance athlete population. South African distance runners formed the specific focus of the research. Based on information provided in *Tom Cottrell's Old Mutual Runners' Guide to Road Races in South Africa* (2004), it is estimated that approximately 1 000 road races are held throughout the country each year, with several of these events attracting in excess of 4 000 participants.

In addition to exercise behaviour, various other psychosocial factors have been shown to play a role in the endurance athlete's susceptibility to infections. For example, a few researchers have found a relationship between the incidence of upper respiratory illness and psychosocial stress, mood and general well-being (May et al. 1985; May, Veatch, Southard & Herring, 1985; Nieman, Johanssen, Lee & Arabatzis, 1990). However, these studies have mainly involved samples of elite competitors, and therefore may be limited in terms of the conclusions that can be drawn.

Hence, an additional objective of the present study was to explore the relationship between the distance runner's susceptibility to the common cold and several of the factors that have been hypothesized to influence illness the risk of physical illness. These include the stress-related variables of life events, coping, and the personality style of hardiness.

The widely-held belief that life events can influence disease susceptibility reflects the view that stress is a characteristic of disruptive or disturbing environments which produce physiological or psychological damage (Cox, 1978). Life events refer to the many important occurrences in a person's life that represent or require a significant life-style readjustment (Holmes & Rahe, 1967).

On the other hand, hypotheses to the effect that individual difference variables such as coping and hardiness influence physical health are based on interactional models of stress (Cox, 1978). A well-known example of the interactional approach to stress is Lazarus and Folkman's (1984) cognitive stress theory which states that stress is a transactional process between the person and the environment. Specifically, stress is said to be dependent on a person's cognitive evaluation of external demands with respect to his or her well-being and available coping resources. The manner in which people cope with stress is also thought to play an important role in their vulnerability to physical illness. The core complexion of cognitive stress theory is reflected in the following statement: "Many factors in the environment and the person must combine to generate stress and its outcomes" (Lazarus & Folkman, 1984, p. 19).

The specific aims of the present study can be transformed into the following research questions: In distance runners:-

- Are life events associated with susceptibility to the common cold?
- Is there a correlation between coping and infection risk?

- Is hardiness related to susceptibility to upper respiratory illness?
- Is there a correlation between exercise behaviour and the risk of colds?

SIGNIFICANCE OF THE PRESENT STUDY

May et al. (1985, p. 111) have maintained: “Identifying the psychological factors that predispose athletes to illness and injury is an important component of any sports medicine programme”. Consistent with this statement, it is envisaged that the present study may help enhance current understanding of the role of specific psychosocial factors in susceptibility to upper respiratory tract infections in distance runners. This knowledge may, in turn, suggest various intervention strategies aimed at reducing the risk of infectious illness in this group. Consequently, a study of this nature may play an important role in keeping runners healthy, which may, in turn, help them to realize their full potential. Ultimately, this research may highlight the need for sports medicine specialists to consider potential psychosocial influences on infectious illness when dispensing health care advice to this group of endurance athletes.

DEFINITIONS OF SOME KEY TERMS

The Distance Runner

The *Oxford Advanced Learner’s Dictionary of Current English* (1992, p. 1110) defines the word, “runner”, as, “a person or animal that runs; one taking part in a race: *a long-distance runner*”. In the present study, a distance runner is defined as an individual who trains for and / or participates in middle or long-distance running events. Middle-distance

races refer to athletic events of 800 metres to 5 000 metres, while long-distance races include road and / or track events of 10 kilometres and longer.

In their book, *The Competitive Runner's Handbook*, Glover and Schuder (1985), have proposed that distance runners may be divided into five different categories on the basis of their experience, training and competition habits, and race times. Using this system, the authors discern the novice, basic, advanced, champion and national class competitors. The hypothesized characteristics of these different types of runners are briefly discussed below.

The novice competitor is described as a runner who is either a beginner with little racing experience, or a more experienced athlete who does not train seriously. This individual typically runs between 25 kilometres and 50 kilometres per week and races one to 10 times a year over a maximum distance of 10 kilometres.

The basic competitor may be viewed as “the average runner”, who finishes towards the middle and back of the field in road races. These athletes have been running for at least two years and generally train fairly hard to achieve their goals. For example, basic competitors may train up to 96 kilometres per week and do some speed work in order to improve their race times. They usually run between five and 12 races a year, ranging in distance from 10 kilometres to the half-marathon (21,1 kilometres). Race times for men in this group range from 40 minutes to 48 minutes for 10 kilometres.

The advanced competitor is the runner who has sufficient talent and resources to attain a higher-than-average level of performance. These athletes usually finish in the top 10% to 25% of the field in road races and have been running for at least four years. They typically train between 64 kilometres and 128 kilometres per week and participate in about 10 to 20 races per year, including several over the standard marathon distance (42,2 kilometres). Males in this group complete 10 kilometre races in 34 minutes to 40 minutes.

The final two types of runners, the champion competitor and the national class / elite athlete, are those unique individuals that possess the necessary attributes to excel at the highest level of competition. These runners have been running for at least five years and often train up to 160 kilometers per week, and usually more than once a day. They typically do speed work two to three times a week when preparing for important races, and compete 10 to 20 times a year over a range of distances. The 10 kilometre race times for male champion competitors range from 30 minutes to 34 minutes, while elite competitors run 10 kilometres in under 30 minutes.

The Common Cold

The common cold is defined as, “a mild, self-limited catarrhal syndrome caused by viral infection of the upper respiratory tract” (Gwaltney, 1979, p. 429). Colds are extremely common in the general population, with adults experiencing as many as two to four colds a year, and children possibly twice that number during the same period (Gwaltney, 1979). It has been proposed that the number of colds may decrease with age as people become immune to previously-experienced viruses. Other upper respiratory tract infections

include pharyngitis, acute laryngitis, acute sinusitis, laryngotracheobronchitis (croup), otitis media and externa, epiglottitis and infections of the oral cavity (Mandell, Douglas & Bennett, 1979).

It is estimated that between 25% and 30% of colds are caused by the rhinovirus group, although coronaviruses, respiratory syncytial virus, adenovirus, parainfluenza virus and influenza type A or B virus may also produce the common cold syndrome (Gwaltney, 1979). The cardinal symptoms of a cold are nasal discharge, nasal congestion, sneezing, sore or “scratchy” throat, and cough or hoarseness. Slight fever may also occur (Gwaltney, 1979).

Colds caused by the rhinovirus typically last for about a week but in a quarter of cases symptoms may continue for up to two weeks (Gwaltney, 1979). A rhinovirus cold usually starts with nasal complaints and a sore throat, which peak on the second or third day of illness and then gradually subside. A cough may also be experienced during the early stages of infection, and usually persists a few days after nasopharyngeal symptoms have subsided. In a small percentage of cases, colds may lead to a secondary bacterial infection of the sinuses and middle ear (Gwaltney, 1979). Other upper respiratory tract infections, such as pharyngitis, an inflammatory syndrome of the pharynx, and acute laryngitis, an inflammatory syndrome of the larynx, usually occur in association with the common cold and influenzal syndromes (Gwaltney, 1979).

According to *Dorland's Illustrated Medical Dictionary* (1994), nasal symptoms similar to those associated with the common cold may also occur as part of an allergic reaction to certain environmental stimuli in sensitive individuals. For example, nasal catarrh, nasal congestion, and sneezing may be symptomatic of seasonal allergic rhinitis (hay fever) or non-seasonal allergic rhinitis. Vasomotor rhinitis, a form of non-allergic rhinitis, triggered by stimuli such as cold, fatigue, anger and anxiety, may also give rise to similar nasal symptoms. However, the chronic and recurrent nature of allergic symptoms should enable them easily to be differentiated from symptoms of infection (Gwaltney, 1979).

STRUCTURE OF THE DISSERTATION

In order to guide the reader, a brief outline of the structure of the dissertation is provided below.

In Chapter 2, the response-based, stimulus-based and interactional approaches to stress are introduced and discussed. Several key terms, such as life events, coping and hardiness, are also defined in this section. Chapter 3 deals with the relationship between stress and physical illness with a focus on the role of life events, coping and hardiness in disease susceptibility. In the following chapter, current theoretical approaches and recent research findings regarding the association between aerobic exercise and upper respiratory tract infections are discussed. Various important exercise-related concepts and principles are also explained. In Chapter 5, the research hypotheses, along with the design and methodological aspects of the study are presented and discussed. The results of the study form the focus of Chapter 6, while in Chapter 7, the research findings are discussed

with reference to the research hypotheses, relevant theories and previous research. The concluding chapter of the dissertation entails a discussion of the benefits and limitations of the study, and also provides recommendations for further research.

CHAPTER 2

MODELS OF STRESS

INTRODUCTION

According to stress researcher and physician, Hans Selye (1975, p. 2139), “Stress is something everyone has and everyone talks about, yet most would be hard put to define exactly what it is”. When attempting to elucidate the meaning of the concept, however, it quickly becomes evident that there is no simple answer to the question, “what is stress?” Researchers, it seems, cannot agree on a definition of the term and several different models of stress have been proposed over the years.

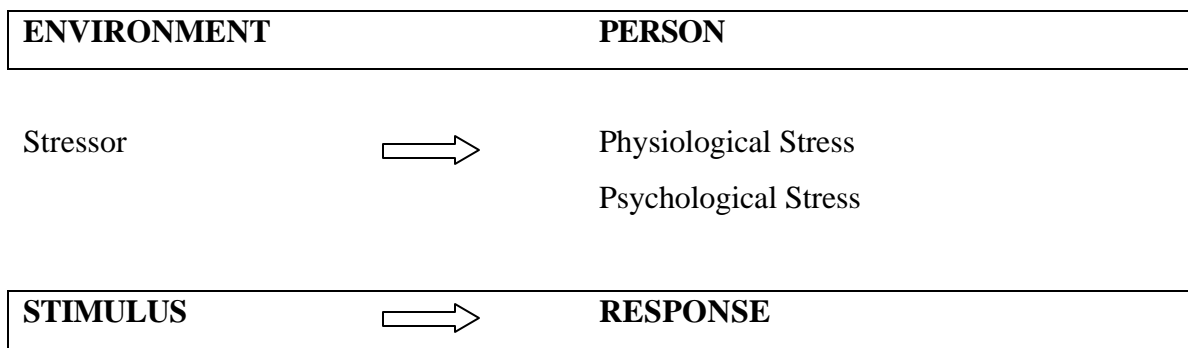
It has been said that models of stress generally vary on the basis of whether they view the concept as a cause or an effect (Reber, 1995). Specifically, the approach that emphasizes the internal physiological or psychological responses elicited by adverse environmental stimuli is known as the response-based model of stress. Conversely, the approach that focuses on the psychosocial demands that produce some change in the individual is termed the stimulus-based model of stress (Cox, 1978). However, a third, relatively new approach to stress is the interactional or relational model, which conceives stress as neither a cause nor an effect. A well-known example of this approach is Lazarus and Folkman’s (1984) cognitive stress theory, which defines stress as a transactional process between the person and the environment. The purpose of this section is to discuss the

above models of stress in more detail and also to introduce and explain the stress-related concepts of life events, coping and hardiness.

THE RESPONSE-BASED MODEL OF STRESS

Proponents of the response-based model of stress are primarily concerned with the individual's response to noxious environmental agents (Cox, 1978). According to this approach, stress may be viewed as a person's physiological and / or psychological reactions to adverse stimuli, or "stressors". The presence of a stress response is, in turn, viewed as evidence of exposure to a "disturbing" environment. The response-based model is illustrated in Figure 2.1.

FIGURE 2.1: THE RESPONSE-BASED MODEL OF STRESS (adapted from Cox, 1978)



Selye's Physiological Stress Theory

The physiological theory of stress proposed by Selye (1975) is probably the most well known approach to stress that focuses on effects rather than causes. In this regard, Selye

viewed stress as a biological concept, defining it as the body's nonspecific response to any "increased demand for readjustment, for performance of adaptive functions which reestablish normalcy" (Selye, 1975, p. 2140).

Selye formulated his theory of stress after observing that cattle injected with a new ovarian hormone displayed the same general pattern of bodily responses. It was soon found that other toxic substances, as well as stimuli such as heat, cold, infection, trauma and nervous irritation evoked the same set of physiological changes. From this, it was deduced that the body reacted in a stereotyped fashion to any increased demand for action made upon the organism. This defensive response was termed the "general adaptation syndrome" and the word, "stressor", was used to refer to stress-inducing stimuli.

According to Selye (1975), the general adaptation syndrome is characterized by various distinct physiological changes. These include the enlargement and hyperactivity of the adrenal cortex, the shrinkage of the thymus, spleen, lymph nodes and other lymphatic structures, and gastrointestinal ulceration and bleeding. With prolonged stressor exposure, three distinct phases to the generalized stress response may be identified. These are the alarm reaction, the stage of resistance and the stage of exhaustion.

The alarm reaction is described as a general calling to arms of the body's defences. During this stage, the hypothalamus secretes a chemical messenger which elicits the release of adrenocorticotrophic hormone from the pituitary gland into the bloodstream. This causes the outer part of the adrenal gland, the adrenal cortex, to secrete the

glucocorticoid, cortisol, into circulation. Cortisol, in turn, causes a number of bodily changes, including shrinkage of the thymus, atrophy of the lymph nodes, reduced inflammation, and increased sugar production.

A feature of the alarm reaction is a decrease in the level of resistance to the offending agent. However, with continued exposure to a noxious stimulus, the body adapts to the demand and the degree of resistance is increased. General physiological arousal also subsides. This is referred to as the stage of resistance, and is characterized by catabolic or energy-conserving events, compared with the anabolic or energy-releasing changes marking the alarm stage. Extended exposure to a stressor may, however, eventually exhaust the body's finite adaptive resources, and the signs of the alarm reaction may return and are now irreversible. However, it has been contended that sleep and rest may partially restore the body's adaptation energy.

Finally, Selye (1975) was of the opinion that stress is essential to life and should not be avoided. Instead, individuals should adopt a "philosophy of life" which can enable them to master and enjoy stress.

Advantages and Limitations

One of the advantages of Selye's definition of stress is that the biological changes described above may provide clear evidence of the presence of stress. However, in large scale stress studies, it may prove impractical to test the physiological reactions of each subject (Prokop, 1991).

Despite its proposed benefits, Selye's physiological stress theory has been criticized on the grounds that it accords little weight to psychological variables, such as emotional distress, pain and discomfort, which may mediate between stressors and the stress response (Stroebe, 2000). For example, physical demands, such as exercise, heat and cold, may evoke negative affect which may, in turn, elicit a physiological stress reaction. Thus, the organism's response to stressors may be a result of a person's psychological reaction to such events, rather than a direct consequence of the effects of these demands on the body.

THE STIMULUS-BASED MODEL OF STRESS

In contrast to the response-based approach, the stimulus-based model of stress is concerned with the psychosocial factors that produce various behavioural, psychological and / or physiological responses, or strains, within the person (Cox, 1978; Vingerhoets, 1985). The principal tenet of this model is captured in the following statement made by Symonds (cited in Cox, 1978, p. 13): "Stress is that which happens to the man, not that which happens in him; it is a set of causes, not a set of symptoms". The key characteristic of stressful situations is that they make some type of demand on the person (Cox, 1978). Often an adjective is placed in front of the word, stress, to indicate its source, such as "psychosocial stress".

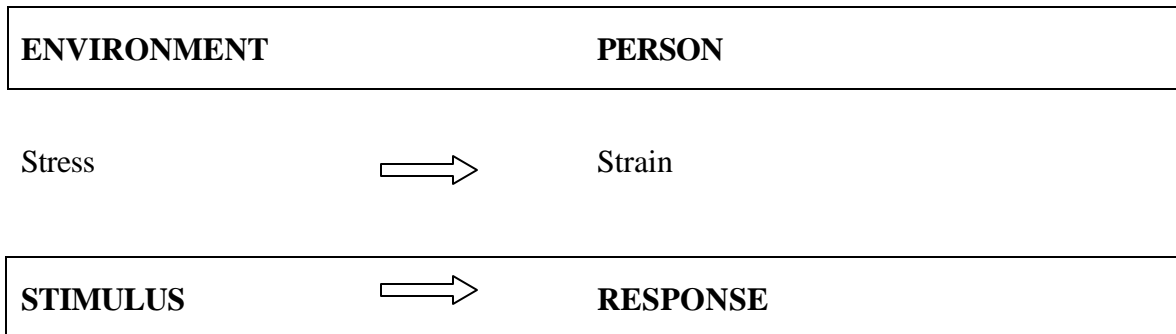
Stress stimuli, or stressors, may vary along several different dimensions. For instance, they may differ according to their quality (pleasant or unpleasant, desirable or undesirable), duration (chronic or acute) and their degree of controllability (Lazarus &

Folkman, 1984). More formally, Elliott and Eisdorfer (cited in Lazarus & Folkman, 1984) have proposed the following four classes of stressors:

- Acute, time-limited stressors, which include events such as parachute jumping and surgery
- Stressor sequences, which are series of events which are initiated by a single discrete occurrence, such as divorce
- Chronic intermittent stressors, which are stressful situations, like sexual difficulties, which occur on a regular basis
- Chronic stressors, which are persistent conditions such as job stress and role strain

The stimulus-based approach has been described as an engineering model of stress in that it draws an analogy between people and physical systems (Cox, 1978). For example, according to Hooke's Law of Elasticity (Cox, 1978), any stress placed on a machine will cause deformation or strain until the load is removed. However, permanent damage may occur if the strain exceeds the metal's "elastic limit". Similarly, it is believed that when environmental demands exceed a person's stress tolerance levels, the resulting strain may lead to physiological and psychological dysfunction. A diagram of the stimulus-based model of stress is shown in Figure 2.2.

FIGURE 2.2: THE STIMULUS-BASED MODEL OF STRESS (adapted from Cox, 1978)



Models of Temporal Relationships between Stressors and Strains

Psychologists have proposed various different models to describe the possible temporal relationship between stressors and strains (Jones & Kinman, 2001). These models are as follows:

- The stress reaction model, which holds that strains increase in accordance with stressor exposure time but decrease when stressors are removed
- The accumulation model, which states that strains are related to an accumulation of stress and remain after stressors have been removed
- The dynamic accumulation model, which holds that strains increase following the removal of stressors
- The adjustment model, which maintains that people adjust to stressors over time and strains decrease accordingly
- The sleeper effect model, which postulates that strains may appear long after stressors have been removed

The Life Events Approach

One of the most widely-recognized of the stimulus-based models of stress is the life events approach. According to this conceptualization, stress is a property of events that signify or require a significant life-style readjustment (Holmes & Rahe, 1967). Such occurrences relate to a number of important aspects of one's life, including family, occupation, residence, social relationships, education, religion, health and recreation. It has been postulated that a cluster of life events can influence the onset of a wide range of physical health problems (Holmes & Rahe, 1967).

Life events are considered to be “stressful” primarily because they denote or require a significant change in a person's normal way of life (Holmes & Rahe, 1967). Therefore, events that are associated with coping or adaptive behaviour may lead to adverse outcomes regardless of their quality or controllability. However, researchers have proposed that life events that are uncontrollable, unexpected or undesirable may require greater readjustment. Therefore, these occurrences may be more damaging than events that are controllable, expected or desirable, respectively (Pearlin, 1999; Scully, Tosi & Banning, 2000). Nevertheless, the same event should be equally stressful to all people.

Advantages and Limitations

A major advantage of the life events approach is that it provides a simple means of measuring stress (Prokop, 1991). For example, people can simply be asked to indicate

which events they have experienced during a given time period and scores can be tallied to provide an index of stress.

However, it has been maintained that this approach ignores the role of minor daily problems and chronic conditions, such as a heavy workload, in strains (Jones & Kinman, 2001). Although less serious than life changes, events such as daily hassles may still have an important influence on adaptational outcomes (Lazarus & Folkman, 1984). A further criticism is related to the assumption that a particular major life change is equally and universally stressful (Prokop, 1991). In this regard, it has been argued that the model does not consider the context of an event or its personal meaning (Brown, 1981). Specifically, it has been contended that people vary in how they interpret and respond to life events (Prokop, 1991). These factors may, in turn, affect the degree to which changes in one's usual way of life lead to negative outcomes. The latter argument implies that individual difference variables may influence adaptational outcomes. In this regard, it has been proposed that genetic, acquired and dispositional individual differences may have the following effects on stress reactions (Cooper & Bright, 2001):

- Direct effects: In this instance, the effects of individual differences on strains, such as colds and influenza, are independent of the effects of the stressor.

Specifically, the individual difference factor exerts direct or additive effects on outcomes.

- Mediating effects: In mediation, a variable intervenes in the stressor-strain relationship. More precisely, the stressor exerts its effects on outcomes through the individual difference factor.
- Moderating effects: A moderating factor alters the nature of the stressor-strain relationship, affecting either its strength or direction. Buffers decrease the strength of the relationship, whereas vulnerability or reactivity factors increase the strength of the association.

THE INTERACTIONAL MODEL: LAZARUS AND FOLKMAN'S COGNITIVE STRESS THEORY

The interactional approach to stress has been formulated in response to a growing need for a comprehensive model of stress that considers the person in relation to his or her environment. Of the different stress theories that may be described as interactional, one of the most influential is Lazarus and Folkman's (1984) cognitive stress theory.

According to this perspective, stress is a transactional process between the individual and the environment. Therefore, in order to understand the concept of stress and its outcomes, one needs to consider characteristics of both the person and the situation. The authors have also proposed that stress should not be viewed as a single variable but as a rubric, or umbrella term which embraces a number of different variables and processes. More specifically, the cognitive approach defines 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 or her well-being" (Lazarus & Folkman, 1984, p.

19). The relationship between person and environment is, furthermore, described as dynamic, mutually influencing and bidirectional.

According to the above conceptualization, cognitive appraisal and coping are two key processes in the stress process. Cognitive appraisal refers to an individual's evaluation of environmental demands with respect to his or her well-being and available coping resources. An environmental demand has, in turn, been defined as, "a request or requirement for physical or mental action, and implies some time constraint" (Cox, 1978, p. 23). Coping refers to the strategies that people use to manage the demands of stressful situations and associated negative emotional reactions (Lazarus & Folkman, 1984).

Three stages of cognitive appraisal, specifically primary, secondary and reappraisal may be distinguished (Lazarus & Folkman, 1984). During primary appraisal, a person assesses a transaction's potential significance, deciding whether the encounter is irrelevant, benign-positive or negative-stressful. Transactions are evaluated as stressful when they are perceived to involve harm, loss, threat or challenge. Harm or loss refers to events that have already occurred, such as injury, illness or bereavement. However, threat and challenge appraisals relate to encounters that may potentially lead to harm or loss, or growth or gain, respectively.

It has been suggested that various personal and situational factors influence primary appraisal (Lazarus & Folkman, 1984). These include personal commitments and beliefs,

as well as the novelty, predictability, ambiguity, duration and timing of stressful events. Commitments refer to cognitive factors, such as choices, values and / or goals, which play a role in determining what factors or events are relevant for a person's well-being. Beliefs are defined as pre-existing ideas about reality which guide perception and understanding of events. Beliefs include notions about personal control, as well as existential beliefs, such as faith in a holy being.

The second critical step in the evaluation process is that of secondary appraisal. During this stage, individuals assess their ability to cope with stressful encounters (Lazarus & Folkman, 1984). This includes deciding what coping strategies may be applied and how effective they are likely to be.

When individuals decide they cannot cope with an event appraised as threatening or harmful, they label themselves as "stressed" and experience a negative emotional reaction (Cohen, 1996). It has been proposed that primary and secondary appraisals interact to affect the degree of stress and the quality and strength of the emotional response (Lazarus & Folkman, 1984). Finally, the concept of reappraisal suggests that events originally perceived as stressful may be reevaluated in the light of new information.

Coping: A Definition

Coping is a multidimensional concept which has been defined as the individual's "constantly changing cognitive and behavioural efforts to manage specific external and / or internal demands that are appraised as taxing or exceeding the resources of the person"

(Lazarus & Folkman, 1984, p. 141). In this case, the phrase, “efforts to manage”, refers to attempts to minimize, avoid, tolerate, accept or master stressful encounters.

The above definition implies that coping is a dynamic process and that the manner in which people cope with stress will depend on the context of the event (Lazarus & Folkman, 1984). For instance, factors such as the degree of control a person has over a particular problem may influence his or her choice of coping strategy (Stroebe, 2000). However, it has also been proposed that individuals have stable coping styles or dispositions (Carver, Scheier & Weintraub, 1989). According to this hypothesis, people have sets of preferred coping strategies which are relatively consistent across time and situations.

Psychologists have traditionally made a distinction between coping functions and coping outcomes. The function of coping refers to the particular purpose of a strategy, while the outcome refers to the effect of a specific strategy on various measures of adaptation, such as somatic health and psychological well-being (Lazarus & Folkman, 1984).

Functions of Coping

With respect to the goal or purpose of coping strategies, two major coping functions have been distinguished (Stroebe, 2000). Specifically, it has been proposed that coping efforts may be broadly classified as problem-focused or emotion-focused in nature (Lazarus & Folkman, 1984). Problem-focused strategies are aimed at managing or resolving stressful encounters, while emotion-focused strategies are directed at regulating the accompanying

emotional distress. The two broad purposes of coping may also be described as danger control and fear control, respectively (Leventhal, Suls & Leventhal, 1993).

Problem-focused forms of coping include a variety of strategies related to problem solving. These efforts may be aimed at altering either aspects of the environment or aspects of the self, such as one's motivations and cognitions (Lazarus & Folkman, 1984). Examples of problem-focused strategies include active coping, suppression of competing activities, planning, restraint and seeking of instrumental social support (Carver et al., 1989).

Emotion-focused forms of coping encompass an array of cognitive and behavioural strategies that are directed at reducing, or in some cases increasing emotional tension. Examples of emotion-focused coping strategies include (cognitive) avoidance, minimization, positive reappraisal, distancing, selective attention, self-blame, substance abuse, venting anger, and seeking of emotional support (Lazarus & Folkman, 1984).

However, it has also been stated that any coping strategy may serve multiple functions, and therefore coping responses cannot consistently be labelled emotion or problem focused (Leventhal et al., 1993). For example, a person may seek social support for either emotional reasons or in order to obtain information or advice on how to solve a problem (Carver et al., 1989). In this case, the former action would be considered an aspect of emotion-focused coping, while the latter would be regarded as a problem-focused strategy.

Furthermore, it has been proposed that the different methods of coping may influence one another in various ways (Lazarus & Folkman, 1984). For example, efforts to reduce feelings of anxiety may facilitate problem-focused forms of coping. However, the use of emotion-focused strategies such as selective inattention and the distortion of important information may hinder successful decision-making. In addition, a reliance on problem focused efforts such as information-seeking may impede strategies aimed at reducing distress (Lazarus & Folkman, 1984).

Approach and Avoidance Coping

Apart from the problem-focused and emotion-focused distinction, the research also suggests a second dimension of coping, namely approach, or attention, versus avoidance (Stroebe, 2000). These concepts refer to an individual's cognitive response to stressful situations (Krohne, 1993). In approach or "non-avoidant" coping, attention is focused on the source of stress and / or on one's psychological or somatic reactions to the stressor. Conversely, avoidance coping involves a focus away from either the stressor or one's reactions to the adverse stimulus (Suls & Fletcher, 1985). These formulations correspond to Krohne's (1993) concepts of attention and (cognitive) avoidance, respectively. Specifically, Krohne (1993, p. 3) defined attention as, "being oriented toward the threat related aspects of a situation," and avoidance as, "turning attention away from threatening cues". It has been suggested that approach coping may be directed towards aspects of the environment, such as stress-inducing stimuli, or towards aspects of the self, such as one's inner states and emotional responses to stressors. The latter has been dubbed, "self-focused attention" (Filipp, Klauer & Ferring, 1993).

Attention and avoidance coping compare to the twin concepts of sensitization and repression, monitoring and blunting, attention and rejection, and vigilance and cognitive avoidance, among others (Krohne, 1993). It has been proposed that the constructs of “intolerance of uncertainty” and “intolerance of emotional arousal” explain the dispositional preference for vigilance and cognitive avoidance, respectively. Specifically, individuals who are unable to tolerate uncertainty should employ vigilance strategies, whereas those with a low tolerance for emotional arousal should adopt avoidance strategies (Krohne, 1993).

Coping Resources

Coping resources have been defined as the personal and environmental resources that people draw on in order to cope with stress (Lazarus & Folkman, 1984). It has been postulated that these factors precede and influence coping.

Personal and environmental resources that are thought to facilitate adaptive coping include variables such as health and energy, positive beliefs, problem-solving skills, social skills, social support and material resources like money (Lazarus & Folkman, 1984). Health and energy are described as physical resources of the person, whereas positive beliefs are viewed as psychological resources. Problem-solving and social skills are considered to be “competencies” which enable a person to find resources to cope with stress (Lazarus & Folkman, 1984). Psychologists have also maintained that certain personality variables, such as hardiness, may enable people to cope more effectively with

stress (Kobasa, Maddi, Puccetti & Zola, 1994). The concept of hardiness is discussed in more detail below.

The Concept of Hardiness

The personality construct of hardiness was originally proposed by Kobasa (1979) and is based on the theories of existential psychologists on the strenuousness of authentic living, competence, propiarte striving and the productive orientation, respectively. Hardiness is defined as a personality style which encompasses the three interrelated attributes of commitment (versus alienation), control (versus powerlessness), and challenge (versus threat) (Kobasa et al., 1994).

Specifically, hardy individuals are thought to possess a tendency to feel deeply committed to and involved in the various aspects of their lives, such as self, family, social relationships, work and social institutions (Kobasa, 1979). The trait of commitment also incorporates a sense of purpose in life and a belief in one's goals, values and priorities. Active involvement in one's environment is said to reflect the attribute of vigorousness as opposed to vegetativeness (Kobasa, 1979).

The control component of hardiness is characterized by a sense of personal mastery over one's life and a perception that one can influence events through one's thoughts and actions. In this regard, hardy individuals believe they are self-determining and not controlled by external forces. Specifically, hardiness is associated with decisional control, cognitive control and coping skill (Kobasa, 1979). Decisional control refers to the

aptitude to choose appropriate coping strategies with which to manage stress, while cognitive control is defined as the ability to incorporate change into an ongoing life-plan. Coping skill means that the individual has a wide range of coping strategies from which to choose, which emanates from having a high degree of achievement motivation.

Challenge, the third element of hardiness, incorporates attributes such as change-seeking, cognitive flexibility and a motivation for endurance (Kobasa, 1979). For example, hardy individuals look for adventure and new experiences, and welcome the unexpected. In accordance with this outlook, change rather than stability is considered the norm. Furthermore, life changes are viewed as a challenge rather than a threat, and as an opportunity for personal growth.

Advantages and Limitations of the Interactional Approach

The major advantage of the interactional approach is that it views stress as a relationship between the person and the environment. As such, it allows for individual variations in physiological and psychological responses to psychosocial demands. This implies that a particular stressor may not be equally or universally stressful. Interactional models are also said to provide clear guidelines for the study of stress (Cox, 1978). However, it has been proposed that this approach may not adequately explain situations in which certain noxious physical stimuli cause direct physiological damage in the absence of psychological mediating mechanisms (Cox, 1978).

SUMMARY AND CONCLUSIONS

The purpose of this chapter was to delineate the stress concept. As observed, stress is a multidimensional concept which may be defined on a biological, psychological and / or social level. Approaches to stress may be further differentiated on the basis of whether they focus on causes, as in the stimulus-based model, or on effects, as in the response-based model. An example of the latter is Selye's physiological stress theory, which defines stress as a uniform bodily response to any increased demand for readjustment to change. A popular stimulus-based model of stress is the life events approach, which views stress in terms of events that signify or require a significant life-style readjustment (Holmes & Rahe, 1967).

In contrast to the above approaches, cognitive stress theory conceptualizes stress as a transactional process between the person and the environment. The concept of coping, defined as the cognitive and behavioural efforts used to manage stress, forms an integral part of the interactional cognitive approach. The purpose of coping strategies may be to solve a problem (problem-focused coping), or to reduce emotional distress (emotion-focused coping). Coping strategies may also be orientated away from stressors and / or away from one's psychological reactions (avoidance coping), or towards the sources of stress and aspects of the self (approach coping). Coping resources refer to the external and internal factors that guide coping processes. Various resources, including hardiness, are believed to foster adaptive coping. Hardiness is, in turn, defined as a personality style which consists of the three interrelated attributes of control, challenge and commitment.

CHAPTER 3

STRESS AND ILLNESS

INTRODUCTION

There seems to be common perception among the general population that stress can be detrimental to physical health. For example, in a study conducted by Pollock (cited in Jones & Bright, 2001), it was found that people believed that factors such as job-related demands could lead to headaches, stomach aches and heart attacks. The idea that psychological and physical well-being are related dates back several centuries. During the 1700s and 1800s, for instance, many physicians were of the opinion that emotional trauma could increase the risk of developing cancer (Leventhal & Tomarken, 1995).

Beliefs about the role of stress in somatic health are supported by biopsychosocial models of illness, which state that disease may be the result of a combination of factors (Stroebe, 2000). For example, it has been proposed that psychosocial variables may be the primary cause of ailments such as certain types of headaches. In addition, factors such as psychological stress may interact with biological factors, like inherited weaknesses and infectious agents, to influence the onset and course of disease (Borysenko, 1984).

In the last 40 years or so, a substantial amount of research has been directed at investigating the role of stress in physical illness. In accordance with diverse definitions of the stress concept, researchers have adopted different approaches to the study of stress and illness. For example, a large number of investigators have explored the relationship

between disease susceptibility and specific psychosocial stressors, such as life events, daily hassles and chronic demands. Many studies in this domain have also examined the direct, moderating and mediating effects of certain individual difference variables, including negative affect, coping, personality and social support, on disease susceptibility. Measures of physical illness adopted in this research have included adrenaline secretions, blood pressure, coronary heart disease, and colds and influenza (Jones & Bright, 2001). Overall, the results of these investigations support popular opinion that a variety of stress-related psychosocial factors may influence the risk of physical illness.

This chapter will discuss various theoretical approaches and recent research findings concerning the relationship between stress and physical illness, with an emphasis on the role of life events, coping, and hardiness in disease susceptibility.

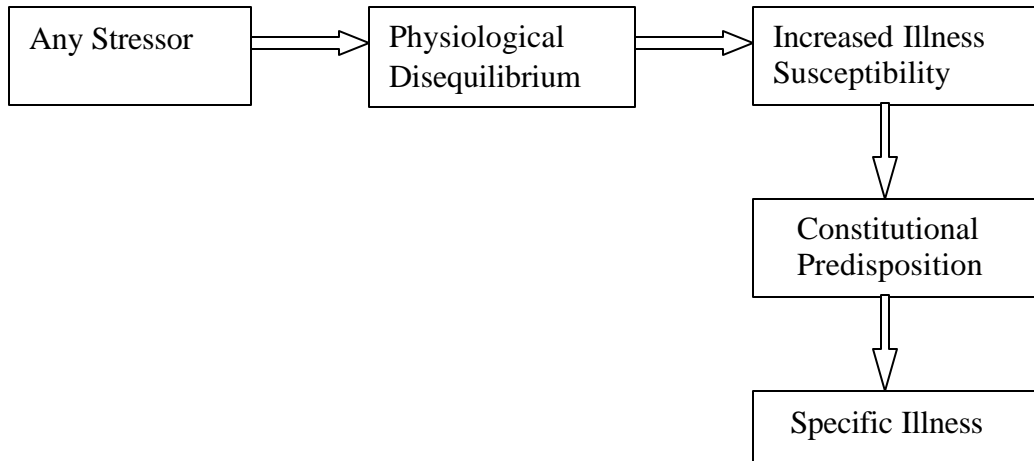
THEORETICAL APPROACHES

Generality versus Specificity Theories of Disease Aetiology

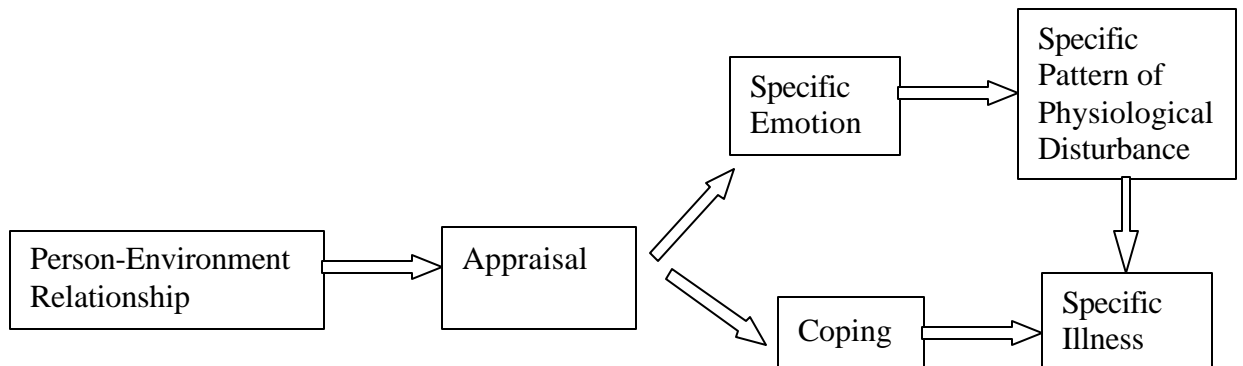
According to Lazarus and Folkman (1984), two broad opposing views, referred to as generality and specificity theories, respectively, characterize ideas about the role of psychological and social factors in health and disease. The main features of the generality and specificity models are demonstrated in Figure 3.1.

FIGURE 3.1: GENERALITY AND SPECIFICITY MODELS OF ILLNESS

The Generality Model of Illness (adapted from Lazarus & Folkman, 1984)



The Specificity Model of Illness (adapted from Lazarus & Folkman, 1984)



Generality theories are reportedly based on the tenets of Selye's general adaptation syndrome, which posits that psychosocial demands evoke general physiological disequilibrium which may be harmful to the organism. The body's uniform response to stressful stimuli is characterized by the secretion of stress hormones which can have powerful effects on bodily tissues and cell activity. In turn, stressor-induced

physiological changes can increase the organism's general susceptibility to disease (Lazarus & Folkman, 1984). Physical disorders that are associated with the body's general stress response have been referred to as, "diseases of adaptation" (Selye, 1975). According to generality theories, endogenous factors such as genetic predispositions, age, sex and personality, and exogenous factors such as learning, drug use and diet determine the specific type of illness that develops as a result of stressor exposure (Cox, 1978).

On the other hand, specificity models reject the idea of a general physiological response to stressors. Instead, proponents of this approach maintain that events appraised as stressful elicit specific emotional reactions which induce distinct patterns of physiological changes (Lazarus & Folkman, 1984). These alterations in bodily functioning can, in turn, increase the risk of specific diseases, rather than a broad range of illnesses. It is also claimed that the cognitive and behavioural strategies that people use to cope with psychosocial demands can have direct effects on the risk of illness (Lazarus & Folkman, 1984). For example, the excessive use of alcohol, tobacco or drugs in response to stress can directly increase the risk of specific health problems, such as coronary heart disease.

Stress and Illness: Proposed Physiological Mediating Mechanisms

Psychophysiologicalists have proposed that psychosocial stressors can influence physical health through two major physiological pathways (Clow, 2001). These are the hypothalamic-pituitary-adrenal-cortical (HPAC) response system and the sympathetic adrenal medullary (SAM) axis. These systems allow the organism to deal with potential

threats to survival, and together regulate the functioning of the cardiovascular and immune systems.

The HPAC System

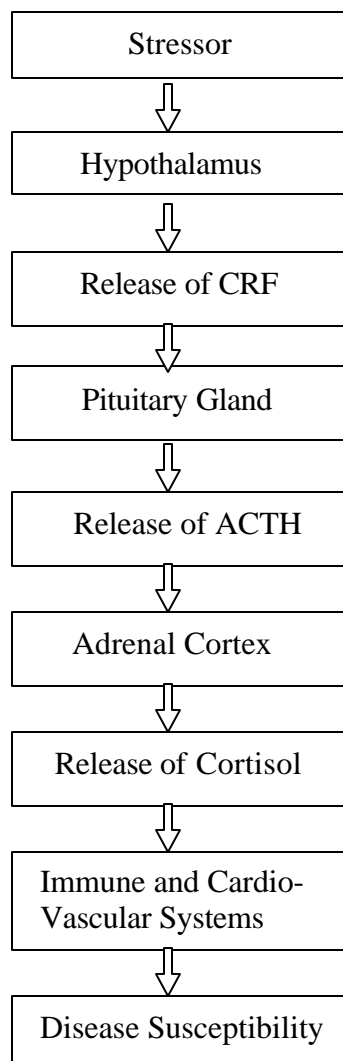
The HPAC axis, which is illustrated in Figure 3.2, is composed of two important neural structures, the hypothalamus and the pituitary gland, as well as the outer portion of the adrenal glands, which are situated on top of the kidneys. HPAC activation results in the secretion of corticotropin-releasing factor (CRF) from the hypothalamus. In turn, CRF induces the pituitary gland to release adrenocorticotrophic hormone (ACTH) into the bloodstream. This hormone then stimulates the discharge of the hormone, cortisol, from the adrenal cortex into general circulation (Maier, Watkins & Fleshner, 1994).

Cortisol can, in turn, influence the activity of a number of bodily organs (Clow, 2001). For example, cortisol promotes the release of glycogen from the liver and muscle, and stimulates the liberation of stored fats and proteins. This, in turn, increases the amount of available energy. Cortisol can also bind with immune cells and alter the functioning of the immune system, which protects the body from infectious agents (Clow, 2001; O'Leary, 1990).

Circulating cortisol levels are usually carefully monitored by the HPAC system and cortisol secretion is inhibited when the amount of this substance in the bloodstream is too high (Clow, 2001). Consequently, stressor-induced cortisol modulations are usually short-lasting, with the hormone returning to normal levels within an hour. However,

repeated activation of the HPAC system due to frequent or chronic stressor exposure can cause this regulatory mechanism to dysfunction, leading to chronically high cortisol levels (Clow, 2001). High circulatory cortisol can, in turn, disturb the fine balance of the immune system and increase the risk of immune-mediated disorders, such as cancer and allergies (Clow, 2001). Furthermore, excess glucose in the bloodstream as a result of chronic stress can promote the formation of atherosclerotic plaques, increasing the likelihood of heart attacks and strokes.

FIGURE 3.2: THE HPAC SYSTEM



The SAM System

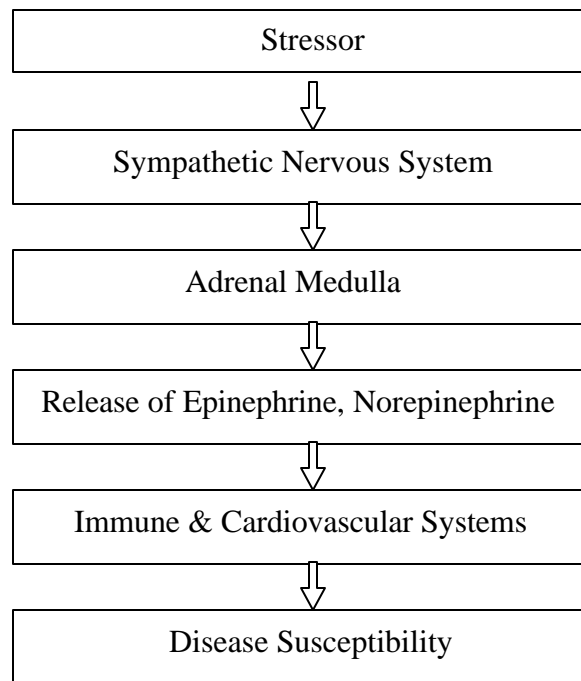
The SAM axis, which is shown in Figure 3.3, incorporates the sympathetic branch of the autonomic nervous system and the inner portion of the adrenal glands, the adrenal medulla. The SAM system is principally activated by acute emotional states, such as fear, anger and excitement, and its effects are usually swift and of short duration (O'Leary, 1990; Clow, 2001).

Activation of the sympathetic nervous system results in the release of the catecholamine, norepinephrine, from sympathetic nerve terminals. The latter make contact with visceral organs, such as the heart and stomach, as well as with immune organs and cells.

Stimulation of the sympathetic nervous system also prompts the adrenal medulla to release both norepinephrine and epinephrine into the bloodstream (Maier et al., 1994).

The purpose of epinephrine and norepinephrine secretion is to prepare the body for a flight or fight response (Clow, 2001). Accordingly, SAM activation causes an increase in heart rate and a narrowing of the blood vessels, thereby raising blood pressure. In addition, blood flow to the brain and skeletal muscles is increased, while that to the kidneys, skin and digestive system is reduced (Clow, 2001). Repeated activation of the SAM system may contribute to the wear and tear of the cardiovascular system, elevating the risk of heart attacks and strokes (Clow, 2001).

FIGURE 3.3: THE SAM SYSTEM



The Immune System: An Overview

According to *Dorland's Illustrated Medical Dictionary* (1994), the immune system is the body's defence against foreign organisms or substances, called antigens, and its primary function is to distinguish self from non-self. The immune response to invading pathogens has been described as a complex and dynamic process which continues for a number of days (Maier et al., 1994). An overview of the basic structure of the human immune system is shown in Figure 3.4.

Two types of immunity, namely innate (naturally occurring) and adaptive (acquired) immunity, may be distinguished (Brenner, Shek & Shephard, 1994). Innate responses are the first line of defence against invaders, while the adaptive immune system assists in recovery from infection and helps prevent re-infection (Brenner et al., 1994). Innate immune processes are termed nonspecific as they defend against all types of antigens (Maier et al., 1994). Conversely, adaptive immunity is described as specific in that each cell is designed to recognize and destroy a particular antigen only.

The innate immune system includes phagocytic, anatomical (e.g. skin), physiological (e.g. mucus membranes), and acute and inflammatory phase responses (Maier et al., 1994). Phagocytes are cells capable of ingesting antigens and include macrophages, which are found in tissue, and monocytes and neutrophils, which reside in the bloodstream (O'Leary, 1990). Natural killer (NK) cells are also involved in natural immunity. The task of these lymphocyte-like cells is to destroy virally-infected cells and types of tumour cells (O'Leary, 1990).

The key components of the adaptive immune system are T and B lymphocytes, which comprise 20% to 25% of the leucocyte, or white blood cell population (Brenner et al., 1994). The adaptive immune system consists further of cellular immunity, mediated by cytotoxic T cells, which destroy target cells, and humoral immunity, mediated by antibodies (immunoglobulins), which are released by plasma B cells (Maier et al., 1994). Various other types of lymphocytes, such as T helper cells, suppressor T cells and memory B cells, are also involved in the adaptive immune response (O'Leary, 1990).

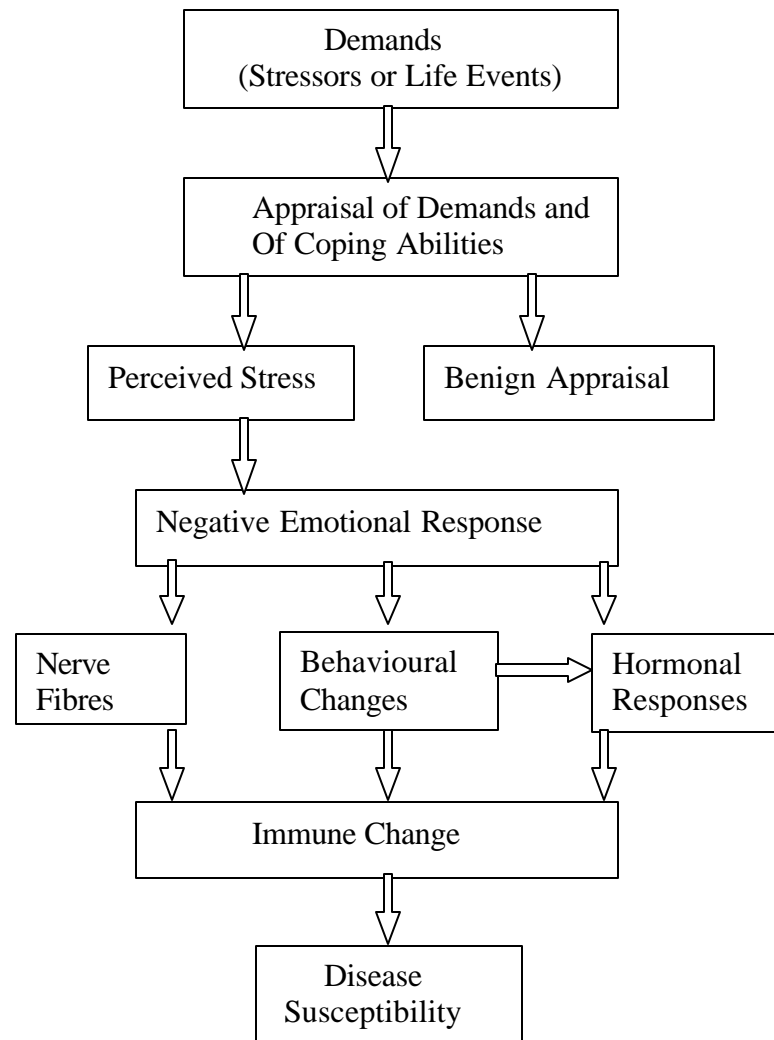
FIGURE 3.4: OVERVIEW OF THE STRUCTURE OF THE HUMAN IMMUNE SYSTEM

THE HUMAN IMMUNE SYSTEM		
Innate (natural, nonspecific) immunity	Adaptive (acquired, specific) immunity	
<ul style="list-style-type: none"> Phagocytic defences <ul style="list-style-type: none"> - Macrophages - Monocytes - Neutrophils Natural killer cells Physiological defences (e.g. mucus) Anatomical defences (e.g. skin) Acute and inflammatory phase responses 	T and B lymphocytes	
	Cellular immunity	Humoral immunity
	Cytotoxic T cells	Plasma B cells (release antibodies)

The Role of Coping and Hardiness in Disease Susceptibility

According to the propositions of cognitive stress theory, the effects of psychosocial stressors on physical health depend on how a person both appraises and copes with demands (Lazarus & Folkman, 1984). Specifically, positive stress appraisals are thought to elicit various physiological and behavioural changes which can, in turn, influence disease susceptibility (Cohen, 1996). A simplified model of how stressors can affect the risk of infectious illness from the perspective of cognitive stress theory is shown in Figure 3.5.

FIGURE 3.5: A MODEL OF STRESS AND ILLNESS BASED ON COGNITIVE STRESS THEORY (adapted from Cohen, 1996)



It has been suggested that a variety of personal and environmental factors can affect cognitive appraisal and coping and therefore, can influence stress-related outcomes (Lazarus & Folkman, 1984). For example, a person's commitments and beliefs, as well as the predictability and timing of an event, can determine how he or she evaluates a potentially stressful encounter. In addition, factors such as health and energy, positive beliefs, problem-solving skills and social support can facilitate adaptive coping.

Researchers have also proposed that certain personality traits, such as dispositional optimism and hardiness, can influence both stress appraisal and coping (Stroebe, 2000). Hardiness, in particular, has received a great deal of attention from researchers in recent years as a potential moderator of the effects of life events on physical health. Specifically, it has been hypothesized that hardiness promotes more positive appraisals of potentially stressful situations and also enables people to manage stress more effectively (Stroebe, 2000). Ideas about the relationship of coping and hardiness to disease susceptibility are discussed in more detail below.

Coping and Illness

It has been suggested that the cognitive and behavioural strategies that people use to cope with psychological stress can influence the risk of physical illness through various pathways. For example, coping processes that are unable to prevent or solve problems or reduce emotional distress may serve to sustain or increase stress-induced neurohormonal secretions (Lazarus & Folkman, 1984). The hormones released during stress can, in turn, alter the functioning of the immune and cardiovascular systems, increasing the risk of immune-mediated and cardiovascular diseases (Clow, 2001). Moreover, certain coping strategies, such as self-blame, can in themselves produce arousal. In addition to this, coping behaviours such as smoking and alcohol use can have direct adverse effects on physical health measures (Lazarus & Folkman, 1984). Finally, the use of inappropriate forms of coping, such as cognitive avoidance, to deal with potentially-serious medical problems may serve to increase the severity of a physical disorder (Lazarus & Folkman, 1984).

Various theoretical viewpoints exist regarding the effectiveness of approach versus avoidance coping strategies in the domain of disease susceptibility. Most of these approaches argue for the superiority of approach coping over avoidance coping. However, other theorists have suggested that no particular coping strategy is inherently adaptive or maladaptive.

From a psychoanalytic perspective, avoidance coping strategies have the potential to harm both physical health and psychological well-being. According to this approach, the tendency to avoid dealing with problems and adverse cognitions and emotions can lead to the repression of threatening information. This repressed material may later re-emerge in a different, more negative form (Suls & Fletcher, 1985).

In addition, control systems theory suggests that a failure to attend to distress or physical symptoms can increase the risk of health problems (Suls & Fletcher, 1985). Specifically, the organism is conceptualized as a complex system of positive and negative feedback loops. Physical or psychological symptoms that represent a discrepancy between one's current state and a standard of comparison are said to cue behaviours that are designed to redress the inconsistency. However, a failure to attend to these cues can lead to the dysregulation of the system, and can increase the intensity of symptoms.

The proposed maladaptiveness of avoidance coping with regard to physical health outcomes is further supported by the opioid peptide hypothesis of repression (Jamner, Schwartz & Leigh, 1988). According to this theory, a repressive coping style can increase

functional endorphin levels in the brain. This can, in turn, lead to decreased immune function and a reduced resistance to infectious and neoplastic diseases. Repressive coping has been defined as the tendency to avoid threatening information and to deny or minimize negative emotions.

Several researchers have suggested, however, that self-focused attention may be maladaptive when dealing with chronic or traumatic stressors. For instance, the theory of self-regulation, proposed by Carver and Scheier (cited in Filipp et al., 1993), predicts that focusing on one's internal thoughts and feelings can intensify negative affect. Specifically, self-focused attention serves as an adaptive response in situations in which the discrepancy between a current and desired state can effectively be reduced or eliminated through one's actions. However, when the likelihood of reducing a discrepancy is low, such as in the case of irrevocable loss, then focusing attention on one's inner states can exacerbate emotional distress. In this regard, it has been stated that the phenomenological salience of distress can compound negative feelings and hinder active coping strategies. Negative affect can, in turn, influence neurochemical stress secretions, increasing the risk of physical illness (Lazarus & Folkman, 1984).

Alternatively, it has been hypothesized that avoidance coping strategies may be dysfunctional if they involve an increase in certain harmful life-style behaviours, such as smoking, alcohol consumption, drug use, sleep deprivation, poor dietary habits and risk-taking (Lazarus & Folkman, 1984). However, the tendency for some individuals to seek

out social support, an approach coping strategy, when under stress, may serve to increase their exposure to infectious organisms (Stroebe, 2000).

It has also been suggested that the use of avoidance strategies such as denial to cope with medical stressors may have detrimental effects on the disease process (Lazarus & Folkman, 1984). Although such forms of coping may be effective in reducing emotional distress, they may cause a person to delay seeking appropriate medical treatment for a health problem. This may, in turn, serve to exacerbate an underlying medical condition.

In addition to the above theoretical perspectives, several researchers have proposed that coping strategies are not intrinsically adaptive or maladaptive. Instead, their effectiveness is said to depend on a number of different factors. These include the domain of health outcome, the context or situation, and the point in time (Cohen, 1995). For example, it has been postulated that the controllability of a stressor may determine the efficacy of a particular strategy (Jones & Bright, 2001). Specifically, in situations of high personal control, such as examinations, attention strategies may lead to better adaptational outcomes than avoidance strategies. Conversely, in situations over which the individual has little control, such as bereavement or paralysis, avoidance-type strategies may generally be more functional (Weidner & Collins, 1993).

In addition to the controllability of a situation, it has been suggested that the duration of a stressor may influence the adaptiveness of a specific strategy. For instance, it has been proposed that avoidance forms of coping may be more adaptive when dealing with short

term, non-physical demands which are of no long-term consequence (Weidner & Collins, 1993). The reason for this could be that paying attention to transient, inconsequential stressors wastes precious energy, which can lead to physical and mental exhaustion and an increased risk of illness. Conversely, attention strategies are considered to be more effective than avoidance forms of coping for dealing with long-term stressors. This may be due to the fact that a stressor's controllability increases over time as more coping resources become available (Weidner & Collins, 1993).

Hardiness and Illness

Personality theorists have proposed that the personality construct of hardiness may play an important role in somatic health and disease (Kobasa, 1979). The purported impact of hardiness on illness may be viewed in the context of the cognitive approach to stress, proposed by Lazarus and Folkman (1984). There are purportedly two primary mechanisms whereby hardiness and its interrelated components of control, challenge and commitment may influence physical health. Firstly, hardiness may influence cognitive appraisal of demands and secondly, hardiness may guide coping processes employed in response to the experience of stress (Stroebe, 2000).

With regard to the first pathway, it has been hypothesized that hardiness affects the appraisal process by promoting more optimistic evaluations of life events (Kobasa et al., 1994). For example, high hardy individuals are believed to approach change with a positive outlook, throwing themselves into new situations with the belief that they can actively control their own destinies (Kobasa, 1979). In contrast, people who are low in

hardiness feel threatened by change and believe they have little control over events in their lives. This suggests that high hardy individuals may evaluate life changes as less stressful than their low hardy counterparts. This may, in turn, protect them from stress-induced immunosuppression and physical health problems (Dolbier, Cocks, Leiferman, Steinhardt, Schapiro, Nehete, Perlman & Sastry, 2001).

Hardiness is also believed to serve as an intrapersonal resource which enables people to cope more effectively with situations appraised as stressful (Stroebe, 2000). As discussed previously, coping resources are hypothesized to influence coping processes. In this regard, it has been proposed that hardy individuals are able to transform stressful situations through their decisive actions (Kobasa et al., 1994). In turn, physiological arousal and thus the risk of immune disturbances may be decreased.

Another hypothesized route through which hardiness may influence physical health measures is via health-related behaviours (Soderstrom, Dolbier, Leiferman & Steinhardt, 2000). Specifically, it has been proposed that hardiness leads to improved physical health by promoting healthy practices, such as good nutrition and moderate aerobic exercise.

RESEARCH FINDINGS

The findings of a large number of studies suggest that specific stress-related psychosocial factors, including life events, coping and hardiness, may influence both the functioning of the immune system and the risk of physical illness. Before reviewing this research and

discussing some of the methodological limitations of stress-illness studies, some of the main methodologies used in stress research will be briefly described.

Stress Research Methodologies

Both quantitative and qualitative research methodologies are commonly used in stress research. Quantitative methods have the advantage of being more objective than qualitative approaches (Jones & Kinman, 2001). They also enable large numbers of people to be studied at once and allow for sophisticated statistical analysis of the data. However, qualitative methods, which involve subjective interpretations, are able to provide a more in-depth understanding of phenomena.

The most popular of the quantitative approaches include epidemiological studies, survey methods and experiments (Jones & Kinman, 2001). Epidemiological research is defined as the study of the incidence and aetiology of physical disease, which may, in turn, lead to recommendations for illness prevention and treatment (Jones & Kinman, 2001).

Epidemiological studies may use survey methods to collect information on stressors, strains and possible intervening variables. In general, surveys, which are described as the most popular method in stress research, may be cross-sectional or longitudinal in nature.

In cross-sectional studies, data is collected in one survey at a single point in time.

Conversely, longitudinal surveys involve taking measures on separate occasions.

Experiments may also be performed in order to assess the effects of stressors on strains.

These are controlled studies in which an independent variable(s) is manipulated by the

researcher. Unlike the other two quantitative approaches, experimental studies are able to provide information about cause and effect. However, as they occur in an artificial setting, their application to real-life environments, or their ecological validity, may be open to question (Jones & Kinman, 2001).

Qualitative methods, although becoming more popular in psychology, are mainly used in anthropological and sociological stress studies (Jones & Kinman, 2001). Popular qualitative methodologies include interviews, case studies and reviews, and meta-analyses.

Stress-illness studies may also be differentiated on the basis of whether they utilize a prospective or retrospective research design. In a prospective study, psychological variables are measured first and then illness is assessed over the course of the study or at the end of the research (Prokop, 1991). In retrospective studies, illness and psychological variables such as life events are measured at the same time.

Life Events, Immune Function and Illness

Life Events and Immune Function

Studies of the effects of psychosocial factors on the immune system fall under the banner of the scientific discipline of psychoneuroimmunology. This field of research is described as the study of the interrelationships among behaviour, the brain and the immune system (Maier et al., 1994).

In support of the life events approach to stress, there appears to be considerable evidence that life changes may adversely affect the functioning of the immune system (Bartrop, Luckhurst, Lazarus, Kiloh & Penny, 1994; Drummond & Hewson-Bower, 1997; Glaser, Kiecolt-Glaser, Speicher & Holliday, 1985; Irwin, Daniels, Bloom, Smith & Weiner, 1987; Kaplan, 1991; Kugler, 1994). It has been hypothesized that stress-induced immune changes can, in turn, increase the risk of disorders such as allergies and cancer (Clow, 2001). However, most studies in this area have not directly assessed whether changes in immune function in response to life events are actually related to an increased risk of physical illness.

Several research findings suggest that exposure to a cluster of life events may suppress various immune parameters in an array of populations. These include rheumatoid arthritis patients, first-year medical students and recurrent genital herpes simplex virus patients (Kaplan, 1991). In addition, in a cross-sectional study involving a group of 37 women, it was found that subjects experiencing major life changes had significantly lower levels of NK cell activity than women reporting fewer changes (Irwin et al., 1987).

Although the above-mentioned studies did not indicate the clinical significance of stress induced immune modulations, the research findings of Drummond and Hewson-Bower (1997) suggest that life events may suppress the immune system, which may, in turn, increase the risk of colds and influenza. Specifically, it was found that children with a history of recurrent upper respiratory tract infections had significantly higher life event scores and lower secretory immunoglobulin A concentrations relative to healthy controls.

Immunoglobulin A is secreted by the submucosa in the upper respiratory tract and is believed to be the first line of defence against viruses and bacteria (Kugler, 1994).

In addition to research that supports a link between cumulative life changes and immune function, various studies suggest that specific life events may have adverse effects on the immune system. In research involving first-year medical students, Glaser et al. (1985) noted that common stressors, such as examinations, were related to an impaired cellular immune response. Depressed immune function has also been reported following bereavement (Bartrop et al., 1994). Furthermore, published reviews of the literature point to a relationship between immunosuppression and events such as space-flights (Kaplan, 1991), imprisonment and examination periods (Kugler, 1994).

Life Events and Illness

Apart from studies that provide support for the hypothesized role of life events in immune function, a substantial body of research suggests that major life changes are related to an increased risk of physical illness (Manning & Fusilier, 1999; Melamed, Kushnir, Strauss & Vigiser, 1997; Rahe, Mahan, Arthur & Gunderson, 1970; Stroebe, 2000; Williams & Lawler, 2001). There is also evidence that life events are associated with a reduced resistance to upper respiratory tract infections (Cobb & Steptoe, 1996; Cobb & Steptoe, 1998; Cohen, Tyrrell & Smith, 1991; Drummond & Hewson-Bower, 1997; Totman, Kiff, Reed & Craig, 1980).

Early compelling evidence for the role of life events in disease susceptibility was provided by Rahe et al. (1970), who conducted a large-scale prospective study involving 2 684 navy personnel. The authors found that subjects with high life change scores experienced 50% more cases of illness while on board ship than low stress subjects.

Various other studies have since confirmed these findings. For instance, a significant positive relationship was found between life events and disease susceptibility in a sample of 192 working adults (Manning & Fusilier, 1999). An advantage of this study is that it utilized relatively objective measures of illness, namely health care costs and the number of health insurance claims filed. Furthermore, in a retrospective study involving low income women, a significant positive correlation was detected between major life changes and self-reported episodes of physical illness (Williams & Lawler, 2001). Other researchers found that recent, mainly negative life events were related to self-reported somatic complaints, such as dizziness, headaches and shortness of breath, in a sample of 1 859 employed men (Melamed et al., 1997). In addition to this research, both longitudinal cohort studies and epidemiological surveys indicate that a single major occurrence, such as the loss of a partner, is associated with an increased risk of disease and mortality (Stroebe, 2000).

In contrast to the above findings, however, a few researchers have failed to find evidence that life events are related to an increased risk of health problems. For example, in a prospective study, Evers, Kraaimaat, Geenen, Jacobs and Bijlsma (2003) noted that the occurrence of major life changes did not predict long-term disease activity in 78 recently

diagnosed rheumatoid arthritis patients. Moreover, in the previously-mentioned study conducted by Melamed et al. (1997), a significant negative relationship was observed between life events and certain cardiovascular disease risk factors, such as blood pressure and serum lipid levels.

Life Events and Upper Respiratory Tract Infections

A number of recent stress-illness studies have been directed at examining the role of psychosocial factors in the risk of developing an upper respiratory tract infection. Due to their prevalence in the general population, infections such as colds and influenza are considered to be particularly suitable for assessing the effects of stress on disease susceptibility (Jones & Bright, 2001).

The above research has generally yielded strong evidence in support of a positive relationship between life events and susceptibility to upper respiratory tract infections. In a previously-cited study, Drummond and Hewson-Bower (1997) observed that children with a history of recurrent respiratory episodes reported significantly more recent major life changes than their healthier counterparts. In another study involving children, it was found that the occurrence of a high number of life events was related to an increased risk of clinically-verified episodes of colds and influenza in a group of 55 boys and 61 girls (Cobb & Steptoe, 1998).

In research involving adults, Cobb and Steptoe (1996) found a significant positive relationship between stressful life events and the incidence of clinically-verified upper respiratory tract infections. This study also demonstrated that life event stress may have both concurrent and future effects on health. For instance, a relation was found between distress ratings and illness for events experienced during the 12-month period prior to the commencement of the study, as well as during the three-month study period itself. Unfortunately, this study did not assess the association between the number or magnitude of life events reported and the risk of upper respiratory illness.

Further support for the role of life events in susceptibility to the common cold was provided by Cohen et al. (1991), who conducted a well-controlled viral-challenge study involving 394 healthy volunteers. The authors reported that higher psychological stress was associated with an increased risk of infection following experimental exposure to a cold virus. Three measures of psychological stress were used in this study. These were the number of recent major life events that were rated as stressful, perceptions of current demands, and current negative affect. The researchers discovered that each stress measure exerted an independent effect on disease susceptibility. Furthermore, it was found that current perceived stress and negative affect were positively related to biological infection, whereas recent stressful life events were correlated with the development of clinical symptoms. It was noted that infection could occur in the absence of symptoms.

There is also evidence that certain types of life events may affect the severity of an infectious episode. In this regard, it was found that subjects who reported more activity changing life events experienced more symptoms and greater virus shedding following nasal inoculation with rhinoviruses than subjects who obtained lower scores on this index (Totman et al., 1980).

Psychological stress has also been related to the severity of upper respiratory tract infection. In a prospective study involving 55 subjects who were experimentally infected with influenza A virus, it was found that the level of psychological stress, as measured by the 10-item Perceived Stress Scale, predicted the severity of the ensuing upper respiratory symptoms (Cohen, Doyle & Skoner, 1999). Severity of infection was assessed using subjective reports of symptoms, as well as objective measures of mucus production. This study also found support for the proposed mediation of local pro-inflammatory cytokine production in the relationship between stress and illness. In this respect, stress was associated with increased concentrations of the cytokine IL-6, which, in turn, was linked to the severity of infection.

Athlete Studies

The findings of several studies involving different types of sports participants indicate that factors such as life events and psychological stress may play an important role in the athlete's physical health status. In this regard, several studies have revealed that major life changes may increase the risk of a variety of health problems in elite competitors. For example, in a prospective study involving elite biathletes, race walkers, figure

skaters, gymnasts and basketball players, significant positive correlations were found between life events and the frequency of self-reported headaches, weight changes, anxiety and substance use (May et al., 1985). Recent major life changes also predicted more frequent, severe and prolonged musculoskeletal disorders of the legs and feet, as well as longer-lasting respiratory problems.

In another prospective study, May et al. (1985) found a significant positive relationship between life events and the incidence of ear, nose and throat (ENT) problems in 73 members of the United States alpine ski team. Higher scores on the life events scale were also positively associated with the duration of ENT problems, headaches, musculoskeletal leg injuries and sleep disorders. Meanwhile, higher general well-being was related to a lower incidence and shorter duration of health problems. Based on the results of the study, the authors concluded that life events, depression, reduced energy, lower life satisfaction, excessive physical health concerns, higher tension, and uncontrolled emotions may adversely affect the athlete's physical health status.

There is also some evidence that psychosocial variables are related to infectious disease susceptibility in recreational athletes. For example, in a study involving 2 311 marathon runners, it was found that only 36,3% of subjects with low levels of perceived stress reported experiencing an upper respiratory tract infection before or after a standard marathon, compared with 45,2% of runners not included in this group (Nieman et al., 1990). Athletes were assigned to the low stress group on the basis that they reported "definitely better" levels of energy and stress, quality of sleep, and overall feelings since

starting to run. Interestingly, it was found that the number of runners in the low stress group increased significantly as weekly training distance increased.

Coping, Immune Function and Illness

Consistent with the assumptions of Lazarus and Folkman's (1984) cognitive stress theory, the findings of numerous studies suggest that the cognitive and behavioural strategies that people use to cope with psychological stress may influence physical health status (Cassidy, 2000; Cobb & Steptoe, 1996; Cobb & Steptoe, 1998; Evers et al., 2003; Jamner et al., 1988; Nowack, 1989; Nowack, 1991; Murberg, Furze & Bru, 2004; Soderstrom et al., 2000; Steiner, Erickson, Hernandez & Pavelski, 2002). With regard to the effectiveness of the different types of coping, there is evidence that focusing attention on a threatening situation may generally be more adaptive than attempts to avoid a stressor (Cassidy, 2000; Cobb & Steptoe, 1998; Evers et al., 2003; Murberg et al., 2004; Soderstrom et al., 2000; Steiner et al., 2002). However, in an early meta-analysis of the relative effectiveness of coping strategies, Suls and Fletcher (1985) found little support for the view that one form of coping may be superior to another. Further analyses led to the suggestion that the adaptiveness of the different forms of coping may depend on whether their short-term or long-term effects are being assessed. For example, the authors found that the use of denial may be adaptive in the short term but that approach-oriented strategies may be more beneficial in the long run.

In recent years, the findings of several studies have attested to the role of coping in physiological functioning. In a review of the literature, Kaplan (1991) stated that there is

evidence that efforts to confront stressors and solve problems are linked to enhanced immune function. In addition, various empirical findings suggest that the approach coping strategy of positive reappraisal, which involves reevaluating an event in a more positive light, may reduce physiological arousal, as reflected in lower levels of urinary norepinephrine (Prokop, 1991).

Conversely, the tendency to avoid stressors and / or to deny negative emotions has been associated with various indicators of immunosuppression and hyperglycemia (high blood sugar) (Jamner et al., 1988). This finding provides support for the opioid peptide hypothesis of repression. There is also substantial evidence that certain avoidance coping behaviours, such as smoking, alcohol consumption and drug use, may negatively affect various quantitative indices of immunocompetence, such as the number and percentage of T cells (Kaplan, 1991).

In addition to reports that coping strategies are related to physiological functioning, the results of a number of studies suggest that the manner in which people cope with stress may influence the onset and course of physical illness. For example, in a retrospective study involving 110 corporate employees and 271 university students, Soderstrom et al. (2000) found that an approach coping style was inversely related to perceived stress and self-reported symptoms of illness, such as colds and influenza, headaches, upset stomachs and feeling nervous or tense.

In contrast to the demonstrated benefits of actively confronting stressors, several studies have found that the inclination to focus attention away from stressful stimuli is associated with a greater risk of general health problems. For example, Soderstrom et al. (2000) observed a significant positive correlation between an avoidance coping style and various psychosomatic symptoms of illness in university students and corporate employees. A positive relationship between avoidance coping and perceived stress was also found in this study. In addition, Cassidy (2000) observed that subjects who reported more frequent episodes of illness were more likely to avoid problems and less likely to approach them. Moreover, several researchers have found that avoidance coping strategies such as withdrawal, alienation, denial, passive acceptance and helplessness may increase the risk of mortality in the elderly (Lazarus & Folkman, 1984).

Avoidance coping responses have also been observed to influence the course of specific disorders. For example, in a prospective study involving 78 recently-diagnosed rheumatoid arthritis patients, Evers et al. (2003) found that a general tendency to avoid, give in to or withdraw from everyday problems predicted increased clinically-assessed, long-term disease activity in this group. In other research, it was observed that a propensity to give up attempts to control stressful encounters was associated with a higher risk of mortality in 119 patients with congestive heart failure (Murberg et al., 2004).

However, the findings of a few other studies suggest that avoidance coping may also have a positive impact on physical health status. For instance, a significant inverse

correlation was observed between avoidance coping and self-reported chronic and infectious illness in a retrospective study involving 194 professional employees (Nowack, 1989). In a later prospective study, Nowack (1991) found that attempts to avoid thinking about a stressor were related to a significantly lower risk of a wide range of physical disorders, including colds and influenza, cancer, ulcers and cardiovascular problems, in a sample of 203 male and female professional workers.

The potential for coping processes to influence the risk of upper respiratory tract infections has also been demonstrated in several other investigations. For example, in a 15-week longitudinal study involving 107 adults, it was found that an avoidance coping style interacted with life event stress to influence the likelihood of developing a clinically-verified upper respiratory tract infection (Cobb & Steptoe, 1996). Specifically, a low tendency to use distraction and cognitive avoidance was associated with significantly more infectious episodes at high levels of life event stress. This suggests that avoidance coping may protect people against colds and influenza under stressful conditions. However, another longitudinal study found that children with high avoidance coping scores, reflecting the tendency to use strategies such as distraction and self-criticism, experienced significantly longer-lasting upper respiratory tract infections than children with low scores (Cobb & Steptoe, 1998). The same study also found a significant inverse correlation between problem-focused coping and the duration of symptoms. Moreover, it was reported that high avoidance coping scores were associated with a significantly increased risk of infectious episodes at high levels of daily hassles.

However, other research findings suggest that the efficacy of coping strategies may depend on factors such as the duration of a stressor. In this regard, there is evidence that avoidance coping responses may be more adaptive than approach coping strategies when stressors are short-lasting, but the latter may be more effective in the long term. For example, Collins, Baum and Singer (cited in Prokop, 1991) found that patients using denial experienced significantly less pain and a more rapid recovery following a brief stressor such as surgery. However, for more prolonged stressors, it was reported that the problem-focused strategy of positive reappraisal was associated with significantly fewer physical complaints. In other research, it was found that patients who used vigilance to cope with pre-operative stress experienced more minor complications post-surgery and spent more days in hospital than a group using avoidance as a coping strategy (Cohen & Lazarus, 1994). In this study, avoidance was described as a denial of emotions and threatening information relating to the operation, whereas vigilance was associated with being overly attentive to these factors.

Hardiness, Immune Function and Illness

The findings of a number of studies indicate that the personality style of hardiness may influence both the functioning of the immune system and susceptibility to physical illness (Dillon & Totten, 1989; Dolbier et al., 2001; Kobasa, 1979; Kobasa et al., 1994; Manning & Fusilier, 1999; Roth, Wiebe, Fillingim & Shay, 1989; Soderstrom et al., 2000; Williams & Lawler, 2001). Although hardiness has been shown to have both direct and moderating effects on physical health, analysis of the research suggests that the direct

effects of hardiness on health are generally stronger than its buffering effects (Soderstrom et al., 2000).

In support of the proposed protective properties of hardiness, there is evidence that hardiness may have a positive impact on the functioning of the immune system. For example, researchers have reported significant differences in functional immune responses between high and low hardy individuals under non-stressful conditions (Dolbier et al., 2001). Specifically, subjects high in hardiness were found to exhibit higher mean proliferative responses to various antigens than low hardy subjects. Proliferation or blastogenesis is described as being probably the most basic response of lymphocytes to invading microorganisms (O'Leary, 1990).

Other studies suggest that hardiness may also enhance resistance to disease. For example, Manning and Fusilier (1999) reported a significant inverse association between hardiness and various objective measures of ill health in a group of 192 adult workers. Specifically, the researchers found that subjects with higher hardiness scores had significantly lower health care costs and claims than individuals low in hardiness. Other researchers observed a significant negative correlation between hardiness and self-reported health problems in a large sample of 373 college students (Roth et al., 1989). This study also found support for the proposition that hardiness may influence physical health via its effects on subjective appraisals and / or via the occurrence of stressful life events. In addition to these investigations, a small prospective study conducted by Dillon and Totten (1989) revealed that hardiness in breast-feeding mothers was related to a

significantly lower incidence of upper respiratory tract infections in their infants. More recently, Soderstrom et al. (2000) noted a significant inverse association between hardiness and self-reported symptoms of psychosomatic illness in both a corporate and a university sample.

Various researchers have found support for the proposition that coping factors may mediate the relationship between hardiness and illness. In this regard, Soderstrom et al. (2000) observed that hardiness was positively related to problem-focused coping which, in turn, was negatively associated with symptoms of illness. In the same study, the authors found a significant inverse correlation between hardiness and avoidance coping, which, in turn, was positively related to the illness measure. Carver et al. (1989) have also reported a relationship between hardiness and coping. Specifically, they found that a hardy personality was positively correlated with the adaptive coping tendencies of planning, active coping, and positive reinterpretation. Moreover, hardiness was negatively related to the avoidance strategies of denial and behavioural disengagement.

Several studies suggest that hardiness may also buffer the effects of stressful life events on illness. For instance, in research involving male business executives, Kobasa (1979) observed that high hardy male business executives scoring above the median on a scale of stressful life events experienced significantly fewer episodes of illness than their low hardy counterparts. In a subsequent study, Kobasa et al. (1994) found that hardiness may reduce the impact of life changes on both concurrent and prospective measures of illness. Exercise and social support were also shown to protect subjects from the adverse effects

of stress. However, of these variables, hardiness had the most pronounced effect on health. The healthiest executives were those who were high in all three resistance resources. No relationship was found between hardiness and exercise, or between exercise and social support. More recently, a hardy personality style and being African American was found to protect low-income women from the adverse effects of life event stress on health (Williams & Lawler, 2001). However, contrary to these findings, Brookings and Bolton (1997) found no support for the proposed buffering effects of hardiness in a study involving a group of college students.

Support has also been found for the proposed stress-attenuating properties of hardiness. For example, Soderstrom et al. (2000) observed an inverse correlation between hardiness and perceived stress. Similarly, Williams and Lawler (2001) reported that although high hardy and low hardy women had similar levels of network stress, the former perceived their external environments as being less stressful.

Methodological Limitations of Stress-Illness Research

There seems to be considerable empirical support for the hypothesized role of the stress-related variables of life events, coping and hardiness in disease susceptibility. However, stress-illness studies may have certain methodological limitations which imply that some of the findings in this area may need to be interpreted with caution.

Firstly, the use of a retrospective research design may lead to the over-reporting of recent life events or psychological stress in order to justify illness (Prokop, 1991). Also, when

stress and illness are assessed simultaneously, it cannot be reliably determined which is the antecedent variable and which the consequent. For example, it is plausible that ill health may precede psychological stress rather than vice versa (Cohen, 1996).

Secondly, both retrospective and prospective studies may utilize self-reports of illness, which may be influenced by individual differences, such as neuroticism or optimism. These factors may lead to symptoms being over-reported or under-reported, respectively (Jones & Kinman, 2001). Related to this is the problem of verifying self-reported infectious episodes (Cohen, 1996). In this regard, it has been proposed that physiological indicators, which include the measurement of cardiovascular and biochemical symptoms as precursors of disease, are more objective than self-report measures of illness (Jones & Kinman, 2001). The use of self-report questionnaires to assess variables such as life events and illness may also produce unreliable data due to the inaccurate recall of information. When self-reports are used to measure both stressors and strains, or when these measures contain conceptually similar items, it is said that the problem of “method variance” may occur (Jones & Kinman, 2001). This means that any observed relationship between the constructs of interest may be a result of the methods used in the research.

Finally, as most stress-illness studies are correlational, it is possible that a third factor could account for any observed significant relationship between stress and illness (Cohen, Line, Manuck, Rabin, Heise & Kaplan, 1997).

SUMMARY AND CONCLUSIONS

The main purpose of this chapter was to examine current theoretical approaches and recent research findings concerning the relationship between stress and physical illness, with an emphasis on the role of life events, coping and hardiness in disease susceptibility.

Two major lines of thought characterize ideas about the relationship between stress and illness. According to generality theories of disease aetiology, psychosocial stressors cause general physiological disequilibrium which, in turn, can increase the risk of a wide range of physical disorders. Conversely, specificity theories maintain that the appraisal of events as stressful evokes a negative emotional reaction which can render a person more vulnerable to specific disorders. According to this viewpoint, coping responses may also influence health-related outcomes. With regard to the effectiveness of the different coping strategies, several theories imply that approach coping may generally be more adaptive than avoidance coping. Finally, it has been proposed that hardiness promotes positive stress appraisals and the use of adaptive coping strategies, and is therefore associated with superior physical health status.

In support of the above ideas, a substantial amount of research suggests that life events, coping and hardiness are related to various measures of physical illness in a variety of populations. However, conclusions that stress-related psychosocial factors play a causal role in disease appear to be largely speculative.

CHAPTER 4

AEROBIC EXERCISE AND UPPER RESPIRATORY TRACT INFECTIONS

INTRODUCTION

In support of popular opinion, the research literature suggests that people who engage in regular physical activity may enjoy a number of important health benefits. For example, there is evidence that aerobic exercise may increase longevity (Paffenbarger, Hyde, Wing & Hsieh, 1986), improve cardiovascular health, and enhance quality of life (Shephard, Kavanagh, Mertens, Qureshi & Clark, 1995). Various studies also indicate that vigorous, dynamic exercise may reduce the risk of colon cancer, hypertension and non insulin dependent diabetes mellitus (Stroebe, 2000).

In addition to the above research, data from several experimental and epidemiological studies suggests that regular, moderate aerobic training and physical fitness may enhance resistance to upper respiratory tract infections (Heath, Ford, Craven, Macera, Jackson & Pate, 1991; Nieman, Nehlsen-Cannarella, Markoff, Balk-Lamberton, Yang, Chritton, Lee & Arabatzis, 1990; Nieman, Buckley, Henson, Warren, Suttles, Ahle, Simandle, Fagoaga & Nehlsen-Cannarella, 1995; Nieman, Henson, Gusewitch, Warren, Dotson, Butterworth & Nehlsen-Cannarella, 1993; Nieman, Johanssen & Lee, 1989). In contrast, various studies involving endurance athletes suggest that chronic or acute heavy exercise may increase susceptibility to colds and influenza (Heath et al., 1991; Linde, 1987; Nieman et al., 1990; Peters & Bateman, 1983; Peters, Goetzsche, Grobbelaar & Noakes, 1993).

Against this background, the main aim of this chapter is to review various theoretical approaches and empirical findings concerning the relationship between aerobic exercise and upper respiratory tract infections. This section will commence with brief definitions of some important concepts and principles.

CONCEPTS AND PRINCIPLES

The Concept of Aerobic Exercise

Aerobic exercise is that which is powered predominantly by aerobic power systems, which produce energy for muscle contraction in the presence of oxygen (Hawley & Burke, 1998). Two aerobic power systems, the aerobic glycolytic (carbohydrate) and the aerobic lipolytic (fat) system, have been identified. Aerobic exercise can be contrasted with anaerobic exercise, which is powered mainly by systems that generate energy for exercise without the use of oxygen (Hawley & Burke, 1998).

It is said that the intensity and duration of exercise determine the relative contribution of the different power systems (Hawley & Burke, 1998). For example, events lasting for approximately 30 seconds are powered predominantly by anaerobic processes. However, aerobic power systems make the largest contribution to continuous, high intensity exercise lasting longer than two minutes.

The Principle of Overload Training

The principle of overload training is commonly applied in the area of performance improvement in endurance sports. In essence, this principle serves to explain why athletes interested in high performance will choose to engage in frequent, intense and / or long duration workouts.

Specifically, the overload principle states that by over-extending the various physiological systems related to exercise performance, positive adaptations that enhance functioning occur (Keizer, 1998; O'Toole, 1998). The volume, intensity and frequency of training, as well as the athlete's initial level of fitness, are said to interact to determine the magnitude of adaptation (Hawley & Burke, 1998). The principle of progressive overload states that continued improvement depends on progressively increasing the training stimulus (Hawley & Burke, 1998).

The overload principle can be traced to the ideas of stress researcher and physician, Hans Selye. In brief, Selye (1975) proposed that any internal or external demand made on the organism triggers a generalized physiological stress reaction. This response is marked by an initial decrease in resistance to the noxious agent (e.g. strenuous exertion), followed by a period of enhanced functioning as the organism adapts to the stressor.

THEORETICAL APPROACHES

J-Shaped Model of Exercise and Infection

On the basis of recent research findings concerning the relationship of aerobic exercise to immune function and the risk of colds and influenza, Nieman (2000) has proposed a J shaped model of exercise and upper respiratory tract infection. According to this representation, regular exercise of moderate intensity and duration may reduce the risk of infectious illness in comparison with a relatively sedentary lifestyle. In contrast, people who engage in chronic or acute heavy exercise may be more susceptible to upper respiratory tract infections than both moderate exercisers and sedentary individuals. Consequently, regular, moderate physical activity may have a protective effect against the common cold, whereas very strenuous workouts may predispose athletes to develop upper respiratory illness.

Exercise and Infection: Proposed Physiological Mediating Mechanisms

There seems to be a broad consensus of opinion that aerobic exercise can modulate the functioning of the immune system and in this way is able to influence susceptibility to upper respiratory tract infections (Brenner et al., 1994; Gotovtseva, Surkina & Uchakin, 1998; Mackinnon, 1994; Nieman, 2000; Pedersen, Rohde & Zacho, 1996; Weidner & Sevier, 1996). Exercise-related immune changes are, in turn, thought to be mediated by alterations in the nervous and endocrine systems in reaction to the exercise stimulus (Gotovtseva et al., 1998; Mackinnon, 1994).

It has been proposed that the body's response to physical exertion differs according to exercise intensity and duration. Specifically, it is believed that moderate physical activity promotes the secretion of neurohormonal substances, such as growth hormone, prolactin and cytokines, which have a stimulatory effect on the immune system (Mackinnon, 1994). Consequently, regular, moderate exercise may help reduce the risk of immune-mediated diseases, such as infections, cancer and allergies.

In contrast to the effects of moderate physical activity on immunity, exhaustive exercise is thought to elicit increased secretions of immunosuppressive substances such as catecholamines and glucocorticoids (Gotovtseva et al., 1998). This theory is based on the work of Selye (1975), who maintained that a general physiological stress reaction follows any increased demand made on the body. Scientists have proposed that the effects of acute exercise on immunity may last for between three and 72 hours (Nieman, 2000). According to the "open window" theory, this transient period of immunosuppression may provide pathogens with an opportunity to invade the system, thus increasing the risk of infectious illness (Nieman, 2000). Furthermore, if individuals undertake a new bout of intense exertion before their immune systems have recovered, then chronic immunosuppression may result (Pedersen et al., 1996).

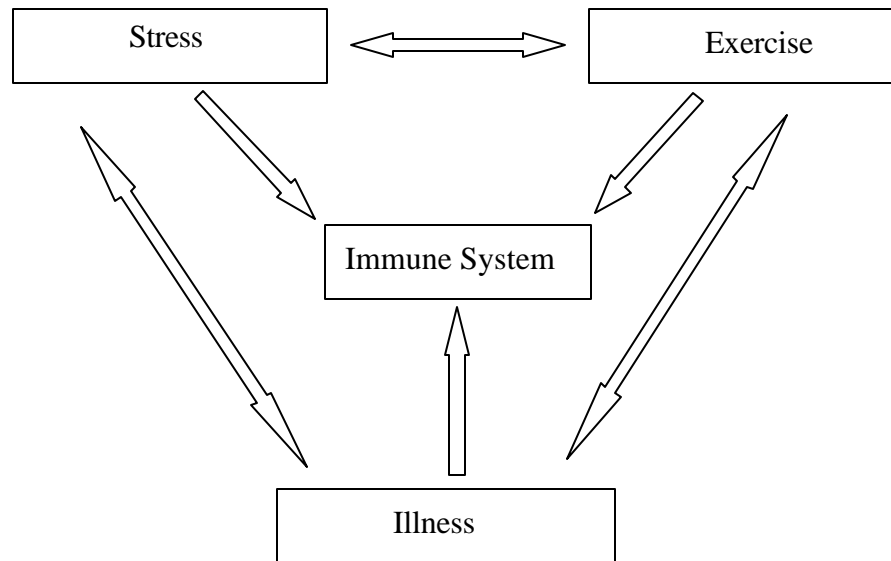
It has also been proposed that the amino acid, glutamine, may mediate the effects of heavy exercise on immune function. According to Castell and Newsholme (1997), prolonged, fatiguing workouts or marathon-type competitions can decrease the blood's glutamine concentrations. This substance is said to be an important source of energy for

some immune cells. Consequently, it has been suggested that decreased plasma glutamine levels can contribute to suppressed immune function and an increased risk of opportunistic infections. In support of this approach, it was found that the provision of oral glutamine after exercise was associated with enhanced immunity and a lower incidence of infections among endurance athletes (Castell & Newsholme, 1997).

Exercise, Stress, Illness and Immune Function: Mackinnon's Theoretical Model

Mackinnon (1994) has formulated a theoretical model, shown in Figure 4.1, which implies that psychological factors may intervene in the relationship between exercise and immune function. In this model, stress, exercise and illness are depicted as three interacting points on a triangle. It is believed that each variable can exert independent and / or interaction effects on the immune system. For example, it has been proposed that exercise can modulate psychological stress levels, which, in turn, can influence the functioning of the immune system and the risk of physical illness. One of the implications of Mackinnon's model is that stress and exercise can have additive effects on the immune system and the resistance to infectious disease.

FIGURE 4.1: MACKINNON'S THEORETICAL MODEL OF THE INTERRELATIONSHIPS AMONG STRESS, EXERCISE, ILLNESS AND THE IMMUNE SYSTEM (adapted from Mackinnon, 1994)



RESEARCH FINDINGS

Exercise and Stress

Consistent with the propositions of Mackinnon's (1994) theoretical model, there is evidence that physical exercise may influence psychological stress reactions. For example, several studies have shown that regular, moderate aerobic exercise may decrease state anxiety, depression, tension and mental confusion, and increase feelings of vigour and exhilaration (Grove, 1995). In addition, Norris, Carroll and Cochrane (1992) found that levels of stress and depression were significantly lower in adolescents reporting greater physical activity. Meanwhile, perceived stress was reported to be

inversely correlated with the frequency of exercise in a survey of 12 110 working adults (Ng & Jeffery, 2003). It has been proposed that the positive effects of exercise on mood states may be mediated by factors such as endorphin and neurotransmitter alterations, expectancy effects, temperature changes and distraction (Grove, 1995).

In contrast to the demonstrated psychological benefits of moderate aerobic training, several studies suggest that heavy training workloads may have adverse effects on mood states. For example, Pierce (2002) found a significant positive correlation between training volume in competitive swimmers and fatigue ratings on the Profile of Mood States. Significant inverse associations between training volume on the one hand and anger and vigour on the other were also reported. Furthermore, a positive relationship between heavy training workloads and depression has been observed in several other studies (Grove, 1995).

Exercise and Immune Function

Moderate Exercise

In support of the proposition that moderate physical activity stimulates the secretion of immunoenhancing substances, a number of studies have found that regular, moderate exercise training and physical fitness may boost various aspects of immunity. For example, Nieman et al. (1993) reported significantly increased natural killer cell activity (NKCA) and T cell function in a group of highly-conditioned elderly women compared with a sedentary control group. In addition, resting NKCA was observed to be significantly higher in a group of experienced male marathon runners relative to a group

of sedentary controls (Nieman et al., 1995). Moreover, an experimental study involving 36 mildly obese, sedentary women found a significant positive correlation between cardiorespiratory fitness and NKCA (Nieman et al., 1990). Natural killer cells are regarded as an important host defence mechanism against viral infections (O'Toole, 1990).

Heavy Exercise

In contrast to the effects of moderate physical activity, a number of studies suggest that heavy exercise workloads may have an adverse impact on the immune system. For example, Hack, Strobel, Weiss and Weicker (1994) found significantly reduced resting neutrophil counts and decreased phagocytic activity in highly-trained runners during peak training periods relative to moderate training phases and untrained subjects. Furthermore, in reviews of the literature, Brenner et al. (1994), Nieman (1996) and Pedersen et al. (1996) cited research findings that indicate that acute bouts of exhausting exercise may temporarily suppress various innate and adaptive immune responses. These include neutrophil function, secretory immunoglobulin A concentrations, lymphocyte proliferation in response to mitogens, and NKCA. Intense exercise lasting longer than one hour appears necessary to trigger changes in NK cells (Pedersen et al., 1996). Apart from exercise intensity and duration, the degree of muscle damage may also influence the extent of exercise-related immunosuppression (Pedersen et al., 1996).

Exercise and Upper Respiratory Tract Infections

Moderate Exercise

The results of several experimental studies involving the general population indicate that regular, moderate aerobic exercise and high levels of physical conditioning may reduce the incidence and duration of the common cold relative to a sedentary lifestyle. For example, in a randomized, controlled study, it was reported that the duration of upper respiratory symptoms in a group of 36 mildly obese women who walked briskly for 45 minutes a day, five days a week, was half that of a sedentary control group (Nieman et al., 1990).

In another experimental trial involving 32 elderly women, it was observed that subjects who were assigned to a walking group experienced significantly fewer episodes of upper respiratory tract infection than a calisthenic control group (Nieman, et al., 1993).

However, the lowest rates of illness were observed in a group of 12 highly-conditioned elderly females who were recruited for cross-sectional comparisons. Specifically, only eight percent of the highly-conditioned group, who exercised on average for 1,5 hours a day, experienced a common cold. In comparison, 21% of the walking group and 50% of the calisthenic group reported infectious symptoms. A potential limitation of these studies, however, is that all subjects were female, which may affect the generalizability of the results.

Various studies involving endurance athletes also suggest that regular, moderate aerobic exercise and physical fitness may reduce the risk of upper respiratory tract infections. For example, in a 12-month longitudinal study, Heath et al. (1991) found that the annual incidence of self-reported respiratory illness in a cohort of 530 male and female marathon runners was 1,2 episodes per person, which was lower than the rate reported in two previous household studies. The runners in this study ran an average of 1 650 kilometres during the year and 83% of the sample had participated in at least one race during this period.

In addition to this research, a survey conducted by a running magazine revealed that 61% of 700 runners believed they had experienced fewer colds since starting to run, whereas only four percent of this group thought they had experienced more (Nieman, 1997). In another study involving non-elite marathon runners, as many as 90% of participants indicated that they rarely became ill (Nieman, 1997). Moreover, in other survey-type research, it was found that only 25% of runners who trained more than 25 kilometres per week reported experiencing an infectious episode during the preceding two-month period. In comparison, 34% of individuals running less than 25 kilometres per week reported symptoms (Nieman et al., 1989). The runners in the 25-kilometre-plus category trained more intensely and more frequently than those in the other group.

Heavy Exercise

In contrast to the potential benefits of moderate exercise, data from several epidemiological surveys involving endurance athletes indicates that heavy training

workloads may increase the risk of colds and influenza. This suggests that aerobic exercise may be beneficial up to a certain level, beyond which further training may be detrimental to the athlete's health.

In a retrospective study of exercise and upper respiratory tract infection which utilized a self-report methodology, Nieman et al. (1990) observed that high-volume endurance training was related to an increased risk of colds, influenza and sore throats. Specifically, it was found that marathon runners training more than 97 kilometres per week were twice as likely as athletes running less than 32 kilometres per week to report an infectious episode. Furthermore, in a 12-month longitudinal study, Heath et al. (1991) found a significant positive correlation between annual training distance and the incidence of upper respiratory tract symptoms in a cohort of 530 male and female runners. Illness and exercise data were self-recorded in monthly logs. Specifically, running more than 778 kilometres during the year was identified as significant risk factor for the development of infection. Individuals running between 1 386 and 2 221 kilometres a year were identified as having the highest risk of illness.

In a prospective study, Peters et al. (1993) found a significantly higher incidence of post race self-reported upper respiratory symptoms in ultra-marathon runners with the highest training workload scores. Specifically, 85% of the high-training status athletes reported symptoms, compared with 48% of the low-training group and 42% of the moderate training group. In another prospective study, Peters and Bateman (1983) found that runners who had trained more 65 kilometres per week before the 56-kilometre Two

Oceans Marathon experienced significantly more infectious symptoms in the two-week post-race period than athletes training less than 65 kilometres per week.

The findings of several studies that have compared elite endurance athletes with sedentary individuals also suggest that heavy training may increase the risk of upper respiratory tract infections. For example, it was found that 44 elite orienteers had a significantly higher annual incidence of upper respiratory illness than non-athletic matched controls (Linde, 1987). On average, the athletes experienced 2,5 infectious episodes per year, whereas the sedentary controls reported an annual incidence of 1,7 infections per person per year. The duration of infectious episodes was also longer in the orienteers. Furthermore, 32% of the controls had no infectious episodes during the year under review, whereas only 10% of the orienteers were infection-free. Illness data in this study was collected using a self-report diary technique.

The findings of several epidemiological studies also suggest that acute strenuous exertion, such as a marathon-type competition, may increase the runner's susceptibility to the common cold. For instance, Peters and Bateman (1983) found that 33,3% of 150 randomly selected runners who had participated in the 56-kilometre Two Oceans Marathon experienced self-reported upper respiratory symptoms in the two-week post race period. In comparison, only 15,3% of non-running controls reported episodes of illness. In addition, Peters et al. (1993) observed that 68% of 84 volunteer subjects who had participated in the 90-kilometre Comrades Marathon experienced post-race upper respiratory symptoms, compared with 45% of age-matched sedentary controls.

Interestingly, it was found that Vitamin C supplementation significantly reduced the incidence of post-race infections. In another epidemiological survey, Nieman et al. (1990) observed that 12,9% of 2 311 randomly-selected runners who had competed in the 1987 Los Angeles Marathon retrospectively reported an upper respiratory tract infection in the week following the event. In contrast, only 2,2% of non-participating control runners experienced an infectious episode during this period. However, another retrospective study found that participation in road races of five kilometers, 10 kilometres and 21,1 kilometres was not related to an increased risk of colds and influenza (Nieman et al., 1989). This suggests that events that take less than two hours to complete may not have adverse effects on the resistance to infectious illness.

On the basis of the above review of the research literature, it appears that aerobic exercise may influence susceptibility to upper respiratory tract infections. However, as a number of the studies in this area have utilized a self-report methodology, some of these research findings may need to be interpreted with caution.

SUMMARY AND CONCLUSIONS

The primary purpose of this chapter was to discuss various theoretical approaches and empirical findings regarding the relationship between aerobic exercise and susceptibility to upper respiratory tract infections. On the basis of this discussion, it seems that aerobic exercise may have paradoxical effects on the body's resistance to infectious illness. Specifically, the research indicates that regular, moderate aerobic training and physical fitness may reduce the risk of the common cold and influenza. Conversely, there is

evidence that heavy training workloads and participation in marathon-type events may increase susceptibility to infection. These findings provide support for the J-shaped model of exercise and upper respiratory illness.

It has been proposed that the relationship between aerobic exercise and upper respiratory tract infection is primarily mediated by exercise-induced changes in the functioning of the nervous, endocrine and immune systems. Consistent with this view, there is evidence that regular, moderate aerobic training and a high level of physical conditioning may boost the functioning of the immune system. Conversely, acute and chronic heavy exercise may suppress various immune parameters. Theory and research also suggests that psychological factors, such as stress, may intervene in the relationship between exercise and infection.

CHAPTER 5

RESEARCH DESIGN AND METHODOLOGY

The primary objective of the present study was to explore the relationship of life events, coping, hardiness and aerobic exercise behaviour to susceptibility to the common cold in distance runners. In this chapter, the research hypotheses, along with the design and methodological aspects of the study are presented and discussed.

THE RESEARCH HYPOTHESES

Statements of the various research hypotheses that were tested in the present study are set out below. A short justification for each hypothesis is also given. In brief, each prediction was based on current theoretical perspectives and recent research findings that suggest that life events, coping, hardiness, training workload and competition frequency may influence the risk of infectious illness.

Hypothesis 1: Life events are positively related to susceptibility to the common cold in distance runners.

This prediction was based on the approach that suggests that a cluster of life events that represent or require a significant life-style readjustment may play a causal role in illness onset. Specifically, it is thought that such occurrences evoke increased secretions of neurohormonal substances that can adversely affect the functioning of the immune and cardiovascular systems. Consequently, it has been proposed that changes in a person's

normal routine can increase the risk of a variety of physical disorders, including heart attacks, strokes, allergies, cancer and infections. In support of the life events approach, a substantial body of research suggests that a cluster of major life changes may increase a person's susceptibility to a wide range of diseases, including upper respiratory tract infections.

Hypothesis 2: In distance runners, approach coping, defined here as the tendency to focus attention on the sources of stress, is negatively related to susceptibility to the common cold.

Hypothesis 3: Avoidance coping, defined here as the tendency to focus attention away from stressors, is positively associated with the risk of colds in distance runners.

The above hypotheses may be viewed within the theoretical framework of cognitive stress theory, which defines stress as a particular relationship between the person and the environment. According to this approach, the effects of psychosocial demands on physical health status depend on how an individual interprets and copes with potentially stressful events. It has been proposed that coping processes can influence the risk of physical illness through various pathways. For example, coping strategies can modulate neurochemical stress reactions and the functioning of the immune system, thereby affecting the body's resistance to infections and other diseases. The hypothesis that avoidance coping is related to an increased susceptibility to the common cold was based

on theoretical approaches, like the opioid peptide hypothesis of repression, that maintain that avoiding problems may be maladaptive. Several empirical findings support this viewpoint. In contrast, there is evidence that approach coping strategies may reduce the risk of health problems in the general population.

Hypothesis 4: The personality style of hardiness is negatively related to susceptibility to the common cold in distance runners.

This hypothesis was based on the proposition that the personality style of hardiness, which is composed of the three interrelated attributes of commitment, challenge and control, may enhance resistance to physical illness. The purported role of hardiness in somatic health may be understood in the context of cognitive stress theory. In this regard, it has been postulated that hardiness promotes physical well-being by encouraging positive appraisals of potentially stressful situations, and by facilitating adaptive coping strategies. This suggests that a high degree of hardiness may be related to lower levels of psychological stress and an enhanced physical health status. In support of the purported health-related benefits of hardiness, a number of researchers have found an inverse correlation between hardiness and the risk of physical illness in various populations.

Hypothesis 5: Training workload is positively related to susceptibility to the common cold in distance runners.

Hypothesis 6: Competition frequency is positively related to susceptibility to the common cold in distance runners.

The above hypotheses were based on the proposition that aerobic exercise of moderate intensity and duration induces the release of neurohormonal substances that enhance immune function. Conversely, it has been maintained that bouts of intense and / or prolonged physical exertion elicit increased secretions of substances that suppress the immune system. Therefore, athletes who train heavily and compete frequently may be more susceptible to infections than individuals who exercise moderately. In support of the proposed benefits of moderate aerobic training, various epidemiological and experimental studies have found a significantly reduced risk of upper respiratory illness in moderate exercisers versus sedentary individuals. In contrast, several researchers have noted an increased risk of infection in athletes during heavy training periods and following participation in long-distance races.

THE RESEARCH DESIGN

The present research may be described as an epidemiological study which utilized an ex post facto, cross-sectional survey design. This type of approach was selected as it was considered to provide a simple, cost-effective, yet valid means of addressing the specific research questions.

To reiterate, epidemiology is a branch of science that deals with the study of determinants of disease, while ex post facto implies that observations followed the fact. This means

that the independent variables were pre-existing, or had already been administered, and were not manipulated by the researcher. Ex post facto designs are usually used in non-experimental, correlational studies in which the goal is to determine relationships between variables. A survey design denotes the fact that the data was collected using questionnaires, which in the present study were self-administered by the participants. Being a cross-sectional survey, subjects were assessed on all variables on one occasion only.

Written, self-administered questionnaires are considered to have several advantages over telephone surveys or face-to-face interviews. For instance, written responses can avoid the potential problem of interview bias which occurs when the interviewer unintentionally influences the subject's responses (Schweigert, 1994). Furthermore, written surveys can be completed at the subject's convenience and are perceived to be more anonymous than oral surveys or personal interviews (Schweigert, 1994). They are also cost-effective and can be distributed to large groups of people at once.

SAMPLING AND PROCEDURES

A convenience sample composed of 124 subjects (86 males and 38 females), ranging in age from 19 to 65 years old, participated in the present study. A convenience sample has been defined as, "a nonrandom sample that is chosen for practical reasons" (McBurney, 1998, p. 160). The research participants had all reportedly undertaken at least two aerobic training sessions per week during the preceding six months and / or had participated in at

least one distance running event of five kilometers or longer during the same period.

Most of the subjects belonged to running clubs in the Johannesburg and Pretoria areas.

Potential participants were approached by the researcher at various locations where they were advised about the study and handed a questionnaire to complete and later return. A covering letter informing subjects of the nature and purpose of the study was included.

Recipients' names and contact details were noted for possible follow-up purposes.

Several members of this group also offered or agreed to distribute questionnaires to fellow runners on the researcher's behalf. A copy of the full questionnaire is included as Appendix 1.

Response Rate

Of the 235 questionnaires distributed, 124 were returned, yielding a response rate of 52,8%. It was determined that male and female recipients responded at a similar rate, with 53,1% of 162 males and 52% of 73 females returning completed questionnaires.

When compared to other studies of this kind involving runners, the response rate can be considered satisfactory. For example, Nieman et al. (1990) reported that 46,9% of questionnaires mailed to finishers of the Los Angeles Marathon were returned. Another similar study in which surveys were posted to road race participants in the United States yielded a response rate of 58%, which was slightly higher than that obtained in the present study.

Several factors, such as the nature of the research and the subjects, as well as the survey design, are said to influence survey response rates (Fife-Schaw, 1998). For example, females are believed to be more cooperative than males, and younger people more helpful than older people. Furthermore, interview-based studies may improve response rates by 10% to 15% compared with questionnaire designs (Fife-Schaw, 1998). However, interview studies may prove costly and time-consuming. In addition, questionnaires that take hours to complete may meet with less success than those that take less than 20 minutes to fill in. In view of this, the questionnaire in the present study was kept as short as possible.

Ethical Considerations

In terms of the ethical requirements of psychological research, an effort was made to ensure that all study participants were informed in advance of the nature, objectives and proposed benefits of the research. Moreover, respondents were advised that all information would remain confidential and anonymous. In planning the study, the welfare of subjects was also considered. However, it was not envisaged that any person would be harmed, either physically or psychologically, as a result of his or her participation in the research. Finally, participants were given the option of receiving additional information about the study and could also request a copy of the research findings.

MEASURING INSTRUMENTS

Life Events

The Social Readjustment Rating Scale (SRRS), developed by Holmes and Rahe (1967), was used to assess the construct of life events. The SRRS has been described as the most frequently-used measuring instrument in stress research (Scully et al., 2000). The scale has the advantages of being easy to understand, administer and score. In a study designed to assess various content-related criticisms of the measure, it was concluded that “the SRRS is a robust instrument for identifying the occurrence of stress-related outcomes” (Scully et al., 2000, p. 875).

The SRRS consists of a list of 43 common life events empirically derived from clinical experience. Each event is said to either represent or require a significant change in the individual’s normal routine. An advantage of the scale is that it assesses not only the number and type of major life changes experienced during a previous period, but also their magnitude (Holmes & Rahe, 1967).

Specifically, the SRRS incorporates both desirable and undesirable events relating to the areas of family, marriage, occupation, economics, residence, social relationships, education, religion, recreation and health (Homes & Rahe, 1967). Items may be further differentiated on the basis of whether they pertain to a person’s life-style or to specific occurrences involving the individual. Included in the former group are events such as changes in eating and sleeping habits and in church and social activities. The second

category includes various major life changes, such as the death of a spouse, marriage and losing one's job. It also includes relatively more minor events, such as a vacation and minor violations of the law.

Each event in the SRRS has been assigned a consensually-defined weight, or life change unit score. This score reflects the average intensity and duration of readjustment required. For example, "death of a spouse" has been assigned a value of 100, while "change in sleeping habits" has been assigned a value of 16. Individuals completing the scale are typically asked to indicate which events they have experienced during a specific time period. A total stress score is then obtained by adding together the values for individual items. Any score of over 150 in any given year is described as a life crisis (Jones & Kinman, 2001). Further, a score of 150-199 is considered a mild crisis, while a score of 200-299 constitutes a moderate crisis, and a score of over 300 is termed a major crisis.

In developing the scale, the authors asked 394 subjects to rate 43 events listed in the Social Readjustment Rating Questionnaire according to the degree of social readjustment each occurrence required. For this purpose, "marriage" was given the arbitrary value of 500 and respondents had to assign values to other events on the basis of whether they required more or less adjustment than marriage. Holmes and Rahe (1967) reported that there was high consensus between different age, gender, generation, race, educational, social class and marital groups with regard to readjustment ratings and the rank order of events.

For the purposes of the present study, a few minor modifications were made to the existing scale. This included omitting outdated items such as, “mortgage over \$10 000” and, “mortgage or loan less than \$10 000”, as well as the item, “Christmas”, which is more of a general event. The wording of various items was also altered in order to enhance their clarity or relevance. For example, the term, “life partner”, was added to the word, “spouse”, as in “the death of a spouse / life partner”. Similarly, the item, “wife beginning or ceasing work outside the home”, was changed to, “your spouse / life partner starting or stopping work”. In addition, the event, “fired at work”, was altered to, “the loss of your job (e.g. through dismissal or retrenchment)”. Finally, the words, “college” and “university”, were added to the term, “school”, while the word, “oldster”, was changed to, “a relative”.

The above modifications to the SRRS resulted in a scale consisting of 40 items. In completing the scale, respondents were asked to indicate, by means of a tick, which events they had experienced in the preceding 12 months, and in which particular six-month period the event had occurred. This approach yielded three life change scores for each subject. These included a score for each six-month period, as well as a total life event score reflecting the sum of these values.

Coping

Coping strategies were measured using the dispositional version of Carver et al.’s (1989) Coping Orientations to Problems Experienced (COPE). COPE is a multidimensional coping inventory that incorporates 14 conceptually distinct scales which measure a

number of theoretically important coping domains. These are active coping, planning, suppression of competing activities, restraint coping, seeking of instrumental social support, positive reinterpretation, acceptance, denial, turning to religion, seeking of emotional social support, focus on and venting of emotions, alcohol use, behavioural disengagement and mental disengagement. A humour scale has also recently been added.

The COPE scales have been found to have good reliability. For example, Cronbach's alpha reliability coefficients above 0,60 have been reported for all the scales except mental disengagement, which consists of diverse acts (Carver et al., 1989). Furthermore, test-retest correlations ranging from 0,42 to 0,89 have been found, suggesting that the test scores are relatively consistent across time (Carver et al., 1989).

Conceptually meaningful although weak correlations have been reported between the different scales. These correlations suggest that two groups of coping strategies may be distinguished (Carver et al., 1989). One cluster consists of theoretically adaptive strategies, while the other category is made up of strategies that are proposed to be less functional. Included in the former group are active coping, planning, suppression of competing activities, restraint coping, positive reinterpretation and growth, seeking of social support, and acceptance. The second cluster is composed of denial, behavioural and mental disengagement, the focus on and venting of emotions, and alcohol use.

A second order factor analysis, which excluded the alcohol item, produced four factors, each incorporating three scales (Carver et al., 1989). One factor included active coping,

planning and suppression of competing activities, while another consisted of the social support scales and focus on emotion. A third factor incorporated denial and both mental and behavioural disengagement, while a fourth factor was made up of acceptance, restraint, and positive reinterpretation and growth.

Research suggests that the COPE scales have both convergent and discriminant validity (Carver et al., 1989). For instance, the authors found significant positive correlations between theoretically functional strategies such as active coping and planning, and beneficial personality traits like optimism, self-esteem, hardiness and control. In contrast, negative correlations were found between several of the above dispositions and theoretically less useful strategies, such as denial and disengagement. Evidence for the discriminant validity of the COPE scales included the finding that correlations between coping and personality variables were not overly strong, suggesting that these factors are not identical.

For the purposes of the present study, 10 of the COPE scales were used to assess the construct of coping. Each scale, in turn, consists of four items which are rated on a four point scale. The five conceptually related scales of active coping, planning, suppression of competing activities, restraint, and positive reinterpretation and growth, were combined to provide a composite index of approach coping. An overall estimate of avoidance coping was obtained by combining the five conceptually-related scales of behavioural disengagement, mental disengagement, denial, focus on and venting of emotions, and substance use.

The active coping scale measures cognitive and behavioural efforts to solve a problem or reduce its effects (e.g. “I take direct action to get around the problem”). Planning assesses attempts to decide how best to deal with a stressor (e.g. “I think hard about what steps to take”). The suppression of competing activities scale measures efforts to avoid other distractions in order to concentrate on the problem (e.g. “I put aside other activities in order to concentrate on this”). Restraint measures another problem-focused strategy, namely attempts to ensure that one acts at the right time and not prematurely (e.g. “I make sure not to make matters worse by acting too soon”). The positive reinterpretation and growth scale assesses cognitive attempts to reappraise the event in a more positive light, which should lead to continued problem-focused efforts (e.g. “I look for something good in what is happening”).

Of the avoidance coping scales, denial measures efforts to refute the reality or existence of a stressor (e.g. “I refuse to believe that it has happened”). The focus on and venting of emotions scale measures the tendency to concentrate on and express negative feelings (e.g. “I get upset and let my emotions out”). Behavioural disengagement measures attempts to reduce one’s efforts to cope with a stressor (e.g. “I just give up trying to reach my goal”). Meanwhile, the related mental disengagement scale assesses behavioural attempts to avoid thinking about a problem (e.g. “I sleep more than usual”). Finally, the alcohol-drug disengagement scale measures the tendency to use alcohol or drugs to avoid thinking about a stressor or to reduce emotional distress (e.g. “I use alcohol or drugs to help me get through it”).

Subjects in the present study were asked to indicate what they usually do and feel when they experience stressful events in their lives by circling one number next to each item. For example, 1 = “I usually don’t do this at all”, while 4 = “I usually do this a lot”. These values were then tallied to provide a score for each scale, ranging from 4 to 16. The scores for conceptually related scales were then added together to provide an aggregate score for approach and avoidance coping tendencies, respectively. Possible values for these measures ranged from a minimum of 20 to a maximum of 80.

Internal consistency reliability values were computed for the composite approach and avoidance coping measures utilized in the present study. Internal consistency reliability refers to the degree to which the individual items in a test are correlated (Rosnow & Rosenthal, 1996). Using the Spearman-Brown formula, overall consistency reliability values of 0,75 and 0,67 were obtained for the approach and avoidance coping measures, respectively.

Hardiness

Bartone, Ursano, Wright and Ingraham’s (1989) 30-item Dispositional Resilience Scale was used to assess the construct of hardiness. The scale is a slightly revised version of a measure originally constructed for use with blue collar workers. The modified measure is considered to be an improvement on the earlier version in that it avoids the use of long, awkward wordings, as well as the exclusive use of negative item indicators (Bartone et al., 1989).

The Dispositional Resilience Scale assesses the three components of hardiness, namely challenge, control and commitment, and also provides a composite index of hardiness. For example, a statement such as, “changes in routine are interesting to me”, measures the variable of challenge, while the statement, “when I make plans, I’m certain I can make them work”, assesses the control dimension. The component of commitment is expressed in the statement, “by working hard you always achieve your goals”. The reliability of the subscales is demonstrated by internal consistency coefficients ranging from 0,62 to 0,82 (Bartone et al., 1989). Cronbach’s alpha of 0,82 has been reported for the overall measure.

In completing the inventory, subjects were asked to indicate how they felt about certain statements about life. Specifically, they were requested to circle a number to show how much they believed each statement was true in general. For example, 0 = “not at all true”, while 3 = “completely true”. Half the items were negatively scored, while the balance was positively scored. The scores for each item were then tallied to provide an overall hardiness index for each subject, with possible scores ranging from 0 to 90.

Training Workload

In order to obtain an estimate of training workload, subjects were asked to describe a “typical training week” in the last six months using a table which had been constructed for this purpose. The type of information elicited included the average number of times run per week, the average duration of each training session (in minutes), and the typical perceived intensity of each workout. In terms of intensity ratings, subjects were able to

choose from the options, “fairly light”, “somewhat hard”, “hard” or “very hard”. Each option was assigned a value ranging from two to five, respectively. Subtotals were then calculated by multiplying the average duration of each workout by a value corresponding to the average intensity thereof. These subtotals were then added together to provide a composite index of recent training workload for each subject. Information provided in the table was also used to obtain separate scores for training duration (the sum of the average duration of each session) and training frequency (the average number of workouts per week).

The above measure of training workload was based on the work of Edwards and Burke (cited in Noakes, 2001), who proposed that training workload can accurately be quantified by means of the following formula: $\text{Workload (points)} = \text{duration (of exercise)} \times \text{training zone (category of exercise intensity)}$. In this regard, the authors identified five different training zones, which they called the healthy heart, temperate, aerobic, threshold and red line zones, respectively. The actual and perceived level of effort associated with each of these training zones, as well as an example of the type of activity related to each category of intensity, is shown in Table 5.1.

The advantages of such an approach is that it takes into account both the duration and intensity of exercise when determining training workload. A number of previous studies investigating the effects of aerobic exercise on infection have tended to assess only the customary volume of training. However, it has been proposed that the intensity and

duration of exercise may also be important factors in infectious disease susceptibility (Nieman, 1994).

TABLE 5.1: AEROBIC EXERCISE TRAINING ZONES

Training Zone	% of Maximum Heart Rate	Subjective Rating	Example of Activity
1 - Healthy Heart	50-60%	Very light	Walking
2 - Temperate	60-70%	Fairly light	Jogging (slow running)
3 - Aerobic	70-80%	Somewhat hard	Running
4 - Threshold	80-90%	Hard	Fast running
5 - Red Line	90-100%	Very hard	Very fast running

Each of the above training zones has been associated with certain benefits. For example, exercising in zone one can improve overall physical health, while the following four zones can stimulate physiological adaptations that improve exercise performance (Noakes, 2001). Specifically, training in zones three, four and five can promote major physiological adaptations in the heart, skeletal muscles and metabolism.

Competition Frequency

In addition to providing data on recent training habits, subjects were asked to indicate how many running events of varying distances they had participated in during the preceding six months. This data yielded three sets of scores for each subject on the competition frequency measure. One score reflected the total number of races the respondent had participated in during the previous six months. The second score

indicated how many of these races were shorter than the standard marathon distance (42,2 kilometres), while the third score reflected how many of these events were of 42,2 kilometres and longer.

Susceptibility to the Common Cold

Susceptibility to the common cold was measured using a self-report checklist approach. Despite having certain limitations, self-report measures of illness are generally considered to be valid indicators of physical health status (Nowack, 1991). Subjects were asked to provide details of the frequency, duration and severity of five cardinal symptoms of the common cold experienced in the previous six months. The specific symptoms assessed were runny nose, blocked or stuffy nose, sore or scratchy throat, sneezing and coughing. Information was also elicited on the number of days that subjects had taken off from training during this period due to infectious symptoms. Using this approach, separate scores were obtained for the measures of: (a) symptom frequency; (b) symptom duration; (c) symptom severity; and (d) symptom-related training days off.

Symptom Frequency

Symptom frequency concerned the average number of times a common cold symptom occurred during the preceding six-month period. A score was obtained for this measure by summing the total number of symptom occurrences (for all symptoms) and dividing this figure by the number of different symptoms reported. For example, if a subject reported experiencing three cases of a sore throat and five episodes of coughing, then the

score for symptom frequency would be four (i.e. $8/2 = 4$). This would mean that reported symptoms occurred four times on average during the period of review. A score of 0 indicated that no symptoms were reported.

Symptom Duration

Symptom duration related to the average number of days symptoms lasted. In order to obtain a score for this measure, the reported average duration of each symptom was multiplied by the number of times each occurred. These values were then added together and divided by the total number of symptom occurrences. For example, if a subject reported experiencing four cases of a sore throat, lasting an average of two days each, and four episodes of coughing, lasting an average of four days each, then the score for symptom duration would be three (i.e. $[(4 \times 2) + (4 \times 4)] / 8 = 3$). This would mean that reported symptoms lasted for three days on average. A score of 0 indicated that no symptoms were reported.

Symptom Severity

Symptom severity concerned the subjective rating of symptoms as mild, moderate, or severe. A score was obtained for this measure by multiplying the reported average severity of each symptom (1 = mild, 2 = moderate, 3 = severe) by the number of times each symptom occurred. These values were then added together and divided by the total number of symptom occurrences. For example, if a subject reported experiencing three mild cases of a sore throat, and two severe cases of a runny nose, then he or she would

receive a score of 1,8 (i.e. $[(3 \times 1) + (2 \times 3)] / 5 = 1,8$). This would mean that reported symptom occurrences were on average mild to moderate in severity. A score of 0 indicated that no symptoms were reported.

Symptom-Related Training Days Off

This measure related to the number of days that subjects had reportedly taken off from training in the previous six months due to the occurrence of symptoms of the common cold. This measure was included for its potential to provide an overall estimate of the frequency, duration and severity of common cold symptoms.

Demographic and Additional Information

The questionnaire was also used to collect information on a number of other variables of interest, namely gender, age, ethnic group, language group, marital status, employment status, weight, height, sleep habits, running history, running motives and personal best (PB) race times. In addition, subjects were requested to indicate whether they kept a log book, participated in any other endurance activities, or suffered from any allergic conditions, such as hay fever.

CHAPTER 6

RESULTS

SUBJECT CHARACTERISTICS

A total of 124 subjects, comprising 86 males (69,3%) and 38 females (30,6%), participated in the present study. The mean age of the research sample was 41,7 with a standard deviation (SD) of 10,36. The oldest participant was 65 years of age, while the youngest was 19 years old. The sample was found to be fairly heterogeneous in terms of language group. Specifically, there were 86 English-speakers (69,9%), 23 Afrikaans speakers, (18,7%), six Zulu speakers (4,9%), four Tswana speakers (3,2%), three North Sotho speakers (2,4%), and one Xhosa-speaking person (0,8%).

In connection with marital status, it was revealed that 77 subjects (62,1%) were married, 31 (25%) had never been married, and 16 individuals (12,9%) were either divorced or separated. It was also found that the majority of participants were employed. Of the total sample, 100 respondents (80,6%) were employed on a full-time basis, 11 (8,9%) worked part-time, four (3,2%) were homemakers, four (3,2%) were retired, and three (2,4%) were either students or scholars. Only two subjects (1,6%) reported being unemployed.

With regard to the respondents' physical characteristics, subjects were on average 1,73 metres in height and weighed an average of 68,66 kilograms. The group's average Body Mass Index (BMI) was 22,63. BMI is a clinical indicator of obesity and is calculated

using the formula of $\text{weight} \div (\text{height})^2$, with weight expressed in kilograms and height expressed in metres. Descriptive statistics for height, weight and BMI, along with chronological age and various running-related variables are shown in Table 6.1.

TABLE 6.1: COUNTS (N), MEANS, STANDARD ERRORS (SE), STANDARD DEVIATIONS (SD), MEDIANS (MED), AND MINIMUM (MIN) AND MAXIMUM (MAX) VALUES FOR THE VARIABLES OF AGE, WEIGHT, HEIGHT, BMI, NUMBER OF YEARS' RUNNING, AND 10KM, 21,1KM AND 42,2KM PERSONAL BEST (PB) RACE TIMES

Variable	N	Mean	SE	SD	Med	Min	Max
Age	122	41,70	0,94	10,36	42,00	19,00	65,00
Weight (in kgs)	121	68,66	1,09	11,00	67,00	46,00	96,00
Height (in metres)	112	1,73	0,00	0,10	1,75	1,40	1,94
BMI	112	22,63	0,27	2,81	22,95	16,30	32,65
No. of Years' Running	122	12,65	0,81	8,90	11,00	1,00	42,00
10km PB (in minutes)	118	43,78	0,73	7,95	43,50	30,00	66,00
21km PB (in minutes)	115	99,20	2,23	23,90	96,00	68,00	228,00
42km PB (in minutes)	97	213,16	3,98	39,16	216,00	142,00	312,00

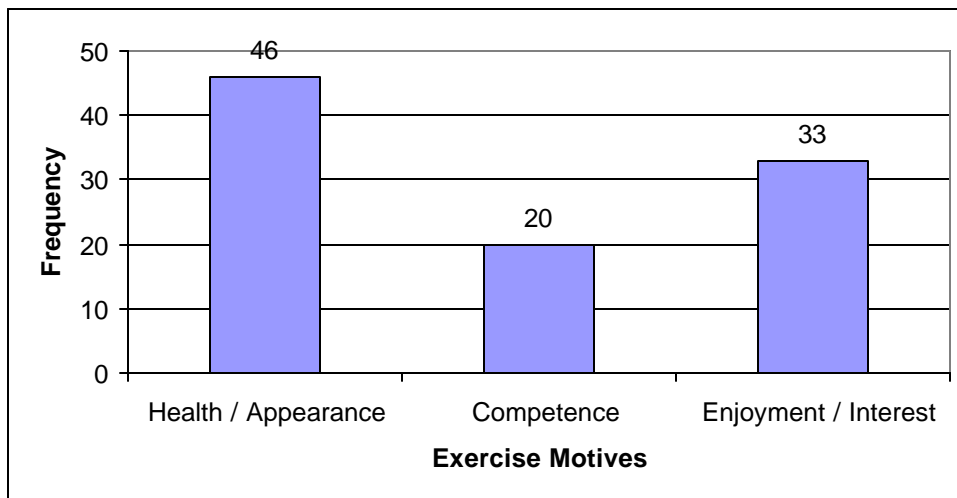
As shown, the group mean for the number of years spent participating in the sport was 12,65 (SD = 8,90), indicating that most of the subjects were experienced athletes.

Furthermore, average personal best race times for the sample were as follows:

10 kilometres – 43:47; 21,1 kilometres – 1:39:12; and 42,2 kilometres – 3:33:10. A total of 71 participants (57,2%) indicated having taken part in the 90-kilometre Comrades Marathon, reporting an average best time of nine hours for the race.

Apart from providing information about previous running experience and performance, respondents were asked to indicate their reasons for participating in the sport. In this regard, subjects were provided with three possible motives for running and asked to rank these in order of personal importance. The results of this enquiry are shown in Figure 6.1.

FIGURE 6.1: FREQUENCY DISTRIBUTION OF EXERCISE MOTIVES IN THE PRESENT SAMPLE



As demonstrated, it was found that the majority of respondents participated in the sport mainly for health and appearance reasons. Specifically, 46 subjects (46%) ranked this factor, as illustrated by the statement, “I want to control my weight and reduce stress,” as

the primary motive for running. A total of 33 respondents (33%) marked enjoyment and interest motives, as reflected in the statement, “I enjoy the activity of running”, as the most important reason for participation. Only 20 individuals (20%) indicated that they were driven mainly by competence concerns, as illustrated by the statement, “I like the challenge and competition”.

The majority of subjects reported keeping a detailed record of their exercise behaviour. Specifically, 72 respondents (58,5%) indicated keeping a log book, compared with 51 subjects (41,5%) who reported not doing so. Log books may be used to record an array of running-related information, including the distance, duration, intensity and type of run. Other relevant data, such as training route and partners, weather conditions, sleep, body weight, and current illness and injury, may also be noted.

Enquiries regarding participation in other forms of endurance exercise revealed that 34 subjects (27,6%) regularly took part in other endurance activities, such as cycling, swimming and rowing. For the entire sample, the average amount of time spent participating in other endurance sports was 1,2 hours per week.

In terms of sleep habits, 76 respondents (62,3%) reported sleeping for an average of seven to eight hours per night, while 42 subjects (34,4%) typically slept for an average of five to six hours per night. Only three runners (2,5%) reported sleeping for nine hours or more, while just one person (0,8%) slept for four hours or less.

Finally, in response to the question, “Do you suffer from any allergic conditions affecting the upper respiratory tract, e.g. hay fever?”, 40 subjects (32,5%) indicated “yes”, while 74 individuals (60,2%) ticked “no”. A further nine respondents (7,3%) indicated not knowing if they had an allergic condition.

SUSCEPTIBILITY TO THE COMMON COLD

In an attempt to include only those reported symptoms that were likely to have had an infectious origin, symptom occurrences that may have had an allergic cause, or were confirmed by subjects as such, were regarded as non-events. Specifically, the following symptoms were considered to be non-infectious in this study:

- All nasal symptoms that were reported by subjects with a history of allergic rhinitis (unless these symptoms were otherwise verified by the person as being of an infectious origin)
- All nasal symptoms that were reported by subjects who were unsure about their allergy status
- Any symptoms that were reportedly experienced on a very frequent or chronic basis e.g. 16 or more times in the past few months, or “every morning”, “daily”, or “all the time”
- Any symptoms that were reportedly experienced for short periods of time only, e.g. for less than an hour, or only at a certain time of the day, such as at night or after exercise

Subsequently, 81 subjects (65,3%) were found to have experienced symptoms of the common cold, such as a runny nose, blocked nose, sore throat, sneezing and coughing, in the preceding six months. The most common symptom was a sore throat, which was reported by 58 subjects (46,8%). A total of 44 respondents (35,5%) reportedly experienced nasal symptoms, while 35 participants (28,2%) had episodes of coughing. Summary statistics for the measures of symptom frequency, symptom duration, symptom severity and symptom-related training days off are presented in Table 6.2.

TABLE 6.2: COUNTS (N), MEANS, STANDARD ERRORS (SE), STANDARD DEVIATIONS (SD), MEDIANS (MED), AND MINIMUM (MIN) AND MAXIMUM (MAX) VALUES FOR THE SUSCEPTIBILITY TO INFECTION MEASURES

Measure	N	Mean	SE	SD	Med	Min	Max
Symptom Frequency	120	1,17	0,11	1,24	1,0	0	6
Symptom Duration	78	6,99	1,15	10,17	5,0	1	80
Symptom Severity	80	1,74	0,08	0,70	2,0	1	3
Training Days Off	120	6,33	0,85	9,33	2,5	0	60

As illustrated above, descriptive statistical analyses revealed that the mean frequency of symptoms for the entire sample was 1,17 with a standard deviation of 1,24. In addition, subjects reported having taken off an average of 6,33 days from training (SD = 9,33) in the preceding six months as a result of symptomatic episodes. Among symptomatic subjects, the mean duration of symptoms was 6,99 days (SD = 10,17), while the average severity of symptoms, as measured on a three-point scale, was 1,74 (SD = 0,70).

Additional analyses showed that coughs and nasal symptoms lasted for an average of

7,71 days (SD = 6,78) and 7,69 days (SD = 14,68), respectively. The mean duration of sore throats was slightly shorter at 5,73 days (SD = 9,20).

Correlational statistical techniques revealed a significant inverse association between age and the frequency of self-reported symptoms of the common cold ($r = -0,27$; $n = 119$; $p = 0,00$ two-tail). This finding provides support for the hypothesis that people experience fewer episodes of infection as they grow older (Gwaltney, 1979).

The Pearson product-moment correlation was used to analyse the relationships among the various susceptibility measures. These correlations are shown in Table 6.3. Specifically, it was found that symptom frequency was significantly related to both symptom duration ($r = 0,26$; $n = 119$; $p = 0,001$ two-tail) and symptom severity ($r = 0,62$; $n = 120$; $p = 0,001$ two-tail). Symptom duration and symptom severity scores were also significantly correlated ($r = 0,47$; $n = 121$; $p = 0,001$ two-tail). However, it is probable that the inclusion in the analyses of subjects not reporting any symptoms accounted for the observed correlations among the above factors. As expected, the measure of symptom related training days off was found to be positively related to symptom frequency ($r = 0,36$; $n = 116$; $p = 0,001$ two-tail), symptom duration ($r = 0,65$; $n = 117$; $p = 0,001$ two-tail), and symptom severity ($r = 0,56$; $n = 119$; $p = 0,001$ two-tail).

TABLE 6.3: CORRELATION COEFFICIENTS FOR RELATIONSHIPS AMONG THE SUSCEPTIBILITY TO INFECTION MEASURES

Measure	Frequency	Duration	Severity	Days Off
Symptom Frequency	1,00	0,26**	0,62**	0,36**
Symptom Duration		1,00	0,47**	0,65**
Symptom Severity			1,00	0,56**
Training Days Off				1,00

Significance: * $p < 0,05$ two-tail ** $p < 0,01$ two-tail

LIFE EVENTS

Descriptive statistics for the different life events measures are displayed in Table 6.4. As shown, the research sample obtained a mean total life change score of 155,25 (SD = 116,80) on the slightly revised version of the Social Readjustment Rating Scale.

Researchers have stated that any score above 150 during a 12-month period on the complete 43-item inventory constitutes a life crisis (Jones & Kinman, 2001). A total of 55 subjects (44,3%) obtained a score that exceeded this threshold. The lowest recorded score was zero, suggesting that no life changes were experienced during the period in question. At the other end of the spectrum, the highest recorded score was 706, which falls into the category of a major life crisis.

A comparison of the mean life event scores for the different time periods revealed that subjects reported having experienced a greater magnitude of life changes in the latter half

of the preceding 12 months. Specifically, the sample's mean score for the first six-month stage ("time-1") was 69,46 (SD = 73,40), compared with a mean score of 88,21 (SD = 78,78) for the second six-month period ("time-2"). A possible explanation for this finding is that it was easier to remember more recent life changes than to recall earlier events.

TABLE 6.4: COUNTS (N), MEANS, STANDARD ERRORS (SE), STANDARD DEVIATIONS (SD), MEDIANS (MED), AND MINIMUM (MIN) AND MAXIMUM (MAX) VALUES FOR THE LIFE EVENTS MEASURES

Measure	N	Mean	SE	SD	Med	Min	Max
Life Events: Time-1	124	69,46	6,59	73,40	53	0	452
Life Events: Time-2	124	88,21	7,07	78,78	76	0	364
Life Events: Total	124	155,25	10,49	116,80	126	0	706

The Relationship between Life Events and Susceptibility to the Common Cold

Pearson product-moment correlation coefficients were calculated to assess the relationship between life events and susceptibility to the common cold. In support of the research hypothesis, significant positive correlations were found between recent life changes and several of the vulnerability indicators. These relationships are displayed in Table 6.9 on page 125. Specifically, it was observed that life events occurring in the preceding 12-month period were significantly related to both symptom frequency ($r = 0,21$; $n = 120$; $p = 0,02$ two-tail), and symptom severity ($r = 0,24$; $n = 123$; $p = 0,01$ two-tail). There was also a significant positive correlation between total life change

scores and the measure of symptom-related training days off ($r = 0,19$; $n = 120$; $p = 0,04$ two-tail). However, life events were not significantly related to symptom duration scores ($r = 0,13$; $n = 121$; $p = 0,14$ two-tail).

Significant positive correlations were also found between “time-2” life event values and symptom frequency ($r = 0,26$; $n = 20$; $p = 0,001$ two-tail), and between “time-2” life events and symptom severity ($r = 0,25$; $n = 123$; $p = 0,001$ two-tail). However, life changes occurring during this period were not significantly related to the symptom duration measure ($r = 0,09$; $n = 121$; $p = 0,31$ two-tail), or to the number of days taken off from training due to symptomatic episodes ($r = 0,15$; $n = 120$; $p = 0,10$ two-tail). In addition, no significant correlations were found between “time-1” life event scores and symptom frequency ($r = 0,06$; $n = 120$; $p = 0,54$ two-tail), or between “time-1” life events and symptom severity ($r = 0,13$; $n = 123$; $p = 0,13$ two-tail). Similarly, “time-1” life event values were not significantly related to symptom duration scores ($r = 0,11$; $n = 121$; $p = 0,21$ two-tail), or to the symptom-related training days off measure ($r = 0,17$; $n = 120$; $p = 0,07$ two-tail).

In order to illustrate the observed significant correlations between life events and susceptibility to infection, subjects were divided into “high stress” and “low stress” groups on the basis of a median split of their life change scores for the preceding 12 month period (median = 126). Each group’s mean score for the specific infection measure was then calculated and plotted on a graph. The outcome of this exercise is shown in Figures 6.2 to 6.4.

FIGURE 6.2: MEAN SYMPTOM FREQUENCY VALUES FOR SUBJECTS WITH HIGH VERSUS LOW LIFE EVENT STRESS

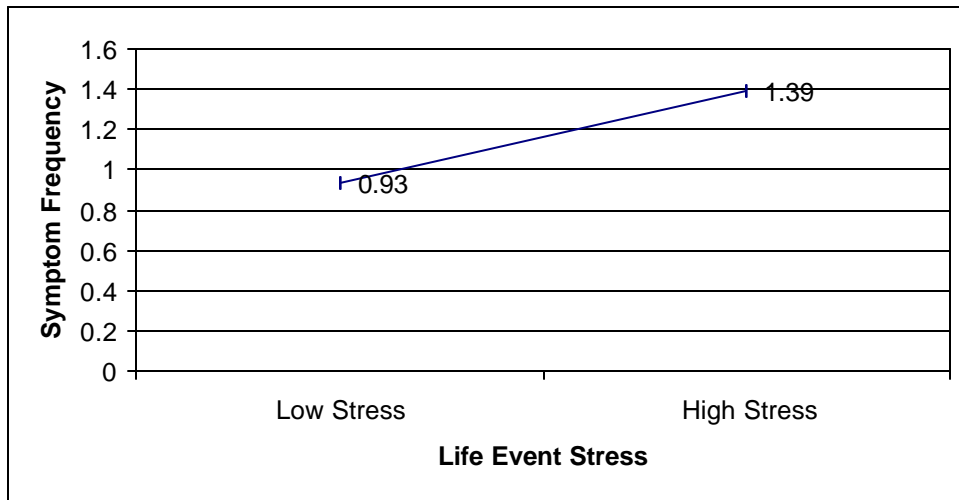


FIGURE 6.3: MEAN SYMPTOM SEVERITY VALUES FOR SUBJECTS WITH HIGH VERSUS LOW LIFE EVENT STRESS

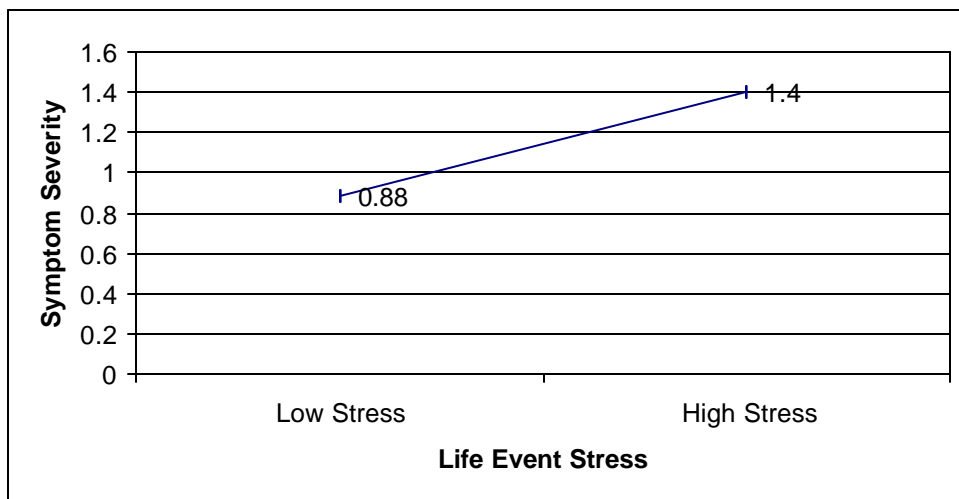
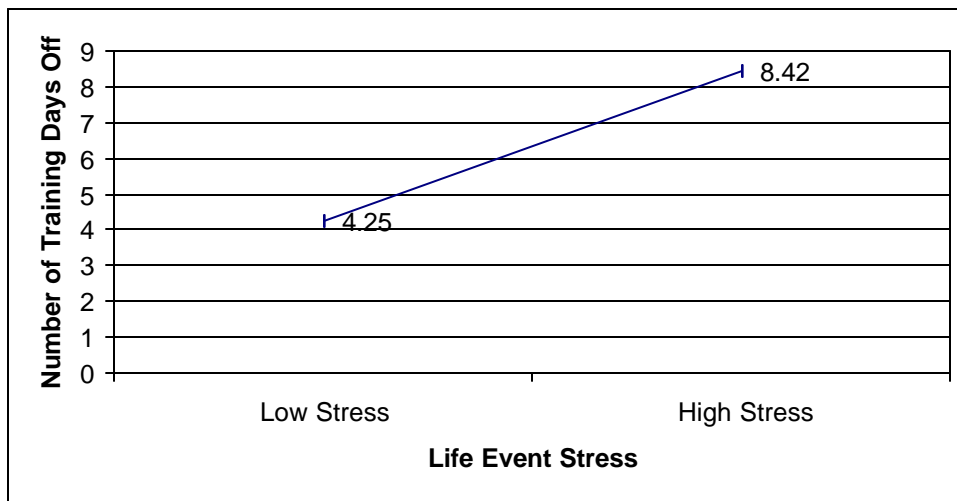


FIGURE 6.4: THE MEAN NUMBER OF DAYS TAKEN OFF FROM TRAINING DUE TO SYMPTOM OCCURRENCES FOR SUBJECTS WITH HIGH VERSUS LOW LIFE EVENT STRESS



In Figure 6.2 it can be seen that the high stress group obtained a mean score of 1,39 for symptom frequency, whereas the low stress group obtained a score of 0,93 for this measure. Similarly, Figure 6.3 indicates that the high stress group obtained a mean score of 1,4 for symptom severity (as measured on a three-point scale), whereas the low stress group's score for this measure was 0,88. Finally, Figure 6.4 illustrates that the high stress group took off an average of 8,42 days from training due to respiratory symptoms in the preceding six months, whereas the low stress group missed only 4,25 days of training due to illness during this period.

COPING

A total of 22 subjects failed to complete the coping inventory in full. In most cases, only one item of the 40-item measure was left unanswered. In order to be able to include these questionnaires in the final analyses, the sample average was assigned to each of the missing items. However, if a large percentage of the questionnaire was not completed, then it was excluded from the analyses. Descriptive statistics for the various coping measures are shown in Table 6.5.

TABLE 6.5: COUNTS (N), MEANS, STANDARD ERRORS (SE), STANDARD DEVIATIONS (SD), MEDIANS (MED), AND MINIMUM (MIN) AND MAXIMUM (MAX) VALUES FOR THE COPING MEASURES

Coping Measure	N	Mean	SE	SD	Med	Min	Max
Approach Coping	122	56,20	0,86	8,68	55,5	36	75
Active Coping	122	11,79	0,21	2,37	12	6	16
Planning	122	12,69	0,23	2,60	13	4	16
Suppression of Activities	122	9,61	0,19	2,09	10	4	14
Positive Reinterpretation	122	11,96	0,23	2,55	12	6	16
Restraint	122	10,15	0,23	2,54	10	5	16
Avoidance Coping	121	34,83	0,74	8,18	33	21	68
Behavioural Disengagement	121	6,22	0,18	2,01	6	4	13
Mental Disengagement	121	8,05	0,21	2,35	8	4	16
Focus on Emotions	121	9,46	0,28	3,13	9	4	16
Denial	121	6,04	0,25	2,72	5	4	16
Substance Use	121	5,07	0,21	2,34	4	4	16

As illustrated, a comparison of the group means for the composite approach and avoidance coping measures revealed that the research participants were more likely to confront stressors than to avoid them. In this regard, the mean score for approach coping was 56,20 (SD = 8,68), compared with a mean score of 34,83 (SD = 8,18) for avoidance coping. It also emerged that the most preferred coping strategy was that of planning (mean = 12,69; SD = 2,60), while the strategy of substance use appeared to be the least popular coping response (mean = 5,07; SD = 2,34).

The Pearson product-moment correlation was used to analyse the relationships among the different coping scales. These correlations are shown in Table 6.6. As expected, significant positive correlations were found among those coping scales that are believed to be conceptually related (Carver et al., 1989). For instance, significant positive relationships were observed among the five approach coping strategies of active coping, planning, suppression of competing activities, restraint, and positive reinterpretation and growth. The magnitude of these associations ranged from $r = 0,71$ ($n = 122$; $p = 0,001$ two tail) for the active coping-planning correlation, to $r = 0,19$ ($n = 122$; $p = 0,04$ two-tail) for the relationship between positive reinterpretation and growth on the one hand, and suppression of competing activities on the other.

TABLE 6.6: CORRELATION COEFFICIENTS FOR RELATIONSHIPS AMONG THE
COPING SCALES

	AC	PL	SA	PO	RE	MD	BD	DE	FE	SU
AC	1,00	0,71**	0,35**	0,47**	0,29**	-0,11	-0,35**	-0,06	0,00	-0,19*
PL		1,00	0,50**	0,50**	0,32**	-0,07	-0,34**	-0,11	-0,04	-0,23**
SA			1,00	0,19*	0,18*	0,15	0,00	0,18*	0,14	0,01
PO				1,00	0,31**	0,04	-0,20*	0,07	0,09	-0,23**
RE					1,00	0,02	0,00	0,19*	-0,10	-0,16
MD						1,00	0,49**	0,49**	0,31**	0,09
BD							1,00	0,47**	0,21*	0,31**
DE								1,00	0,11	0,20*
FE									1,00	0,20*
SU										1,00

Key : AC : Active Coping
PL : Planning
SA : Suppression of Competing Activities
PO : Positive Reinterpretation and Growth
RE : Restraint
MD : Mental Disengagement
BD : Behavioural Disengagement
DE : Denial
FE : Focus on and Venting of Emotions
SU : Substance Use

Significance: *p < 0,05 two-tail **p < 0,01 two-tail

As shown, most of the avoidance coping scales were also significantly inter-correlated. For example, high positive correlations were found between mental disengagement and behavioural disengagement ($r = 0,49$; $n = 121$; $p = 0,001$ two-tail), between behavioural disengagement and denial ($r = 0,47$; $n = 121$; $p = 0,001$ two-tail), and between mental disengagement and denial ($r = 0,49$; $n = 0,49$; $p = 0,001$ two-tail). The only avoidance scales that were not significantly related were denial and focus on emotions ($r = 0,11$; $n = 121$; $p = 0,23$ two-tail), and mental disengagement and substance use ($r = 0,09$; $n = 121$; $p = 0,34$ two-tail).

In addition to the above, mostly negative or low correlations were found between the different approach and avoidance coping scales. However, there were also exceptions to this rule. For instance, a significant but moderate positive correlation was found between the avoidance strategy of denial and the approach strategy of suppression of competing activities ($r = 0,18$; $n = 121$; $p = 0,047$ two-tail). Denial was also positively associated with the approach coping strategy of restraint ($r = 0,19$; $n = 121$; $p = 0,03$ two-tail). However, the composite approach and avoidance coping measures adopted in the present study were not significantly correlated ($r = -0,12$; $n = 121$; $p = 0,18$ two-tail).

The Relationship between Coping and Susceptibility to the Common Cold

The Pearson product-moment correlation was used to assess the relationship between coping and susceptibility to the common cold. The correlations between the various indicators of vulnerability and the composite measures of approach and avoidance coping, respectively, are shown in Table 6.9. Contrary to the research hypotheses, neither

composite coping index was significantly related to the susceptibility measures.

Specifically, approach coping was not significantly correlated with symptom frequency ($r = -0,03$; $n = 119$; $p = 0,71$ two-tail), symptom duration ($r = 0,04$; $n = 120$; $p = 0,70$ two tail), symptom severity ($r = -0,12$; $n = 121$; $p = 0,18$ two-tail), or symptom-related training days off ($r = -0,09$; $n = 118$; $p = 0,36$ two-tail). Similarly, avoidance coping was not significantly related to symptom frequency ($r = 0,07$; $n = 118$; $p = 0,48$ two-tail), symptom duration ($r = 0,03$; $n = 119$; $p = 0,73$ two-tail), symptom severity ($r = 0,01$; $n = 120$; $p = 0,92$ two-tail), or symptom-related training days off ($r = 0,08$; $n = 117$; $p = 0,39$ two-tail).

However, further analysis of the data revealed a significant positive relationship between the avoidance coping strategy of denial and symptom frequency scores ($r = 0,21$; $n = 118$; $p = 0,02$ two-tail). This indicated that a higher tendency to deny or refute the reality or existence of a stressor was associated with a significantly increased incidence of self reported infectious symptoms. However, the avoidance coping strategies of mental disengagement, behavioural disengagement, substance use, and focus on emotions were not significantly related to the common cold indices. Moreover, the various measures of infection were not significantly correlated with any of the approach coping scales, which included active coping, planning, suppression of competing activities, positive reinterpretation and growth, and restraint. The correlations between the various coping scales and vulnerability measures are displayed in Table 6.7.

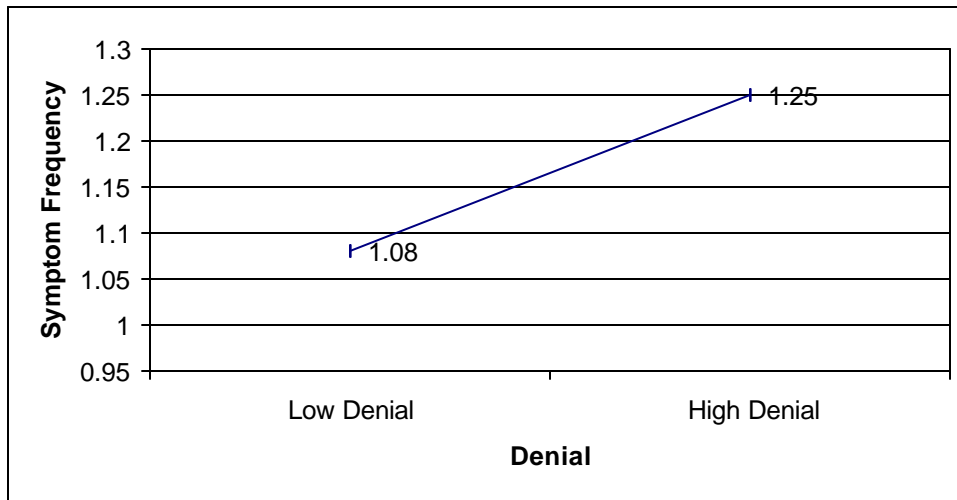
TABLE 6.7: CORRELATION COEFFICIENTS FOR RELATIONSHIPS BETWEEN
THE COPING SCALES AND SUSCEPTIBILITY TO INFECTION MEASURES

Coping Scale	Symptom Frequency	Symptom Duration	Symptom Severity	Training Days Off
Active Coping	-0,08	-0,02	-0,08	-0,11
Planning	-0,03	0,07	-0,15	-0,06
Suppression of Activities	0,00	-0,04	-0,16	-0,03
Positive Reinterpretation	0,04	0,02	-0,00	-0,07
Restraint	-0,06	0,09	-0,05	-0,04
Behavioural Disengagement	0,02	-0,04	-0,07	0,06
Mental Disengagement	0,03	0,14	0,03	0,12
Focus on Emotions	0,07	-0,02	-0,04	-0,05
Denial	0,21*	0,04	0,06	0,01
Substance Use	0,03	-0,02	0,04	0,16

Significance : * $p < 0,05$ two-tail ** $p < 0,01$ two-tail

In order to provide a visual representation of the relationship between denial and symptom frequency, subjects were divided into “high denial” and “low denial” groups on the basis of a median split of their scores on the denial scale (median = 5). Each group’s mean score for symptom frequency was then calculated and plotted on a graph. In Figure 6.5, it can be seen that the high denial group obtained a mean score of 1,25 for symptom frequency, whereas the low denial group’s score for this measure was 1,08.

FIGURE 6.5: MEAN SYMPTOM FREQUENCY VALUES FOR SUBJECTS WITH HIGH VERSUS LOW SCORES ON THE DENIAL SCALE



HARDINESS

A total of 12 subjects failed to complete the hardiness measure in full. In most cases, only one item of the 30-item inventory was left unanswered. In order to be able to include these questionnaires in the final analyses, the sample average was assigned to each of the missing items. However, if a large percentage of the questionnaire was not completed, then it was excluded from the analyses.

The research participants obtained a mean score of 59,68 ($SD = 9,66$; $SE = 0,87$; $n = 123$) on the Dispositional Resilience Scale, which provides an overall index of the personality style of hardiness. The lowest score obtained by the group was 34, while the highest score was 80. The maximum score obtainable on the scale is 90.

Previous researchers have suggested that hardiness may be related to chronological age (Soderstrom et al., 2000). Specifically, it is believed that hardiness may increase as one grows older. This hypothesis was assessed using correlational statistical techniques. Contrary to expectations, no significant relationship was observed between hardiness and the age of research participants ($r = 0,10$; $n = 121$; $p = 0,26$ two-tail).

The Relationship between Hardiness and Susceptibility to the Common Cold

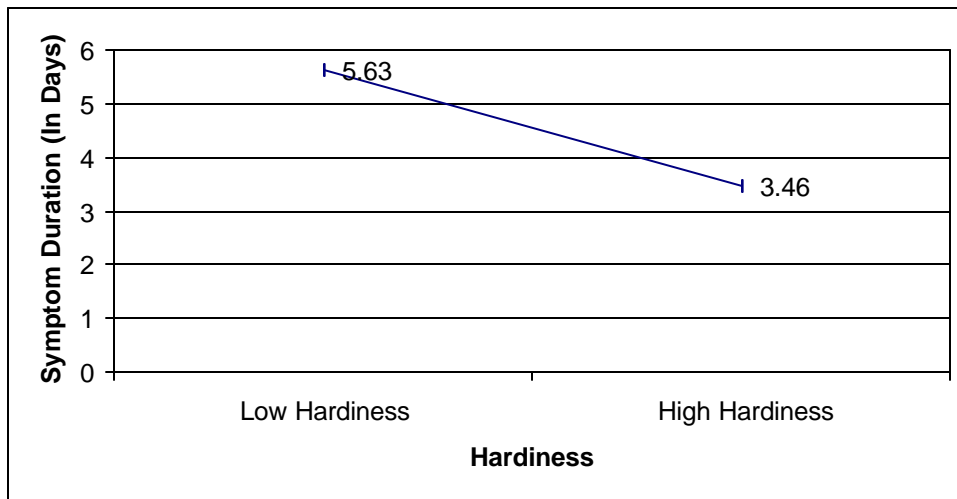
The Pearson product-moment correlation was used to assess the relationship between personality hardiness and susceptibility to the common cold. The correlations between hardiness and each of the susceptibility measures can be viewed in Table 6.9.

Specifically, it was found that hardiness was significantly related to the symptom duration index, with higher levels of hardiness being associated with lower symptom duration scores ($r = -0,19$; $n = 120$; $p = 0,04$ two-tail). However, no significant correlations were observed between hardiness and symptom frequency ($r = -0,14$; $n = 119$; $p = 0,12$ two-tail), symptom severity ($r = -0,13$; $n = 122$; $p = 0,14$ two-tail), or symptom-related training days off ($r = -0,17$; $n = 119$; $p = 0,07$ two-tail), respectively.

In order to illustrate the relationship between hardiness and symptom duration, subjects were divided into “high hardiness” and “low hardiness” groups on the basis of a median split of their scores on the Dispositional Resilience Scale (median = 62). Each group’s mean score for the symptom duration measure was then calculated and plotted on a graph. Figure 6.6 illustrates that the high hardiness group obtained a mean score of 3,46

days for symptom duration, whereas the low hardiness group's score for this measure was 5,63 days.

FIGURE 6.6: MEAN SYMPTOM DURATION VALUES FOR SUBJECTS WITH HIGH VERSUS LOW LEVELS OF HARDINESS



TRAINING WORKLOAD AND COMPETITION FREQUENCY

Summary statistics for the various training workload and competition frequency measures are shown in Table 6.8. Specifically, the research sample obtained a mean score of 927,97 for training workload, with a standard deviation of 460,17. To reiterate, scores for this measure were calculated by multiplying the average duration of each training session (in minutes) by a value reflecting the average intensity thereof, and then summing these scores to obtain a weekly total. The highest score recorded for this measure was 2 850. The sample mean for weekly training duration (in minutes) was 310,44 (5:10:26), with a standard deviation of 137,97 (2:17:58), and a maximum of 676 (11:16). It was also

observed that subjects had reportedly trained an average of 5,63 times per week (SD = 2,28) in the previous six months.

In terms of recent competitive activity, it was found that study participants had competed in an average of 8,66 distance running events in the preceding six-month period. The maximum number of races run during this stage was 31. On average, respondents had participated in a total of 7,54 races of five kilometers to 32 kilometres in distance, and in a total of 1,04 races of 42,2 kilometres and longer.

TABLE 6.8: COUNTS (N), MEANS, STANDARD ERRORS (SE), STANDARD DEVIATIONS (SD), MEDIANS (MED), AND MINIMUM (MIN) AND MAXIMUM (MAX) VALUES FOR THE TRAINING WORKLOAD AND COMPETITION FREQUENCY MEASURES

Measure	N	Mean	SE	SD	Med	Min	Max
Training Workload	119	927,97	42,18	460,17	900	0	2850
Training Duration	119	310,44	12,65	137,97	310	0	676
Training Frequency	119	5,63	0,21	2,28	5	0	12
Total Races	123	8,66	0,68	7,51	6	0	31
Races < 42,2kms	123	7,54	0,62	6,83	5	0	27
Races > or = 42,2kms	123	1,04	0,14	1,57	0	0	8

An assessment of the association between the athlete's recent training workload and best ever race performances revealed that higher training workloads were related to significantly faster race times, as could be expected. Specifically, significant negative

correlations were observed between the training workload measure and personal best race times for 10 kilometres ($r = -0,43$; $n = 114$; $p = 0,001$ two-tail), 21,1 kilometres ($r = -0,29$; $n = 111$; $p = 0,001$ two-tail), and 42,2 kilometres ($r = -0,28$; $n = 93$; $p = 0,01$ two-tail), respectively.

The Relationship of Training Workload and Competition Frequency to Susceptibility to the Common Cold

The Pearson product-moment correlation was used to analyse the relationship of training workload and competition frequency to susceptibility to the common cold. These correlations can be viewed in Table 6.9. Contrary to the research hypotheses, no significant relationships were found between indices of aerobic exercise training and the susceptibility to infection measures. Specifically, a composite index of recent training workload was not significantly related to symptom frequency ($r = 0,07$; $n = 115$; $p = 0,46$ two-tail), symptom duration ($r = 0,03$; $n = 116$; $p = 0,74$ two-tail), symptom severity ($r = 0,02$; $n = 118$; $p = 0,82$ two-tail), or symptom-related training days off ($r = -0,02$; $n = 116$; $p = 0,84$ two-tail). Similarly, no significant correlations were observed between the common cold measures and either the frequency or duration of recent endurance training.

TABLE 6.9: CORRELATION COEFFICIENTS FOR RELATIONSHIPS OF LIFE EVENTS, COPING, HARDINESS, TRAINING WORKLOAD AND COMPETITION FREQUENCY TO THE SUSCEPTIBILITY TO INFECTION MEASURES

Measure	Symptom Frequency	Symptom Duration	Symptom Severity	Training Days Off
Life Events: Total	0,21*	0,13	0,24**	0,19*
Life Events: Time-1	0,06	0,11	0,13	0,17
Life Events: Time-2	0,26**	0,09	0,25**	0,15
Approach Coping	-0,03	0,04	-0,12	-0,09
Avoidance Coping	0,07	0,03	0,01	0,08
Hardiness	-0,14	-0,19*	-0,13	-0,17
Training Workload	0,07	0,03	0,02	-0,02
Training Duration	0,02	0,00	-0,03	-0,03
Training Frequency	0,10	-0,01	-0,00	-0,04
Total Races	-0,04	-0,02	-0,12	-0,02
Races < 42kms	-0,08	-0,03	-0,15	-0,03
Races > or = 42kms	0,01	0,04	0,03	0,05

Significance : * $p < 0,05$ two-tail ** $p < 0,01$ two-tail

As shown in the above table, the total number of races run during the previous six months was not significantly related to symptom frequency ($r = -0,04$; $n = 119$; $p = 0,64$ two-tail), symptom duration ($r = -0,02$; $n = 120$; $p = 0,84$ two-tail), symptom severity ($r = -0,12$; $n = 122$; $p = 0,19$ two-tail) or symptom-related training days off ($r = -0,02$; $n = 119$;

$p = 0,84$ two-tail). Furthermore, no significant correlations were found between the frequency of participation in races of five kilometers to 32 kilometres and symptom frequency ($r = -0,08$; $n = 119$; $p = 0,39$ two-tail), symptom duration ($r = -0,03$; $n = 120$; $p = 0,73$ two-tail), symptom severity ($r = -0,15$; $n = 122$; $p = 0,10$ two-tail) or symptom-related training days off ($r = -0,03$; $n = 119$; $p = 0,73$ two-tail). In the same way, the frequency of participation in races of 42,2 kilometres and longer was not significantly related to the measures of symptom frequency ($r = 0,01$; $n = 118$; $p = 0,86$ two-tail), symptom duration ($r = 0,04$; $n = 119$; $p = 0,64$ two-tail), symptom severity ($r = 0,03$; $n = 121$; $p = 0,77$ two-tail) or symptom-related training days off ($r = 0,05$; $n = 117$; $p = 0,60$ two-tail).

MULTIPLE REGRESSION ANALYSES OF THE RELATIONSHIPS OF LIFE EVENTS, COPING, HARDINESS, TRAINING WORKLOAD AND COMPETITION FREQUENCY TO SUSCEPTIBILITY TO THE COMMON COLD

Multiple regression analysis was used to study the relationship between susceptibility to the common cold and the composite of life events, coping, hardiness, training workload and competition frequency. This relationship is indicated by the multiple correlation coefficient, R . Specifically, it was revealed that the linear composite of life events, hardiness, approach and avoidance coping, training workload and competition frequency did not explain a significant proportion of the variation in symptom frequency ($R = 0,24$; $F(6;105) = 1,12$; $p = 0,36$), symptom duration ($R = 0,28$; $F(6;106) = 1,49$; $p = 0,19$), symptom severity ($R = 0,28$; $F(6;107) = 1,51$; $p = 0,18$), or symptom-related training

days off ($R = 0,23$; $F(6; 105) = 0,95$; $p = 0,46$). However, the regression coefficients in the regression equations indicated that life events made a significant contribution to symptom severity ($B = 0,002$; $t = 2,38$; $p = 0,02$ two-tail). In addition, hardiness was found to contribute significantly to the prediction of symptom duration ($B = -0,30$; $t = -2,63$; $p = 0,01$). The multiple regression analysis results are shown in Tables 6.10 to 6.13.

TABLE 6.10: RESULTS OF MULTIPLE REGRESSION ANALYSIS WITH SYMPTOM FREQUENCY AS THE DEPENDENT VARIABLE AND TRAINING WORKLOAD, COMPETITION FREQUENCY, LIFE EVENTS, AVOIDANCE COPING, APPROACH COPING AND HARDINESS AS THE PREDICTOR VARIABLES (N = 112)

Predictor Variables	Regression Coefficients (B)	Standard Error	t Stat	P-value
Training Workload	0,000	0,00	0,54	0,59
Competition Frequency	-0,002	0,02	-0,14	0,89
Life Events	0,002	0,00	1,72	0,09
Avoidance Coping	-0,004	0,02	-0,25	0,80
Approach Coping	0,004	0,02	0,23	0,82
Hardiness	-0,020	0,02	-1,28	0,20
Overall Multiple Regression Statistics	$R = 0,24$ $R^2 = 0,06$ $F(6,105) = 1,12$			

TABLE 6.11: RESULTS OF MULTIPLE REGRESSION ANALYSIS WITH SYMPTOM DURATION AS THE DEPENDENT VARIABLE AND TRAINING WORKLOAD, COMPETITION FREQUENCY, LIFE EVENTS, AVOIDANCE COPING, APPROACH COPING AND HARDINESS AS THE PREDICTOR VARIABLES (N = 113)

Predictor Variables	Regression Coefficients (B)	Standard Error	t Stat	P-value
Training Workload	0,000	0,00	0,34	0,74
Competition Frequency	0,014	0,12	0,12	0,90
Life Events	0,006	0,01	0,76	0,45
Avoidance Coping	-0,097	0,11	-0,86	0,39
Approach Coping	0,204	0,12	1,75	0,08
Hardiness	-0,296	0,11	-2,63	0,01
Overall Multiple Regression Statistics	R = 0,28 R ² = 0,08 F(6,106) = 1,49			

TABLE 6.12: RESULTS OF MULTIPLE REGRESSION ANALYSIS WITH SYMPTOM SEVERITY AS THE DEPENDENT VARIABLE AND TRAINING WORKLOAD, COMPETITION FREQUENCY, LIFE EVENTS, AVOIDANCE COPING, APPROACH COPING, AND HARDINESS AS THE PREDICTOR VARIABLES (N = 114)

Predictor Variables	Regression Coefficients (B)	Standard Error	T Stat	P-value
Training Workload	0,000	0,00	0,33	0,74
Competition Frequency	-0,014	0,01	-1,09	0,28
Life Events	0,002	0,00	2,38	0,02
Avoidance Coping	-0,015	0,01	-1,22	0,23
Approach Coping	-0,008	0,01	-0,62	0,54
Hardiness	-0,008	0,01	-0,62	0,54
Overall Multiple Regression Statistics	R = 0,28 R ² = 0,08 F(6,107) = 1,51			

TABLE 6.13: RESULTS OF MULTIPLE REGRESSION ANALYSIS WITH SYMPTOM-RELATED TRAINING DAYS OFF AS THE DEPENDENT VARIABLE AND TRAINING WORKLOAD, COMPETITION FREQUENCY, LIFE EVENTS, AVOIDANCE COPING, APPROACH COPING AND HARDINESS AS THE PREDICTOR VARIABLES (N = 112)

Predictor Variables	Regression Coefficients (B)	Standard Error	t Stat	P-value
Training Workload	-0,000	0,00	-0,08	0,94
Competition Frequency	0,014	0,12	0,11	0,91
Life Events	0,012	0,01	1,50	0,14
Avoidance Coping	-0,039	0,12	-0,32	0,75
Approach Coping	0,021	0,12	0,16	0,87
Hardiness	-0,168	0,12	-1,40	0,17
Overall Multiple Regression Statistics	$R = 0,23$ $R^2 = 0,05$ $F(6,105) = 0,95$			

RELATIONSHIPS AMONG LIFE EVENTS, COPING, HARDINESS, TRAINING WORKLOAD AND COMPETITION FREQUENCY

The Pearson product-moment correlation was used to assess the relationships among life events, coping, hardiness, training workload and competition frequency. The correlation coefficients for these associations are shown in Table 6.14.

TABLE 6.14: CORRELATION COEFFICIENTS FOR RELATIONSHIPS AMONG LIFE EVENTS, COPING, HARDINESS, TRAINING WORKLOAD AND COMPETITION FREQUENCY

Measure	Events	Approach	Avoid	Hardy	Training	Racing
Life Events	1,00	0,05	0,27**	-0,17	0,10	-0,05
Approach Coping		1,00	-0,12	0,49**	0,08	-0,05
Avoidance Coping			1,00	-0,40**	-0,03	-0,08
Hardiness				1,00	0,10	0,08
Training Workload					1,00	0,28**
Competition Freq.						1,00

Significance: * $p < 0,05$ two-tail ** $p < 0,01$ two-tail

As illustrated, several significant correlations were observed among the independent variables in this study. Specifically, a significant positive association was found between life events and avoidance coping ($r = 0,27$; $n = 121$; $p = 0,001$ two-tail). This finding indicated that a higher magnitude of recent life changes was related to greater use of strategies such as denial, substance use, behavioural disengagement, mental disengagement, and focus on emotions. Hardiness and approach coping were also found to be positively related ($r = 0,49$; $n = 122$; $p = 0,001$ two-tail). In addition, a significant inverse correlation was observed between hardiness and avoidance coping ($r = -0,40$; $n = 121$; $p = 0,001$ two-tail). These findings demonstrated that higher hardiness scores were associated with higher levels of approach coping and lower degrees of avoidance coping.

Finally, a significant positive association was found between training workload and competition frequency ($r = 0,28$; $n = 118$; $p = 0,001$ two-tail). This implies that runners who train the hardest also tend to run the most races. This finding could be expected due to the likelihood that the desire to compete may be the reason that athletes train hard.

CHAPTER 7

DISCUSSION

The primary purpose of this study was to assess the relationship between specific psychosocial factors and susceptibility to the common cold in distance runners. On the basis of current theoretical approaches and recent empirical findings, it was hypothesized that life events, avoidance coping, training workload and competition frequency were positively related to the risk of infection in this group. Conversely, it was predicted that higher degrees of approach coping and hardiness, respectively, were associated with a lower susceptibility to the common cold.

In support of the research hypotheses, the study found that a higher magnitude of recent life changes and a greater tendency to deny the reality of stressors were related to an increased risk of upper respiratory tract infections. Furthermore, as predicted, higher levels of hardiness appeared to be protective against the common cold. These findings highlight the need for sports medicine specialists to consider certain stress-related psychosocial factors when making recommendations for the prevention and treatment of upper respiratory tract infections in distance runners. However, it should be noted that the above variables only accounted for a small proportion of the variance in symptom scores. Therefore, a large number of other factors could conceivably contribute towards the risk of colds in these individuals.

The main aim of this chapter is to discuss the results of the study with reference to the research hypotheses and in relation to existing theoretical perspectives and previous research findings.

SUSCEPTIBILITY TO THE COMMON COLD

The common cold is regarded as the most prevalent disease in the general population, with scientists estimating that the average adult experiences two to four infectious episodes per year (Gwaltney, 1979). In the present study, it was found that 65,3% of subjects reportedly experienced one or more symptoms of the common cold in the previous six-month period.

It is difficult to compare the above finding directly with the results of other studies due to wide variations in how upper respiratory tract infections have been defined and measured. However, the various studies cited below may provide a broad indication of how this result relates to previous research. Firstly, Cobb and Steptoe (1996) found that 27,1% of an adult sample experienced at least one verified episode of upper respiratory illness during a 15-week period. Furthermore, in a study involving a cohort of 530 male and female runners, Heath et al. (1991) reported that 66% of subjects experienced at least one upper respiratory infection during the 12 months under review. In this particular study, infection was defined as self-reported symptoms of a runny nose, sore throat or cough on two consecutive days. In two other investigations, it was observed that 30% and 43,2% of distance runners, respectively, experienced at least one infectious episode, defined as a cold, influenza or sore throat, during the two-month period before a road

race (Nieman, et al., 1989; Nieman et al., 1990). It was also reported that 33,3% of athletes experienced one or more symptoms of an upper respiratory tract infection, such as a runny nose, sneezing, sore throat and cough, in the two weeks following participation in a marathon-type event (Peters & Bateman, 1983).

It can be noted that the prevalence of the different common cold symptoms in the present study concurs with that found in previous research involving endurance athletes.

Specifically, the finding that a sore throat was the most common symptom among subjects, followed in order by nasal symptoms and coughs, agrees with the results of a survey that assessed the runner's risk of post-race infection (Peters & Bateman, 1983).

The finding that the average duration of symptoms among symptomatic subjects in the present study was seven days agrees with the assertion that colds caused by the rhinovirus group typically last for about a week (Gwaltney, 1979). It also matches the results of several previous studies involving both athletes and the general population. For example, Linde (1987) noted that the mean duration of upper respiratory tract infections in a group of elite orienteers and a non-running control group was 7,9 and 6,4 days, respectively. However, only cases of symptoms that lasted in excess of three days were included in this analysis, which may have had the effect of raising the sample average. In addition, Nieman et al. (1990) found that the mean duration of symptoms per incident in a group of sedentary women was seven days. However, the duration of symptoms in a group of mildly obese women who exercised moderately (i.e. did brisk walking) was only 3,6 days, which was markedly lower than that found in the present study.

The discovery of an inverse association between age and symptom frequency lends support to the hypothesis that people experience fewer colds as they grow older (Gwaltney, 1979). It also concurs with the findings of Nieman et al. (1990), who observed that younger runners reported more infectious episodes than older runners during the two-month training period before a marathon. However, in a study conducted in the general population, Cobb and Steptoe (1996) found no significant age differences between subjects who experienced infectious episodes and those who did not.

THE RELATIONSHIP BETWEEN LIFE EVENTS AND SUSCEPTIBILITY TO THE COMMON COLD

Researchers have proposed that a cluster of events that denote or require a significant change in one's normal way of life can play a causal role in illness onset (Holmes & Rahe, 1967). Specifically, such events are thought to evoke increased secretions of neurohormonal substances that can adversely affect the functioning of the immune and cardiovascular systems. Consequently, life changes may increase the risk of disorders such as heart attacks, strokes, allergies, cancer and infections (Clow, 2001). On the basis of these ideas, it was predicted that life events were positively related to susceptibility to the common cold in distance runners.

In support of the research hypothesis, correlational and multiple regression statistical analyses revealed significant positive correlations between life events and several of the susceptibility indicators adopted in this study. Specifically, higher life change scores

were related to more frequent and more severe self-reported symptoms of the common cold, and to more days taken off from training due to symptomatic episodes. Together, these findings imply that a higher magnitude of recent life events is associated with an increased susceptibility to upper respiratory tract infections in distance runners.

The relationship found between life events and disease susceptibility in this study is consistent with the results of previous research conducted in the general population. For example, Rahe et al. (1970) found that navy personnel reporting a higher number of recent life changes experienced significantly more cases of illness than subjects reporting fewer events. In another study, recent life event stress in a sample of office workers was positively correlated with health care costs and the number of health insurance claims filed (Manning & Fusilier, 1999). In addition, Williams and Lawler (2001) found a positive association between the magnitude of life changes and seriousness of illness scores in a group of low-income women.

The discovery of a relationship between life events and susceptibility to upper respiratory tract infections also concurs with previous research findings. For example, Cohen et al. (1991) observed that higher cumulative life event stress increased the risk of developing common cold symptoms following experimental exposure to one of five cold viruses. In addition, various researchers have documented a positive relationship between life events and the incidence of upper respiratory tract infections in children (Cobb & Steptoe, 1998; Drummond & Hewson-Bower, 1997). Moreover, Totman et al. (1980) reported that a

high number of activity-changing life events was related to an increased magnitude of experimental colds in a group of volunteers.

The results of the present study also match the findings of earlier research involving elite endurance athletes. For example, May et al. (1985) observed that major life changes were positively related to ear, nose and throat problems in members of the US alpine ski team. In another study involving various groups of elite athletes, including race walkers and biathletes, it was found that a higher magnitude of life events was associated with an increased risk of upper respiratory tract infections (May et al., 1985).

The finding of a significant positive relationship between life events and infectious disease susceptibility is in line with the view that events that represent or demand a life-style readjustment may have deleterious effects on physical health status. In this regard, it is plausible that the effort of coping with disruptions in one's normal routine elicits increased secretions of neurohormonal substances that can suppress the immune system (Cohen, 1996).

However, another feasible explanation for the research findings is that frequent upper respiratory tract infections may increase the risk of experiencing major life changes. It is also conceivable that a third variable could account for the observed correlation between life events and infectious symptoms (Cohen et al., 1997). For instance, it is possible that a factor such as a low socioeconomic status may predispose individuals to experience a

higher magnitude of life events and, at the same time, render them more susceptible to colds and influenza.

THE RELATIONSHIP BETWEEN COPING AND SUSCEPTIBILITY TO THE COMMON COLD

Coping is a multidimensional concept which has been defined as the individual's cognitive and behavioural efforts to manage stressful situations. It has been proposed that coping responses can influence neurochemical stress reactions and therefore, can affect the functioning of the immune system and the risk of infectious illness (Lazarus & Folkman, 1984; Clow, 2001). Various theoretical perspectives and recent research findings suggest that efforts to avoid dealing with problems may generally be maladaptive. However, there is evidence that approach coping strategies may enhance the resistance to infectious disease. On this basis, it was hypothesized that avoidance coping was positively related to susceptibility to the common cold in distance runners, whereas approach coping was inversely associated with the risk of infection.

The finding that subjects generally preferred to confront rather than avoid stressors is consistent with the results of previous research. For example, in a study designed to assess the relationships between psychosocial factors and various symptoms of illness, Soderstrom et al. (2000) reported that the group mean for a composite measure of approach coping was higher than that for avoidance coping in both a corporate and a university sample. Moreover, in the development of scale items for the COPE inventory,

Carver et al. (1989) stated that college students reported using theoretically adaptive strategies, such as active coping and planning, more frequently than the potentially less adaptive strategies, such as behavioural disengagement and mental disengagement.

Contrary to the research hypotheses, no significant correlations were found between the composite indices of approach and avoidance coping on the one hand and the susceptibility to infection measures on the other. However, further correlational analysis of the data yielded a significant positive relationship between the avoidance coping strategy of denial and symptom frequency scores. This finding implies that distance runners who frequently tend to deny the reality of stressors may be more susceptible to the common cold than athletes who use this coping strategy less often. However, none of the other coping strategies assessed were related to the risk of infectious illness in this group.

The finding regarding denial and disease susceptibility in this study is consistent with previous research that suggests that avoidance coping strategies may increase the incidence and course of various physical disorders. For example, Cassidy (2000) noted that people who reported more frequent episodes of ill health were more likely to avoid problems and less likely to approach them. In addition, Evers et al. (2003) found that a high tendency to avoid, give in to or withdraw from everyday problems predicted increased clinically-assessed, long-term disease activity in rheumatoid arthritis patients. In other research, it was observed that a propensity to give up attempts to control stressful encounters was associated with a higher risk of mortality in patients with congestive heart

failure (Murberg et al., 2004). However, no relation was detected between mortality risk and the specific tendency to deny problems.

A positive relationship between avoidance coping and upper respiratory infections has also been demonstrated in previous research. For example, Soderstrom et al. (2000) found that the tendency to avoid problems and focus on emotions was related to an increased incidence of the common cold and other illnesses in university and corporate samples. In addition, Cobb and Steptoe (1998) observed that greater use of coping strategies such as distraction, social withdrawal and self-criticism was associated with significantly longer lasting upper respiratory tract infections in children. In contrast, Nowack (1991) found that attempts to avoid thinking about a stressor were related to a significantly lower risk of a wide range of physical disorders, including colds and influenza, cancer, ulcers and cardiovascular problems, in a group of professional employees.

The finding that denial was associated with an increased susceptibility to upper respiratory tract infections in the present study supports theoretical approaches that postulate that ignoring problems may increase the risk of infectious disorders. For example, the opioid peptide hypothesis of repression states that a repressive coping style, which is characterized by the tendency to avoid threatening information and to deny or minimize negative emotions, can elevate functional endorphin levels in the brain (Jamner et al., 1988). This can, in turn, lead to decreased immune function and reduced resistance to infectious and neoplastic diseases. Consistent with this proposition, researchers have

found a positive relationship between repressive coping and decreased monocyte counts (Jamner et al., 1988).

It can also be speculated that avoidance coping strategies may influence the risk of illness through psychological pathways. For example, focusing attention away from stressors may allow problems to grow in magnitude with concomitant increases in psychological stress and negative affect. In support of this hypothesis, higher use of avoidance coping strategies has been associated with greater psychological stress. In turn, higher levels of perceived stress have been associated with increased physical illness (Soderstrom et al., 2000). Moreover, tendencies to disengage from and deny problems, and to focus on emotional distress, have been positively correlated with measures of trait anxiety (Carver et al., 1989).

On a broader level, the discovery of a significant, albeit limited relationship between coping and disease susceptibility is consistent with the tenets of cognitive stress theory. According to this approach, stress is a transactional process between the person and the environment (Lazarus & Folkman, 1984). Specifically, stress and its outcomes are said to depend on both how a person appraises and copes with demands.

Finally, the finding that approach coping was not related to any of the infection measures in this study seems to contradict the results of several previous investigations (e.g. Cobb & Steptoe, 1998; Soderstrom et al., 2000). However, the absence of significant correlations between illness risk and most of the coping measures assessed, suggests that

the efficacy of coping responses may vary according to the situation (Jones & Bright, 2001). This implies that coping strategies may not be intrinsically harmful or inherently beneficial to one's physical health status. For example, it has been proposed that when stressors are uncontrollable, such as bereavement, avoidance strategies may initially be more beneficial than attention strategies (Weidner & Collins, 1993). Conversely, in situations of high personal control, attention strategies may be more adaptive. In addition, there is evidence that avoidance coping may be more advantageous when dealing with short-term, inconsequential demands. However, in the case of chronic stressors, such as unemployment, approach coping may lead to better adaptational outcomes (Weidner & Collins, 1993).

THE RELATIONSHIP BETWEEN HARDINESS AND SUSCEPTIBILITY TO THE COMMON COLD

Hardiness has been defined as a personality style which consists of the interrelated dimensions of commitment (versus alienation), control (versus powerlessness), and challenge (versus threat) (Kobasa et al., 1994). Hardy individuals are said to possess a sense of mastery over events in their lives, a strong commitment to the self, family, social relationships, work and social institutions, and a desire to seek out new experiences, which are viewed as an opportunity for growth (Kobasa, 1979). It has been postulated that hardiness leads to positive appraisals of potentially stressful life events and promotes the use of adaptive coping strategies (Stroebe, 2000). Therefore, the personality trait of hardiness may protect people from stress-induced immunosuppression and physical

illness. It has also been proposed that people who are high in hardiness may follow a healthier life-style than low hardy individuals (Soderstrom et al., 2000). On the basis of these ideas, it was hypothesized that hardiness was inversely associated with susceptibility to the common cold in distance runners.

In support of the research hypothesis, correlational and multiple regression analyses yielded a significant negative correlation between hardiness and symptom duration scores. This finding implies that distance runners who possess a combination of high levels of personal control, commitment and challenge may be more resistant to upper respiratory tract infections than their low hardy counterparts.

The relationship found between hardiness and disease susceptibility in this study is consistent with previous research involving the general population. For instance, Soderstrom et al. (2000) found a significant inverse correlation between hardiness and various symptoms of illness, including the common cold, in both corporate employees and university students. In another study, Manning & Fusilier (1999) reported a significant inverse correlation between hardiness and health care use in a group of office workers. A hardy personality was also associated with fewer physical health problems in a large sample of college students (Roth et al., 1989). Furthermore, it was observed that hardiness in breast-feeding mothers was negatively related to the incidence of upper respiratory tract infections in their infants (Dillon & Totten, 1989). There is also evidence that the immune function of people who are high in hardiness is superior to that of individuals who are low in this personality dimension (Dolbier et al., 2001).

The results of the present study tend to support the proposition that hardiness serves as an intrapersonal coping resource that protects people from the adverse effects of stress (Stroebe, 2000). According to this approach, hardiness fosters a healthy status by promoting optimistic appraisals of potentially stressful situations (Kobasa et al., 1994). Therefore, hardiness may be linked to lower psychological stress and consequently, may reduce the risk of stress-induced immunosuppression. In support of these ideas, several studies have found a significant inverse association between hardiness and perceived stress (Roth et al., 1989; Soderstrom et al., 2000; Williams & Lawler et al., 2001). In turn, positive correlations have been observed between perceived stress and infection risk (Cohen, 1996; Soderstrom et al., 2000).

Personality theorists have also proposed that hardiness fosters the use of theoretically adaptive coping strategies which are generally associated with better health outcomes (Kobasa et al., 1994). For example, high hardy individuals are said to engage in approach coping strategies in order to render stressful situations more manageable (Soderstrom et al., 2000). Various researchers have found support for the hypothesized relationship between hardiness and coping (Carver et al., 1989; Soderstrom et al., 2000). Consistent with the results of these studies, a significant positive correlation was observed between hardiness and approach coping in the present study. Moreover, a significant inverse association was found between hardiness and avoidance coping.

On a more general level, the discovery of a relationship between hardiness and disease susceptibility in the present study suggests that individual difference factors may

influence stress-related outcomes. This finding is consistent with the basic principles of cognitive stress theory, which asserts that stress is a transactional process between the person and the environment (Lazarus & Folkman, 1984).

THE RELATIONSHIP OF TRAINING WORKLOAD AND COMPETITION FREQUENCY TO SUSCEPTIBILITY TO THE COMMON COLD

It has been proposed that moderate aerobic exercise training promotes the release of neurohormonal substances that enhance the functioning of the immune system (Mackinnon, 1994). Conversely, bouts of prolonged and / or intense exercise are believed to elicit increased secretions of neurohormonal substances such as cortisol into the bloodstream (Gotovtseva et al., 1998). These substances may, in turn, suppress the immune system (O'Leary, 1990). Therefore, moderate exercise training may enhance resistance to upper respiratory tract infections, whereas heavy exercise may increase the risk of colds and influenza (Nieman, 2000). On the basis of these ideas, it was hypothesized that training workload and competition frequency were positively related to susceptibility to the common cold in distance runners.

Contrary to the research hypotheses, correlational and multiple regression statistical procedures failed to detect any significant relationships between the various training and competition measures on the one hand and the susceptibility to infection indicators on the other. Therefore, the proposition that exercise behaviour is associated with the athlete's risk of upper respiratory illness was not supported. Specifically, self-reported symptoms

of infection were not related to the frequency or duration of training, or to a composite index of training workload that reflected the customary duration and intensity of recent exercise. In addition, no significant correlations were observed between the common cold measures and the number of races of varying distances undertaken in the previous six months.

In contrast to the above findings, several previous studies have found that heavy versus moderate training workloads may increase the risk of colds and influenza in endurance athletes. For example, it was reported that marathon runners training more than 97 kilometres per week were twice as likely as those running less than 32 kilometres per week to contract an upper respiratory tract infection (Nieman et al., 1990). Other researchers found that distance runners in a high-training status group experienced significantly more infectious episodes following an ultra-marathon than subjects in moderate and low-training groups (Peters et al., 1993). In addition, Heath et al. (1991) observed a significant positive correlation between annual training distance and the incidence of upper respiratory tract symptoms in a cohort of 530 male and female runners. However, comparable to the findings of the present study, the authors detected no significant correlations between illness risk and factors such as the average number of days and the average number of miles run per week in the past year.

Various researchers have also found that participating in a marathon-type event may increase the athlete's susceptibility to upper respiratory illness. For example, Nieman et al. (1990) reported that 12,9% of 2 311 runners who had competed in the Los Angeles

Marathon experienced an upper respiratory tract infection in the week following the event, compared with 2,2% of non-participating control runners. However, parallel to the findings of the present study, it was found that participation in events of five kilometers, 10 kilometres and 21,1 kilometres did not significantly increase the runner's risk of colds and influenza (Nieman et al., 1989). Furthermore, Heath et al. (1991) reported that having competed in a road race in the previous year was not significantly related to the risk of infection in a large group of runners. Therefore, it seems that participating in shorter distance races may not increase the endurance athlete's risk of upper respiratory tract infections.

Nieman (2000) has proposed that the relationship between aerobic exercise and the risk of respiratory illness can be modelled in the form of a "J" curve. This approach suggests that as the intensity and duration of exercise increases from low to moderate, the risk of upper respiratory tract infections systematically decreases. However, an increase in exercise workload from moderate to high is accompanied by a simultaneous decrease in the resistance to upper respiratory illness. The J-shaped model may partially serve to explain why no significant correlations were found between the exercise workload and common cold measures in the present study. Specifically, a possible inverse correlation between infection and exercise of low to moderate intensity may have obscured the presence of a positive relationship between colds and exertion of moderate to high intensity. Therefore, the present findings do not necessarily invalidate the theory that moderate exercise may reduce the risk of developing a common cold, whereas heavy exercise may increase this risk.

THE RELATIONSHIPS AMONG LIFE EVENTS, COPING, AND HARDINESS

In addition to the research findings already discussed, various other significant relationships were observed among the different variables in the present study. Specifically, it was found that life events were positively related to avoidance coping, while hardiness was positively correlated with approach coping and inversely related to avoidance coping.

The finding that a higher magnitude of life changes was associated with greater avoidance coping seems to support the viewpoint that the tendency to use avoidance strategies increases under stressful conditions (Lazarus & Folkman, 1984). Alternatively, it is plausible that a reliance on theoretically maladaptive coping strategies, such as denial and substance use, may increase the probability of experiencing major life changes. Another possible explanation for this finding is that a third variable, such as age or personality, may influence both coping tendencies and life event exposure.

The finding of a positive relationship between hardiness and approach coping, and an inverse correlation between hardiness and avoidance coping, is consistent with the proposition that hardy people prefer to use active, problem-focused coping strategies (Kobasa et al., 1994). It also agrees with the findings of several other researchers. For example, Soderstrom et al. (2000) found that hardiness was positively related to approach coping and negatively related to avoidance coping in university students and corporate employees. In another study, Carver et al. (1989) reported that hardiness was inversely

correlated with the avoidance strategies of denial and behavioural disengagement, and positively associated with the approach coping dimensions of active coping, planning, and positive reinterpretation and growth.

In conclusion, the various relationships found between life events and coping, and between coping and hardiness suggests that stress-related psychosocial factors may exert direct and / or indirect effects on infectious disease susceptibility in distance runners.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

Major advances in the field of medicine over the last few centuries have given impetus to the traditional biomedical model of disease. According to this perspective, the primary causes of most physical disorders can be traced to various internal and external biological factors (Stroebe, 2000). However, while this approach is valid, it appears that it may be too simplistic. By implication, the biomedical model ignores the role of factors such as cognitions, emotions, experiences and behaviours in illness onset and progression (Stroebe, 2000).

Recent research in health psychology and behavioural medicine has given rise to the idea that disease is a product of biological, psychological and social influences (Stroebe, 2000). For example, it has been suggested that psychosocial factors may be a direct cause of gastrointestinal problems and certain types of headaches. In addition, it is thought that psychosocial variables can interact with biological phenomena, such as genetic predispositions and microbiological agents, to influence disease susceptibility (Borysenko, 1984).

THE RESEARCH PROBLEM

Identifying the psychosocial factors that influence the risk of physical disorders may suggest additional or alternative strategies for preventing and treating various diseases.

Research of this nature could provide special benefits to people such as endurance athletes, whose physical health status may influence their ability to train and compete. In support of this, the research indicates that infections such as the common cold and influenza can impair various measures of aerobic exercise capacity (Weidner & Sevier, 1996). Moreover, it has been proposed that health problems can adversely affect the athlete's psychological well-being (May et al., 1985).

Most studies that have assessed the relationship between psychosocial factors and illness risk in endurance athletes have focused on the relationship between aerobic exercise behaviour and the risk of upper respiratory tract infections. However, it appears that the role of training and competition in infectious disease susceptibility in this group has not been fully investigated. Therefore, one of the aims of the present study was to assess further the association between exercise behaviour and susceptibility to the common cold in an endurance athlete population, specifically distance runners.

Apart from the need for additional research on the relationship between exercise behaviour and the resistance to colds, it seems that little is known about the effects of other psychosocial factors on infection risk in endurance athletes. Therefore, a further objective of the study was to investigate the relationship between the distance runner's susceptibility to the common cold and various factors that have been hypothesized and / or shown to influence the risk of illness in the general population. These include the stress-related variables of life events, coping and hardiness.

THE RESEARCH HYPOTHESES AND FINDINGS

The following specific research hypotheses were tested in the present study: In distance runners:-

- Life events, which are occurrences that represent or require a significant life-style readjustment, are positively related to susceptibility to the common cold.
- There is a negative relationship between approach coping, defined as the tendency to focus attention on the sources of stress, and the risk of developing a cold.
- There is a positive correlation between avoidance coping, defined as the tendency to focus attention away from stressors, and susceptibility to infection.
- The personality style of hardiness, characterized by the interrelated attributes of control, challenge and commitment, is inversely associated with susceptibility to the common cold.
- Training workload is positively associated with the risk of upper respiratory tract infection.
- There is a positive relationship between competition frequency and the risk of infectious illness.

The above hypotheses were derived from various theoretical approaches and recent research findings. For example, the prediction regarding life events and susceptibility to infection was based on the proposition that changes in one's normal way of life can increase the risk of physical illness (Holmes & Rahe, 1967). Specifically, such occurrences are thought to elicit increased secretions of neurohormonal substances that

can suppress the functioning of the immune system. The findings of a number of studies appear to support this approach.

The hypothesized role of coping and hardiness in illness susceptibility can be viewed within the theoretical framework of Lazarus and Folkman's (1984) cognitive stress theory. This approach conceives psychological stress as a transaction between the person and the environment. Further, it is maintained that adaptational outcomes, such as somatic health, depend on how the individual interprets and copes with environmental demands. In this context, personality theorists have proposed that hardiness can exert positive effects on health by promoting optimistic stress appraisals and the use of adaptive coping strategies (Stroebe, 2000). With respect to coping, it is believed that coping responses may affect the risk of certain diseases via coping-induced modulations of physiological functioning. However, coping strategies may also influence psychological stress reactions which, in turn, may affect physical health status (Lazarus & Folkman, 1984). On the whole, theory and research suggests that avoidance coping is associated with poorer physical health outcomes than approach coping.

Finally, it has been proposed that aerobic exercise can modulate the functioning of the immune system and consequently, can influence the risk of infectious illness. Specifically, regular, moderate exercise is thought to enhance immune function while acute bouts of heavy exercise are believed to contribute to immunosuppression (Mackinnon, 1994).

In support of the various research hypotheses, the results of the study suggest that a higher magnitude of recent life events and a greater tendency to deny the reality of stressors are related to an increased susceptibility to the common cold in distance runners. Moreover, the research findings indicate that high levels of hardiness may protect these athletes against infectious illness. Contrary to expectations, however, approach coping tendencies were not related to the risk of upper respiratory tract infections in this group. A plausible explanation for this finding is that the effectiveness of coping strategies may generally depend on factors relating to the situation, such as the duration and controllability of a stressor (Jones & Bright, 2001; Weidner & Collins, 1993).

The hypotheses regarding aerobic exercise behaviour and infection risk were also not supported. A conceivable reason for this is that a possible inverse correlation between infection and training of low to moderate intensity and duration may have obscured the presence of a positive relationship between illness and exercise of moderate to high intensity and duration. Therefore, the inability to detect a significant association between training and competition on the one hand and infection risk on the other does not necessarily contradict the theory that aerobic exercise behaviour may influence the athlete's susceptibility to the common cold.

Finally, although the results of this study provided support for several of the research hypotheses, the magnitude of the observed correlations was not large. Therefore, the practical importance of the results may be open to debate.

LIMITATIONS OF THE PRESENT STUDY

The present study may have several methodological limitations, which implies that the research findings may need to be interpreted with caution. Firstly, it is evident that the use of a self-report methodology may yield unreliable data. For example, retrospective self-reports may be prone to response bias as a result of recall problems or due to the tendency to over-report socially desirable behaviours and to under-report undesirable behaviours (Fife-Schaw, 1998). Self-report psychometric questionnaires may also produce inaccurate responses when individuals attempt to portray a good image of themselves (Hammond, 1998). Furthermore, individual difference factors such as neuroticism or optimism may influence self-reports (Jones & Kinman, 2001). For example, people high in neuroticism may tend to over-report factors such as recent symptoms of illness, while optimists may under-report such events. It has been said that the use of self-report techniques to assess both stressors and strains may lead to the problem of method variance (Jones & Kinman, 2001). This means that any observed relationship between the constructs of interest may be explained by the research methods.

Another potential limitation of the present study concerned the difficulty of verifying the infectious status of self-reported upper respiratory symptoms. Although an effort was made to exclude possible allergic symptoms, it is conceivable that symptoms that were allergic in origin were included in the analyses.

Finally, correlational studies do not provide information about cause and effect, while the use of a convenience sample may limit the generalizability of the research findings.

CONTRIBUTIONS AND APPLICATIONS OF THE PRESENT STUDY

Despite the above methodological limitations, the present study may help to promote understanding of the role of specific psychosocial factors in the distance runner's susceptibility to upper respiratory tract infections. This knowledge may, in turn, have various applications. For example, such information could be used by health care professionals to devise and implement strategies aimed at keeping the athlete healthy. Interventions and techniques geared towards the prevention and treatment of upper respiratory illness in this group could, in turn, help to promote optimal athletic performance and psychological well-being.

Various strategies for illness prevention are implied by the findings of this study. For example, in the quest for optimal health, distance runners may need to try and minimize their exposure to life changes, regardless of the desirability of these events. This advice is based on evidence that any accumulation of changes in the athlete's normal routine may increase the risk of upper respiratory tract infections. Furthermore, individuals who tend to cope with stress by denying the reality of stressors may need to learn more adaptive coping skills. The research results also suggest that psychosocial intervention strategies aimed at developing the general characteristics of hardiness may be effective in enhancing the athlete's resistance to infectious respiratory illness. The attributes of hardy individuals include a sense of personal control over events in their lives, a deep commitment to all areas of their existence, and a positive view of change (Kobasa, 1979).

In addition to the above strategies, various stress management techniques may play a role in keeping the distance runner healthy. For example, tools such as relaxation training, meditation and biofeedback training may be effective in reducing physiological tension (Cavanaugh, 1997). Stress inoculation may also be a useful strategy for altering stress inducing cognitions (Hughes, Pearson & Reinhart, 1984).

RECOMMENDATIONS FOR FURTHER RESEARCH

Various recommendations for further research on the role of psychosocial factors in disease susceptibility in distance runners can be proposed. Firstly, in order to confirm the findings of the present study, it is recommended that further research is carried out utilizing a larger research sample that is randomly selected from the national database of registered athletes. Additional research using various methods of data collection is also advised. For example, diary techniques, in which participants record events as and when they occur, could be used to obtain information on variables such as exercise behaviour, life events and health problems. Apart from ostensibly yielding more reliable data than questionnaires, self-recorded diaries can indicate the temporal ordering of events (Rosnow & Rosenthal, 1996). This may, in turn, lead to more accurate research conclusions. In addition, clinical diagnosis of symptoms, and the use of tools such as heart rate monitors could provide more objective measures of illness and exercise intensity, respectively. A potential limitation of subjective ratings of exertion is that such measures could be influenced by factors such as depression, neuroticism, femininity and anxiety (Grove, 1995).

The relationship between psychosocial factors and susceptibility to infection in distance runners may be further explored using a longitudinal research design in which subjects are assessed at regular intervals over an extended period of time. An experimental research approach could also be adopted in order to assess the effects of factors such as training workload on the athlete's risk of upper respiratory illness. For example, subjects could be randomly assigned to two groups which are then differentially exposed to an exercise intervention. After a period, the illness incidence of the two groups could be compared in order to determine whether the exercise treatment had any effect.

It is suggested that future studies also consider examining the role of different kinds of life events in infectious disease susceptibility in the population of interest. In this regard, it has been proposed that events that are uncontrollable, unscheduled or undesirable require more adjustment energy than events that are controllable, scheduled or desirable, respectively (Pearlin, 1999; Scully et al., 2000). Consequently, the former kinds of occurrences may be more harmful than events belonging to the latter group. An exploration of these ideas may provide psychologists with a deeper insight into the relationship between life events and infection risk in distance runners.

Another area of research that could merit further investigation is that concerning the relationship between coping and infectious disease. Specifically, it is recommended that future studies assess the proposition that the effects of coping on physical health status mainly depend on factors relating to the situation. For example, it has been proposed that avoidance strategies may generally be adaptive when events are uncontrollable or of short

duration, but could be maladaptive in other situations (Jones & Bright, 2001; Weidner & Collins, 1993). Further research in this area could potentially promote further understanding of the relationship between coping and disease susceptibility in distance runners.

Other relationships that could be explored in future studies include the potential moderating effects of psychosocial factors on disease susceptibility. For instance, it has been suggested that hardiness, approach coping and moderate physical activity can buffer the adverse effects of life events on the risk of physical illness (Manning & Fusilier, 1999; Soderstrom et al., 2000). Conversely, it is thought that avoidance coping and heavy exercise workloads can increase the probability of health problems in response to life changes (Soderstrom et al., 2000; Shephard & Shek, 1999). An investigation of these issues could help clarify the role of psychosocial factors in the disease process in endurance athletes.

In conclusion, the main objective of the present study was to assess the relationship between specific psychosocial factors and susceptibility to the common cold in distance runners. The research findings found support for the hypotheses that life events, avoidance coping and hardiness are related to the athlete's risk of developing an upper respiratory tract infection. Despite certain methodological limitations, the findings of the study are generally consistent with the results of previous research involving the general population. Nevertheless, it is recommended that follow-up studies using alternative methodologies are carried out in order to confirm these results. Further research that is

designed to address several other questions regarding the relationship between psychosocial factors and disease susceptibility in distance runners is also advised.

Overall, this study may prove valuable in enhancing current understanding of the role of life events, coping, hardiness and exercise behaviour in susceptibility to upper respiratory tract infections in individuals such as distance runners.

REFERENCES

- Bartone, P.T., Ursano, R.J., Wright, K.M., & Ingraham, L.H. (1989). The impact of a military air disaster on the health of assistance workers. *The Journal of Nervous and Mental Disease*, 177(6), 317-328.
- Bartrop, R.W., Luckhurst, E., Lazarus, L., Kiloh, L.G., & Penny, R. (1994). Depressed lymphocyte function after bereavement. In A. Steptoe & J. Wardle (Eds.), *Psychosocial processes and health: A reader* (pp. 166-170). New York, US: Cambridge University Press.
- Borysenko, J. (1984). Psychoneuroimmunology: Behavioural factors and the immune response. *Revision*, 7(1), 56-65.
- Brenner, I.K., Shek, P.N., & Shephard, R.J. (1994). Infection in athletes. *Sports Medicine*, 17(2), 86-107.
- Brookings, J.B., & Bolton, B. (1997). A longitudinal structural equation analysis of stress, hardiness, social support, depression, and illness. *Multivariate Experimental Clinical Research*, 11(3), 109-120.
- Brown, G.W. (1981). Life events, psychiatric disorder and physical illness. *Journal of Psychosomatic Research*, 25(5), 461-473.
- Carver, C.S., Scheier, M.F., & Weintraub, J.K. (1989). Assessing coping strategies: A theoretically-based approach. *Journal of Personality and Social Psychology*, 56(2), 267-283.
- Cassidy, T. (2000). Stress, healthiness and health behaviours: An exploration of the role of life events, daily hassles, cognitive appraisal and the coping process. *Counselling Psychology Quarterly*, 13(3), 293-311.
- Castell, L.M., & Newsholme, E.A. (1997). The effects of oral glutamine supplementation on athletes after prolonged, exhaustive exercise. *Nutrition*, 13, 738-742.
- Cavanaugh, J.C. (1997). *Adult development and aging*. Pacific Grove, CA: Brooks/Cole.
- Clow, A. (2001). The physiology of stress. In F. Jones & J. Bright (Eds.), *Stress: Myth, theory and research* (pp. 47-61). New Jersey, US: Prentice Hall.
- Cobb, J.M., & Steptoe, A. (1996). Psychosocial stress and susceptibility to upper respiratory tract illness in an adult population sample. *Psychosomatic Medicine*, 58, 404-412.

- Cobb, J.M., & Steptoe, A. (1998). Psychosocial influences on upper respiratory illness in children. *Journal of Psychosomatic Research*, 45(4), 319-330.
- Cohen, F. (1995). Measurement of coping. In S.V. Kasl & C.L. Cooper (Eds.), *Research methods in stress and health psychology* (pp. 283-305). Oxford, England: John Wiley & Sons Ltd.
- Cohen, S. (1996). Psychological stress, immunity, and upper respiratory infections. *Current Directions in Psychological Science*, 5(3), 86-90.
- Cohen, S., Doyle, W.J., & Skoner, D.P. (1999). Psychological stress, cytokine production, and severity of upper respiratory illness. *Psychosomatic Medicine*, 61, 175-180.
- Cohen, F., & Lazarus, R.S. (1994). Active coping processes, coping dispositions, and recovery from surgery. In A. Steptoe & J. Wardle (Eds.), *Psychosocial processes and health: A reader* (pp. 348-368). New York, US: Cambridge University Press
- Cohen, S., Line, S., Manuck, S.B., Rabin, B.S., Heise, E.R., & Kaplan, J.R. (1997). Chronic social stress, social status, and susceptibility to upper respiratory infections in nonhuman primates. *Psychosomatic Medicine*, 59(3), 213-221.
- Cohen, S., Tyrrell, D.A., & Smith, A.P. (1991). Psychological stress and susceptibility to the common cold. *New England Journal of Medicine*, 325(9), 606-612.
- Cooper, L., & Bright, J. (2001). Individual differences in reactions to stress. In F. Jones & J. Bright (Eds.), *Stress: Myth, theory and research* (pp. 109-131). New Jersey, US: Prentice Hall.
- Cox, T. (1978). *Stress*. Great Britain: The Macmillan Press Ltd.
- Dillon, K.M., & Totten, M.C. (1989). Psychological factors, immunocompetence, and health of breast-feeding mothers and their infants. *Journal of Genetic Psychology*, 150(2), 155-162.
- Dolbier, C.L., Cocke, R.R., Leiferman, J.A., Steinhardt, M.A., Schapiro, S.J., Nehete, P.N., Perlman, J.E., & Sastry, J. (2001). Differences in functional immune responses of high vs. low hardy healthy individuals. *Journal of Behavioural Medicine*, 24(3), 219-229.
- Dorland's illustrated medical dictionary* (28th ed.) (1994). Philadelphia: W.B. Saunders Co.
- Drummond, P.D., & Hewson-Bower, B. (1997). Increased psychosocial stress and decreased mucosal immunity in children with recurrent upper respiratory tract infections. *Journal of Psychosomatic Research*, 43(3), 271-278.

- Evers, A., Kraaimaat, F., Geenen, R., Jacobs, J., & Bijlsma, J. (2003). Stress vulnerability factors as long-term predictors of disease activity in early rheumatoid arthritis. *Journal of Psychosomatic Research*, 55, 293-302.
- Fife-Scaaw, C. (1998). Surveys and sampling issues. In M. Breakwell, S. Hammond & C. Fife-Schaw (Eds.), *Research methods in psychology* (pp. 99-115). London: Sage Publications.
- Filipp, S.H., Klauer, T., & Ferring, D. (1993). Self-focused attention in the face of adversity and threat. In H.W. Krohne (Ed.), *Attention and avoidance: Strategies in coping with aversiveness* (pp. 268-294). Washington, US: Hogrefe & Huber Publishers.
- Glaser, J.K., Kiecolt-Glaser, R., Speicher, C.E., & Holliday, J. (1985). Stress, loneliness and changes in herpesvirus latency. *Journal of Behavioural Medicine*, 8(3), 249-260.
- Glover, B., & Schuder, P. (1985). *The competitive runner's handbook*. US: Penguin Books.
- Gotovtseva, E.P. Surkina, I.D., & Uchakin, P.N. (1998). Potential interventions to prevent immunosuppression during training. In R.B. Kreider, A.C. Fry & M.L. O'Toole (Eds.), *Overtraining in sport* (pp. 243-272). US: Human Kinetics Publishers.
- Grove, J.R. (1995). An introduction to exercise psychology. In T. Morris & J. Summers (Eds.), *Sport psychology: Theory, applications and issues* (pp. 437-455). Queensland, Australia: Jacaranda Wiley.
- Gwaltney, Jr, JM. (1979). The common cold. In G.L. Mandell, R.G. Douglas & J.E. Bennett (Eds.), *Principles and practice of infectious diseases* (pp. 429-435). US: John Wiley & Sons.
- Gwaltney, Jr, JM. (1979). Pharyngitis. In G.L. Mandell, R.G. Douglas & J.E. Bennett (Eds.), *Principles and practice of infectious diseases* (pp. 435-441). US: John Wiley & Sons.
- Gwaltney, Jr, JM. (1979). Acute laryngitis. In G.L. Mandell, R.G. Douglas & J.E. Bennett (Eds.), *Principles and practice of infectious diseases* (pp. 441-442). US: John Wiley & Sons.
- Hack, V., Strobel, G., Weiss, M., & Weicker, H. (1994). PMN cell counts and phagocytic activity of highly trained athletes depend on training periods. *Journal of Applied Physiology*, 77(4), 1731-1735.
- Hammond, S. (1998). Introduction to multivariate data analysis. In M. Breakwell, S. Hammond & C. Fife-Schaw (Eds.), *Research methods in psychology* (pp. 360-385). London: Sage Publications.

- Hawley, J., & Burke, L. (1998). *Peak Performance. Training and nutritional strategies for sport*. Australia: Allen & Unwin.
- Heath, G.W., Ford, E.S., Craven, T.E., Macera, K.L., Jackson, K.L., & Pate, R.R. (1991). Exercise and the incidence of upper respiratory tract infections. *Medicine and Science in Sports and Exercise*, 23(2), 152-157.
- Holmes, T.H., & Rahe, R.H. (1967). The social and readjustment rating scale. *Journal of Psychosomatic Research*, 11, 213-218.
- Hughes, G.H., Pearson, M.A., & Reinhart, G.R. (1984) Stress: Sources, effects, and management. *Family and Community Health*, 7(1), 47-58.
- Irwin, M., Daniels, M., Bloom, E.T., Smith, T.L., & Weiner, H. (1987). Life events, depressive symptoms, and immune function. *American Journal of Psychiatry*, 144, 437-441.
- Jamner, L.D., Schwartz, G.E., & Leigh, H. (1988). The relationship between defensive and repressive coping styles and monocyte, eosinophile, and serum glucose levels: Support for the opioid peptide hypothesis of repression. *Psychosomatic Medicine*, 50, 567-575.
- Jones, F. & Bright, J. (2001). *Stress: Myth, theory and research*. New Jersey, US: Prentice Hall.
- Jones, F. & Kinman, G. (2001). Approaches to studying stress. In F. Jones & J. Bright (Eds.), *Stress: Myth, theory and research* (pp. 17-45). New Jersey, US: Prentice Hall.
- Kaplan, H.B. (1991). Social psychology of the immune system: A conceptual framework and review of the literature. *Social Science and Medicine*, 33(8), 909-923.
- Keizer, H.A. (1998). Neuroendocrine aspects of overtraining. In R.B. Kreider A.C. Fry & M. L. O'Toole (Eds.), *Overtraining in sport* (pp. 145-167). US: Human Kinetics Publishers.
- Kobasa, S.C. (1979). Stressful life events, personality and health: An inquiry into hardiness. *Journal of Personality and Social Psychology*, 37, 1-11.
- Kobasa, S.C., Maddi, S.R., Puccetti, M.C., & Zola, M.A. (1994). Effectiveness of hardiness, exercise and social support as resources against illness. In A. Steptoe & J. Wardle (Eds.), *Psychosocial processes and health: A reader* (pp. 247-260). New York, US: Cambridge University Press.
- Krohne, H.W. (1993). Vigilance and cognitive avoidance as concepts in coping research. In H.W. Krohne (Ed.), *Attention and avoidance: Strategies in coping with aversiveness* (pp. 19-50). Washington, US: Hogrefe & Huber Publishers.

- Kugler, J. (1994). Stress, salivary immunoglobulin A and susceptibility to upper respiratory tract infection: Evidence for adaptive immunomodulation. *Psychologische Beitrage*, 36, 175-182.
- Lazarus, R.S., & Folkman, S. (1984). *Stress, appraisal and coping*. New York: Springer Publishing Company Inc.
- Leventhal, E.A., Suls, J., & Leventhal, H. (1993). Hierarchical analysis of coping: Evidence from life-span studies. In H.W. Krohne (Ed.), *Attention and avoidance: Strategies in coping with aversiveness* (pp. 71-99). Washington, US: Hogrefe & Huber Publishers.
- Leventhal, H. & Tomarken, A. (1995). Stress and illness: Perspectives from health psychology. In S.V. Kasl & C.L. Cooper (Eds.), *Research methods in stress and health psychology* (pp. 27-55). Oxford, England: John Wiley & Sons Ltd.
- Linde, F. (1987). Running and upper respiratory tract infections. *Scandinavian Journal of Sports Science*, 9(1), 21-23.
- Mackinnon, L.T. (1994). Current challenges and future expectations in exercise immunology: Back to the future. *Medicine and Science in Sports and Exercise*, 26(2), 191-194.
- Maier, S.F., Watkins, L.R., & Fleshner, M. (1994). Psychoneuroimmunology: The interface between behaviour, brain and immunity. *American Psychologist*, 49(12), 1004-1017.
- Mandell, G.L., Douglas, R.G., & Bennett, J.E. (1979). *Principles and practice of infectious diseases*. US: John Wiley & Sons.
- Manning, M.R., & Fusilier, M. R. (1999). The relationship between stress and health care use: An investigation of the buffering roles of personality, social support and exercise. *Journal of Psychosomatic Research*, 47(2), 159-173.
- May, J.R., Veach, T.L., Reed, M.W., & Griffey, M.S. (1985). A psychological study of health, injury and performance in athletes on the U.S. alpine ski team. *Physician and Sportsmedicine*, 13(10), 111-115.
- May, J.R., Veach, T.L., Southard, S.W., & Herring, M.W. (1985). The effects of life change on injuries, illness and performance in elite athletes. In N.K. Butts, T.T. Gushikin & B. Zarins (Eds.), *The elite athlete* (pp. 171-179). Jamaica & New York: Spectrum Publishing.
- McBurney, D.H. (1998). *Research methods*. California: Brooks/Cole.
- Melamed, S., Kushnir, T., Strauss, E., & Vigiser, D. (1997). Negative association

- between reported life events and cardiovascular disease risk factors in employed men: The CORDIS study. *Journal of Psychosomatic Research*, 43(4), 247-258.
- Murberg, T.A., Furze, G., & Bru, E. (2004). Avoidance coping styles predict mortality among patients with congestive heart failure: A 6-year follow-up study. *Personality and Individual Differences*, 36, 757-766.
- Ng, D.M., & Jeffery, R.W. (2003). Relationships between perceived stress and health behaviours in a sample of working adults. *Health Psychology*, 22(6), 638-642.
- Nieman, D.C. (1994). Exercise, infection and immunity. *International Journal of Sports Medicine*, 15, 131-141.
- Nieman, D.C. (1996). The immune response to prolonged cardiorespiratory exercise. *American Journal of Sports Medicine*, 24(6), 98-103.
- Nieman, D.C. (1997). Risk of upper respiratory tract infection in athletes: An epidemiologic and immunologic perspective. *Journal of Athletic Training*, 32(4), 344-350.
- Nieman, D.C. (2000). Is infection risk linked to exercise workload? *Medicine and Science in Sports and Exercise*, 32(7, suppl), s406-411.
- Nieman, D.C., Johanssen, L.M., Lee, J.W., & Arabatzis, K. (1990). Infectious episodes in runners before and after the Los Angeles Marathon. *The Journal of Sports Medicine and Physical Fitness*, 30(3), 316-328.
- Nieman, D.C., Johanssen, L.M., & Lee, J.W. (1989). Infectious episodes in runners before and after a road race. *Journal of Sports Medicine and Physical Fitness*, 29(3), 289-296.
- Nieman, D.C., Buckley, K.S., Henson, D.A., Warren, B.J., Suttles, J., Ahle, J.C., Simandle, S., Fagoaga, O.R., & Nehlsen-Cannarella, S. (1995). Immune function in marathon runners versus sedentary controls. *Medicine and Science in Sports and Exercise*, 27(7), 986-992.
- Nieman, D.C., Henson, D.A., Gusewitch, G., Warren, B.J., Dotson, R.C., Butterworth, D.E., & Nehlsen-Cannarella, S.L. (1993). Physical activity and immune function in elderly women. *Medicine and Science in Sports and Exercise*, 25(7), 823-831.
- Nieman, D.C., Nehlsen-Cannarella, S.L., Markoff, P.A., Balk-Lamberton, A.J., Yang, H.,

- Chritton, D.B., Lee, J.W., & Arabatzis, K. (1990). The effects of moderate exercise training on natural killer cells and acute upper respiratory tract infections. *International Journal of Sports Medicine*, 11, 467-473.
- Noakes, T.D. (2001). *Lore of Running*. South Africa: Oxford University Press.
- Norris, R., Carroll, D., & Cochrane, R. (1992). The effects of physical activity and exercise training on psychological stress and well-being in an adolescent population. *Journal of Psychosomatic Research*, 36(1), 55-65.
- Nowack, K.M. (1989). Coping style, cognitive hardiness, and health status. *Journal of Behavioural Medicine*, 12(2), 145-158.
- Nowack, K.M. (1991). Psychosocial predictors of health status. *Work and Stress*, 5(2), 117-131.
- O'Leary, A. (1990). Stress, emotion and human immune function. *Psychological Bulletin*, 108(3), 363-382.
- O'Toole, M.L. (1998). Overreaching and overtraining in endurance athletes. In R.B. Kreider, A.C. Fry & M.L. O'Toole (Eds.), *Overtraining in sport* (pp. 3-17). US: Human Kinetics Publishers.
- Oxford advanced learner's dictionary of current English* (4th ed.) (1992). Oxford: Oxford University Press.
- Paffenbarger, R.S., Hyde, R.T., Wing, A.L., & Hsieh, C. (1986). Physical activity, all cause mortality, and longevity of college alumni. *New England Journal of Medicine*, 314, 605-613.
- Pearlin, L.I. (1999). Stress and mental health: A conceptual overview. In A.V. Horwitz, & T.L. Scheid (Eds.), *A handbook for the study of mental health: Social contexts, theories and systems* (pp. 161-175). New York, US: Cambridge University Press.
- Pedersen, B.K., Rohde, T., & Zacho, M. (1996). Immunity in athletes. *Journal of Sports Medicine and Physical Fitness*, 36, 236-245.
- Peters, E.M., & Bateman, E.D. (1983). Ultramarathon running and upper respiratory tract infections: An epidemiological survey. *South African Medical Journal*, 64(15), 582-584.
- Peters, E., Goetzsche, J.M., Grobbelaar, B., & Noakes, T.D. (1993). Vitamin C supplementation reduces the incidence of upper respiratory tract infection in ultramarathon runners. *American Journal of Clinical Nutrition*, 57, 170-174.
- Pierce, E.F. (2002). Relationship between training volume and mood states in

- competitive swimmers during a 24-week season. *Perceptual and Motor Skills*, 94, 1009-1012.
- Prokop, C.K. (1991). Stress and illness. In V.J. Derlega, B.A. Winstead & W.H. Jones (Eds.), *Personality: Contemporary theory and research* (pp. 481-508). Chicago, US: Nelson-Hall Inc.
- Rahe, R.H., Mahan, J.L., Arthur, R.J. & Gunderson, E. (1970). The epidemiology of illness in naval environments. 1. Illness types, distribution, severities, and relationship to life change. *Military Medicine*, 135(6), 443-452.
- Reber, A.S. (1995). *Dictionary of psychology*. England: Penguin Books.
- Rosnow, R.L., & Rosenthal, R. (1996). *Beginning behavioural research: A conceptual primer*. New Jersey: Prentice Hall.
- Roth, D.L., Wiebe, D.J., Fillingim, R.B., & Shay, K.A. (1989). Life events, fitness, hardiness, and health: A simultaneous analysis of proposed stress-resistance effects. *Journal of Personality and Social Psychology*, 57(1), 136-142.
- Schweigert, W.A. (1994). *Research methods and statistics for psychology*. California: Brooks/Cole.
- Scully, J.A., Tosi, H., & Banning, K. (2000). Life event checklists: Revisiting the Social Readjustment Rating Scale after 30 years. *Educational and Psychological Measurement*, 60(6), 864-876.
- Selye, H. (1975). Implications of stress concept. *New York State Journal of Medicine*, 75(12), 2139-2145.
- Shephard, R.J., Kavanagh, T., Mertens, D.J., Qureshi, S., & Clark, M. (1995). Personal health benefits of Masters athletics competition. *British Journal of Sports Medicine*, 29(1), 35-40.
- Shephard, R.J., & Shek, P.N. (1999). Exercise, immunity and susceptibility to infection. *Physician and Sportsmedicine*, 27(6), 47-59.
- Soderstrom, M., Dolbier, C., Leiferman, J., & Steinhardt, M. (2000). The relationship of hardiness, coping strategies, and perceived stress to symptoms of illness. *Journal of Behavioural Medicine*, 23(3), 311-328.
- Steiner, H., Erickson, S.J., Hernandez, N.L., & Pavelski, R. (2002). Coping styles as correlates of health in high school students. *Journal of Adolescent Health*, 30(5), 326-335.

- Stroebe, W. (2000). *Social psychology and health*. Buckingham, UK: Open University Press.
- Suls, J., & Fletcher, B. (1985). The relative efficacy of avoidant and nonavoidant coping strategies: A meta-analysis. *Health Psychology, 4*(3), 249-288.
- Tom Cottrell's Old Mutual runners' guide to road races in South Africa* (2004). Parklands: Guide Book Publications
- Totman, R., Kiff, J., Reed, S.E., & Craig, W. (1980). Predicting experimental colds in volunteers from different measures of recent life stress. *Journal of Psychosomatic Research, 24*, 155-163.
- Vingerhoets, A. (1985). *Psychosocial stress: An experimental approach: Life events, coping and psychobiological functioning*. Lisse: Swets & Zeitlinger.
- Weidner, G., & Collins, R.L. (1993). Gender, coping and health. In H.W. Krohne (Ed.), *Attention and avoidance: Strategies in coping with aversiveness* (pp. 241-265). Washington, US: Hogrefe & Huber Publishers.
- Weidner, T.G., & Sevier, T.L. (1996). Sport, exercise and the common cold. *Journal of Athletic Training, 31*(2), 154-159.
- Williams, D., & Lawler, K.A. (2001). Stress and illness in low-income women: The roles of hardiness, John Henryism and race. *Women and Health, 32*(4), 61-75.

