Leisure-Time Physical Activity in Individuals with Osteoporosis: Associations with Psychological Well-Being

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Abstract

With approximately 16% of the Canadian population living with osteoporosis, and rates expected to increase (Osteoporosis Canada, 2009), cost-effective treatment modalities that improve bone health and psychological well-being reflect an important public health agenda. Physical activity has been implicated as one non-pharmaceutical mechanism to help improve psychological well-being in the general population (Fox, Stathi, McKenna, & Davis, 2007) and in people diagnosed with osteoporosis (Osteoporosis Canada, 2007). The purpose of this investigation was to determine the association between leisure-time physical activity (LTPA) and well-being in people diagnosed with osteoporosis. A secondary purpose, using Basic Needs Theory (BNT; Deci & Ryan, 2002) was to determine if the fulfillment of three psychological needs (i.e., competence, autonomy and relatedness) mediated the relationship between LTPA and well-being. People diagnosed with osteoporosis ($N = 190$; $M_{age} = 68.14$; $SD_{age} = 11.54$) were asked to complete a battery of questionnaires assessing LTPA, hedonic and eudaimonic well-being and perceived psychological need satisfaction in physical activity contexts. Bivariate correlations revealed a pattern of negligible (*r's* -0.02 to 0.35) to small correlations between LTPA and well-being with contextual positive affect ($r = 0.24$) and subjective vitality ($r = 0.22$) demonstrating statistical significance ($p < .01$). Results of the multiple mediation analysis indicated that perceived satisfaction of the three psychological needs mediated the relationship between LTPA and well-being with perceived competence emerging as a unique mediator. As such, LTPA was positively associated with well-being in people who are diagnosed with osteoporosis, and the fulfillment of the three psychological needs may be the mechanism through which this

effect is carried. Health promotion specialists and practitioners should encourage patients with osteoporosis to engage in LTPA, and support their needs for competence, autonomy and relatedness. Practical implications for researchers and health promotion specialists are discussed in terms of the results of this investigation.

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CHAPTER ONE: INTRODUCTION

Osteoporosis is a skeletal disease characterized by reduced bone density and an increased risk of fractures (World Health Organization [WHO], 1994) with condition diagnosis defined as a bone mineral density 2.50 standard deviations below the average attained by healthy sex and race-matched adults (WHO, 1994). Epidemiological data suggests that approximately 16 % of Canadians over the age of 50 are diagnosed with osteoporosis, with prevalence estimates suggestive that both females and males (1:4 and 1:8 respectively) are afflicted over their lifetime (Tenenhouse et al., 2000). Considerable public health and financial burden is associated with condition diagnosis. Osteoporotic fractures cost the Canadian health care system an estimated 1.3 billion dollars per year (Goeree et al., 1996). Considering the prevalence of osteoporosis in combination with demographic trends in aging (Statistics Canada, 2005), a major public health agenda concerns identifying effective prevention and treatment modalities to offset condition onset or manage progression.

Osteoporosis: Its Genesis

Both uncontrollable and controllable factors contribute to the onset and progression of osteoporosis. Known uncontrollable factors include genetics, age, gender and ethnicity (US Department of Health & Human Services, [USDHHS], 2004) with these factors accounting for between 50 to 90% of bone mass. Genetic makeup influences bone mass accrual by an individual (USDHHS, 2004). It is also responsible for bone structure, rate of bone loss, and bone responsiveness to environmental stimuli such as physical activity and nutrients (USDHHS, 2004). Age affects the risk of developing osteoporosis, with diagnosis associated with advancing age (USDHHS, 2004). Typically,

an individual will attain peak bone mass during late adolescence. During adulthood, bone reabsorption and formation are in equilibrium, therefore bone mass is maintained. Bone density loss begins in midlife for both males and females (USDHHS, 2004). During the ages of 40 to 50 bone loss slowly progresses with a rapid progression during the menopausal transition for females (USDHHS, 2004). During these ages, both males and females may lose up to 25% of their bone density, which can lead to osteoporotic fractures and increased bone fragility (USDHHS, 2004). Gender is an important risk factor for osteoporosis, with more females than males afflicted and conditions specific to females (e.g., amenorrhea and menopause) result in decreased bone density (USDHHS, 2004). Ethnic differences in condition prevalence have been documented with those of Caucasian or Asian descent more likely to have osteoporosis than those of African descent (Dennison, Mohamed, & Cooper, 2006).

It is critical to understand the role of controllable factors in determining osteoporosis as these factors result in the prevention or reduction of bone deterioration which accounts for approximately 10 to 50% of bone mass and structure (USDHSS, 2004; Wolf, Zmuda, Stone, & Cauley, 2000). Controllable factors include lifestyle behaviours such as nutrient intake and daily physical activity. Nutrition plays an integral role in maintaining bone mass. Because bone mass peaks during adolescence, it is important to begin calcium intake at a young age and continue throughout life (USDHHS, 2004). Calcium provides bone-building nutrients and regulates the absorption of these nutrients. Vitamin D aids in the absorption and utilization of calcium, therefore it is important to get enough vitamin D in order to maintain bone health with calcium. Finally,

low body weight, smoking cigarettes, alcohol abuse and caffeine intake are associated with low bone mass (USDHHS, 2004).

Physical activity is an important controllable lifestyle factor associated with increasing or preventing bone loss. Research suggests that engagement in physical activity compares favourably to the effects of calcium supplementation (Wolff, van Croonborg, Kemper, Kostense, &Twisk, 1999). Physical activity aids in bone health across the lifespan, as bones are responsive to the mechanical load placed upon the skeleton (Bouchard, Blair, & Haskell, 2006; USDHHS, 2004). Various physical activities, particularly load-bearing activities, are recommended in the prevention and treatment of osteoporosis as cross-sectional and longitudinal data have demonstrated their role in increasing bone mineral density, improving mobility, reducing the risk of falls, and decreasing fracture risk (Bouchard et al., 2006; Fiatarone et al., 1990; Lock, Lecouturier, Mason, & Dickenson, 2006; Mackelvie, McKay, Khan, & Crocker, 2003; USDHHS, 2004). Increased physical activity has also been implicated in the prevention of comorbidities such as cardiovascular disease, diabetes, some cancers, and also helps control weight (USDHHS, 2004).

Well-being: An Overview

Historically, psychological health has been conceptualized to reflect the presence of mental disorders (e.g., depression) or health-related ailments (e.g., disease and disability; Keyes, Shmotkin, & Ryff, 2002). Criticized for being restrictive in focus (e.g., Keyes et al., 2002) advocates have endorsed a conceptualization of psychological health as more than simply the absence of a diagnosable disorder-- a tradition which emanates from a biomedical focus on health. This more broadly defined view of health was

adopted by the World Health Organization (WHO) Constitution in which psychological health was described as; a state of "well-being in which an individual realizes his or her own abilities, can cope with the normal stress of life, can work productively and fruitfully, and is able to make a contribution to his or her community" (WHO, 2005, p. 2). The view promoted through the WHO has translated into the dichotomization of psychological health into ill-being or well-being, with the former characterized by the presence of diagnosable illness (e.g., depression, high blood pressure) and the later reflective of optimal psychological experiences and functioning (Deci & Ryan, 2008).

With the distinction between ill and well-being established, research efforts have focused on addressing a variety of empirical questions including those centering on definitions, measurement, causes and consequences. Examination of the extant literature has classified well-being research into one of two traditions: hedonic and eudaimonic (Ryan & Deci, 2001). Hedonic well-being (also known as subjective well-being; Ryan & Deci, 2001) refers to an internal state that represents evaluations about the quality of one's life, broadly defined. Hedonic well-being is often represented by the presence of life satisfaction and positive affect and the absence of negative affect (Ryan & Deci, 2001; Ryan, Huta, & Deci, 2008). Eudaimonic well-being refers to living a complete human life, or realizing human potentials (Ryan & Deci, 2001). Conceptually, eudaimonic well-being has been promoted as being related to, but distinct from, the hedonistic tradition, as it has been argued that happiness is not a direct outcome of well-being (Ryan & Deci, 2001; Ryff & Keyes, 1995). Although the distinction between approaches is not universally endorsed (King & Hicks, 2007; Nave, Sherman, & Funder, 2008), it has been argued that eudaimonic well-being considers the content of one's life

and the processes associated with living well, whereas hedonic well-being considers outcomes associated with happiness (Ryan et al., 2008). Empirical findings have supported the above tenants with markers of hedonic well-being correlating more strongly with subjective experiences (i.e., excitement, relaxation, and contentment) whereas eudaimonic well-being demonstrates patterns of association more strongly linked with opportunities to realize human potentials (e.g., clear goals, effort expended; Waterman, 2007).

Examining Variations in Hedonic and Eudaimonic Well-being

The relationship between personality and well-being has been extensively investigated with two traits, extraversion and neuroticism, the dimensions most consistently associated with individual differences in well-being. Based on meta-analytic findings, DeNeve and Cooper (1998) demonstrated that personality variables were associated with 4% of the variance for all indices of hedonic well-being with small bivariate correlations between extraversion ($r = 0.17$) and neuroticism ($r = -0.22$) the strongest predictors. Steel, Schmidt and Shultz (2008) suggest that the personality-well-being relationship documented by DeNeve and Cooper (1998) was weaker than expected due to measurement commensurability (i.e., when researchers collapse disparate measures into one global index). Based on the meta-analytic findings of Steel et al. (2008), the relationship between extraversion and neuroticism with indices of well-being was up to four times greater than reported by DeNeve and Cooper (1998) with as much as 39% of hedonic well-being variance accounted for by personality. Similar findings between extroversion and neuroticism have been documented with variation in eudaimonic well-being (Abbott et al., 2008; Schmutte & Ryff, 1997).

Well-being has been shown to have a small pattern of association on varied physical health outcomes (Lyubomirsky, King, & Diener, 2005; Pressman & Cohen, 2005) with meta-analytic data suggestive that hedonic well-being and ill-being have a differential impact on objective health markers (Howell, Kern, & Lubomirsky, 2007). Howell et al. (2007) demonstrated that higher levels of hedonic well-being were more likely to enhance functioning ($r = 0.14$) and higher levels of ill-being were more likely to decrease functioning ($r = -0.10$). Furthermore, hedonic well-being impacted short and long term health outcomes and forestalled disease related decline (Howell et al., 2007).

Considerably less research attention has been devoted to the link between eudaimonic forms of well-being and physical health outcomes. Further, research investigating this link has employed non-experimental designs, which afford minimal opportunity to offer causal claims (Trochim, 2001). Despite its relative empirical infancy, findings between eudaimonic well-being and physical health outcomes complement those embedded in the hedonic literature with patterns of relationships between biological markers and ill-being, hedonic and eudaimonic well-being found (Ryff, Singer, & Love, 2004; Ryff et al., 2006). More specifically, lower biological risk as assessed through cardiovascular (e.g., HDL cholesterol, systolic blood pressure) and neuroendocrine (e.g., cortisol, norepinephrine) markers were associated with higher eudaimonic well-being (Ryff et al., 2006). Finally, mortality and disease have been linked more to the absence of eudaimonic well-being than the presence of hedonic well-being (Clark & Watson, 1991; Huppert & Whittington, 2003). Taken together, these research findings suggest that well-being demonstrates meaningful associations with health indicators.

Well-being in those Diagnosed with Osteoporosis

Consequences associated with a diagnosis of osteoporosis are not limited to physical implications (e.g., reduced mobility, increased fracture risk), but extend to psychological outcomes (Bianchi et al., 2005). Women diagnosed with osteoporosis report greater incidence of depression and anxiety than women without osteoporosis (Coelho, Silva, Maia, Prata, & Barros, 1999; Gold, 2001). Depression has also been associated with lifestyle behaviours such as increased smoking and alcohol intake and physical inactivity which may result in condition progression (Mezuk, Eaton, & Goldon, 2008).

When considering well-being markers examined in people diagnosed with osteoporosis, quality of life, a hedonic form of well-being, appears to be the most commonly used outcome. Quality of life indicators demonstrate that 41% of females diagnosed with the condition report reduced quality of life (Bianchi et al., 2005) with reductions in quality of life and health-related quality of life lower than asymptomatic populations (Adachi et al., 2001; Lips & van Schoor, 2005; Papaioannou, 2006; Rabenda et al., 2007). Moreover, individuals diagnosed with osteoporosis self-report decrements in quality of life similar to those with other chronic conditions (i.e., arthritis and diabetes) (Sawka et al., 2005). Various demographic and health status variables are associated with reductions in quality of life including: advanced age; level of education; the number of concomitant diseases; pain severity; physical inactivity; vitamin D insufficiency and; fracture status (Basaran, Guzel, Coskun-Benlidayi, & Guler-Uysal, 2007; Hopman et al., 2006; Salaffi et al., 2007).

The bulk of well-being research examining people with osteoporosis has considered fracture status, with associations found between existing fractures, history of

fractures and quality of life (Adachi et al., 2001; Oleksik et al., 2000). Using both condition specific and global measures of health-related quality of life in those diagnosed, Salaffi et al. (2007) reported those with vertebral fractures had a decreased quality of life as a function of the number of fractures sustained, presence of comorbid conditions, and age compared to individuals without fractures. Ekstrom, Ivanoff and Elmstahl (2008) found that people with osteoporosis who have sustained a fracture reported reduced life satisfaction compared to non-fractured controls. Location of the fracture has been shown to differentially impact quality of life with vertebral fractures associated with decrements moreso than either hip or wrist fractures (Oskar et al., 2008).

Extending to other well-being indices recent research by Gunnell, Mack, Wilson, Oster, and Grattan, (2009) noted that Canadian's with osteoporosis reported good levels of self-perceived health, mental health, and satisfaction with life. This contradictory finding may be attributable to the use of single-item vs. multiple item indicators typically evident in the health literature (Devellis, 2003). Further, comparisons with other known groups (e.g., other diagnosed conditions) were not made to note whether well-being was comparable to other cohorts.

Physical Activity and Well-being in those Diagnosed with Osteoporosis

Physical activity has been forwarded as one plausible mechanism for promoting psychological health (Health Canada, 2008; Osteoporosis Canada, 2008, WHO, 2008). Narrative and meta-analytic reviews have found small effects in general (Bize, Johnson, & Plotnikoff, 2007; Fox, 2002) and older (Netz, Wu, Becker, & Tenenbaum, 2005) adult populations with regular physical activity associated with lower ill-being (e.g., depression; Craft & Landers, 1998) and improved psychological well-being (e.g., self-

esteem; Biddle, Fox, & Boutcher, 2000). Older adults with chronic conditions have also reported higher hedonic well-being with increased physical activity (Courneya & Friedenreich, 1999; Rejeski, Brawley, & Shumaker, 1996). However, investigations examining psychological well-being and physical activity have generally examined structured exercise or fitness levels (Renno, Granito, Driusson, Costa, & Oishi, 2005) as their outcome measures as opposed to leisure-time physical activity (Fox et al., 2007) Recognizing this limitation, Fox and colleagues (2007) investigated lifestyle physical activity and indices of hedonic well-being and found consistent positive, but weak relationships *(r's* = 0.20 to 0.28) in non-clinical older adults.

Cross-sectional and intervention based research using people diagnosed with osteoporosis and osteopenia (a risk factor for osteoporosis), have found significant positive associations between quality of life, life satisfaction and structured exercise (Chien, Yang, & Tsauo, 2005; Kemmler et al., 2002; Liu-Ambrose et al., 2005). For example, agility training, strength training and muscle strength (an index of physical fitness as opposed to physical activity) have been associated with significantly improved health-related quality of life and quality of life (Carter et al., 2002; Hongo et al., 2007; Mikaykshi et al., 2007). Further, associations between health-related quality of life and baseline levels of physical activity were found (Liu-Ambrose et al., 2005). Finally, a home based-exercise intervention found a 7% increase in quality of life in individuals with osteoporosis compared to no change in healthy controls that were not prescribed an exercise program (Hongo et al., 2007).

Research has demonstrated associations between physical activity, quality of life (Basaran, et al., 2008; Malmros, Mortensen, Jensen, Charles, 1998; Papaioannou et al.,

2003), health-related quality of life (Papaioannou et al., 2006), and psychological health in people living with osteoporosis (Gunnell et al., 2009) comparable to those found in the general population (Fox et al., 2007). However, these results were only found when the time spent in activity was at least moderate intensity or activity was sustained for several hours a week (Fox et al., 2007; Papaioannou et al., 2006).

Investigations examining the association between physical activity and well-being in individuals with osteoporosis has generally been atheoretical. Theory driven research assists investigators through the articulation of assumptions and hypotheses (Glanz & Rimer, 2005). Consequently, theory can be used in the clarification of key constructs and relationships with outcome variables of interest. Researchers have advocated for the advancement of theory driven research in physical activity contexts (Bauman, Sallis, Dzewaltowski, & Owen, 2002) and psychological well-being research (Ryan & Deci, 2001; Ryff, 1989). Theory based research allows researchers to investigate the specific psychological processes that are regulating behaviour (Rothman, 2004). In other words, the purpose of theory is to disentangle complex human behaviour and provide a parsimonious explanation (Green et al., 1994). Further, theories are not static entities, with any one study providing a limited test of a theory (Weinstein & Rothman, 2005). Extrapolating from the above, theories are dynamic entities that evolve over time. With repeated empirical inquiry, the theory should become better articulated, the underlying processes clarified and the conditions under which the theory holds more accurate.

Theory further helps health-practitioners and interventionists identify specific variables of interest that should be targeted to promote behaviour change or well-being. By specifying which variables are influencing behaviour, theory based research allows

researchers and practitioners to determine *why* an intervention has been successful (Rothman, 2004). Moreover, theory-based research has greater practical value in that the practitioners will be able to use specific resources and target specific variables to achieve behaviour change. Various health-based theories have been advanced for understanding behaviour change and well-being. One theory that has demonstrated its applicability to understanding a wide spectrum of behaviours and well-being is that of Self-Determination Theory (SDT; Deci & Ryan, 1985; 2002).

Self-Determination Theory: An Overview

Self-Determination Theory (SDT; Deci & Ryan, 1985; 2002) is an organismic dialectical framework for understanding human behaviour. SDT proposes that humans are active growth-oriented organisms who innately strive for challenges in their environments in an effort to actualize their potentials (Deci & Ryan, 2002). Early SDT research examining the factors that influence intrinsic motivation (Deci, 1971) has been expanded to include four subcomponents or "mini-theories" (Deci & Ryan, 2002; p. 9) that identify the conditions and processes that facilitate sustained behaviour and healthy development. Cognitive Evaluation Theory (CET) describes the factors that promote (or thwart) intrinsic motivation (Ryan & Deci, 2007). Organismic Integration Theory (OIT) examines the concept of internalization, integration of values and regulations in an attempt to explain extrinsically motivated behaviour (Deci & Ryan, 2002). According to Ryan and Deci (2007), OIT is a differentiated approach to understanding the quality of motivation that identifies various types of extrinsic motivation ranging from those that are externally controlled (i.e., less self-determined) to those that are self-endorsed and personally valued (i.e., more self-determined) and thus autonomous. Individuals are

inclined to internalize the regulation of activities initially activated via external factors to the extent to which they are consistent with their sense of self (Deci & Ryan, 2002). Causality Orientation Theory (COT) was formulated in an effort to explain individual differences in the way people orient towards the social environment (Deci & Ryan, 2002). The last of the four mini-theories is that of Basic Needs Theory (BNT). BNT was created to understand the role of competence, autonomy and relatedness needs in relation to motivation, goals, health and well-being (Deci & Ryan, 2002). While the four mini-theories identified comprise SDT (Deci & Ryan, 2002), BNT serves an integral role in the present investigation toward examining the role of leisure-time physical activity (LTPA) on well-being. Consequently, BNT will be further examined with attention to conceptual definitions and anticipated consequences based on SDT.

Basic Needs Theory

Deci and Ryan (2002) posit the existence of three basic psychological needs; competence, autonomy and relatedness that are thought to be universal, innate, and necessary for on-going psychological growth, integrity, and well-being (Deci & Ryan, 2002; Ryan & Deci, 2001). Conversely, when psychological needs are thwarted (or frustrated), negative consequences such as ill-being, maladjustment, and increased fragmentation ensue (Deci & Ryan, 2001). In essence, the concept of psychological needs identify the conditions necessary for well-being and their fulfillment is associated with effective functioning.

Psychological needs have been conceptually differentiated from desires and motives as needs are innate and required by all and when satisfied exert positive effects on well-being (Deci & Ryan, 2000). Moreover, satisfaction of psychological needs have a

functional impact whether they are consciously or unconsciously sought after (Ryan & Deci, 2007). Finally, the complementary role of each psychological need for optimal development has been supported in the theoretical and empirical literature (Deci & Ryan, 2000; Reis, Sheldon, Gable, Roscoe, & Ryan, 2000) such that any one of the three needs cannot be neglected without repercussion.

The identification of the three fundamental needs was derived from both an inductive and deductive line of research (Deci & Ryan, 2000). Competence refers to interacting effectively within the environment while successfully completing challenging tasks (White, 1959). The need for competence is believed to motivate people to seek optimally challenging tasks and continually attempt to maintain and enhance skills (Deci & Ryan, 2002). Autonomy refers to a feeling of sense of volition and agency in a particular behaviour such that actions originate from an internal locus of causality (deCharms, 1968). The need for autonomy is consistent with acting from interest and enjoyment of integrated values in concordance with the self (Deci & Ryan, 2002). Relatedness is the feeling of a meaningful connection or belonging with one's social milieu (Baumeister & Leary, 1995). The need for relatedness is not considered as an outcome (e.g., becoming a spouse) but instead is the psychological sense of belonging (Deci & Ryan, 2002).

Although believed to be universal (Deci & Ryan, 2008), the manner in which psychological needs are satisfied may vary by person, context, or time with the final outcome of need fulfillment resulting in greater endorsement of more self-determined forms of motivation and psychological well-being (Deci & Ryan, 2002). When the basic psychological needs of competence, autonomy, and relatedness are satisfied in specific

contexts, internalization and integration of values and regulations are facilitated (Deci & Ryan, 2000; Ryan & Deci, 2007). People have a natural tendency to internalize the values of their social milieu, a process facilitated by the need for relatedness and competence (Deci & Ryan, 2000). While feelings of competence and relatedness are enough to create introjected values (an extrinsic form of regulation), the process of more self-determined forms of motivation are stimulated through a sense of volition in line with the self (i.e., autonomy; Deci & Ryan, 2000). This contention has been supported empirically with elite swimmers (Pelletier, Fortier, Vallerand, & Briere, 2001). Finally, research has consistently demonstrated that intrinsic and self-determined forms of regulation are associated with greater well-being (Burton, Kydon D'Alessandro, & Koestner, 2006; Ryan, 1995). In sum, the propensity to support the needs for competence, autonomy and relatedness facilitate the process of internalization and integration of external motivations to more self-determined forms which in turn influences well-being (Deci & Ryan, 2000).

Basic Needs Theory and Physical Activity Contexts

Consistent with Deci and Ryan's (2000) contentions, cross-sectional studies in exercise and physical activity contexts have found associations between greater need fulfillment and more self-determined exercise motives (McDonough & Crocker, 2007; Vlachopoulos & Michailidou, 2006; Wilson, Mack, Muon, & LeBlanc, 2007). However, comparably little research has investigated the relationship between psychological need satisfaction and well-being in exercise contexts (Wilson & Rodgers, 2007). A recent systematic review of investigations examining psychological need satisfaction and exercise settings found patterns of small-to-moderate positive relationships between psychological need satisfaction in exercise and well-being (Wilson,

Mack, Gunnell, Oster, & Gregson, 2008). Investigations to date have generally supported the propositions of BNT advocated by Deci and Ryan (2002). For example, satisfaction of the three psychological needs predicted well-being over the course of a 3-month exercise intervention (Edmunds, Ntoumanis & Duda, 2007). Corroborating these findings, Wilson, Longley Muon, Rodgers, and Murray (2006) demonstrated the positive influence of psychological need fulfillment to both hedonic and eudaimonic indices in females in exercise contexts with the aforementioned relationship continuing over time. Finally, the universal nature of need satisfaction (Deci & Ryan, 2002) in exercise contexts has received partial support as gender was not found to moderate the need fulfillment – well-being relationship (Wilson, Mack, Blanchard, & Gray, 2009; Wilson, Mack, & Lightheart, 2008).

Adopting sport as the physical activity context of interest, cross-sectional research demonstrated that autonomy supportive coaching environments were linked to need fulfillment, which in turn was linked to indices of well-being and ill-being (e.g., subjective vitality and physical symptoms) in adolescent soccer and cricket players with perceived competence the strongest predictor (Reinboth, Duda & Ntoumanis, 2004). Corroborating these findings, greater satisfaction of the need for competence followed by autonomy then relatedness has been found within exercise contexts (Wilson, Rodgers, Fraser, & Murray, 2004; Wilson et al., 2008). Recent research by Perreault and colleagues (2007) investigating the relationship between need satisfaction and athlete burnout (a form of ill-being) demonstrated that each of the three psychological needs was negatively associated with burnout. Extending beyond cross-sectional research Reinboth and Duda (2006) demonstrated that athlete changes in need satisfaction over a 5-month

period was a significant predictor for changes in eudaimonic well-being. Diary studies of US adolescent gymnasts found that daily need satisfaction predicted increases in daily well-being (e.g., subjective vitality and self-esteem) (Gagné, Ryan & Bargman, 2003). However, no study has explicitly examined the mediational role of need fulfillment between LTPA and well-being.

Research Questions

The proposed research aimed to examine the association between LTPA and markers of well-being in people who self-report or have a confirmed diagnosis of osteoporosis. To this end, the following hypotheses were advanced. Recent non-experimental research (Gunnell et al., 2009; Papaioannou et al., 2006) demonstrated that physical activity was associated with increased hedonic well-being in people diagnosed with osteoporosis. To date, no research has explicitly examined the relationship between LTPA and eudaimonic well-being in individuals living with osteoporosis. However, given the association between markers of hedonic and eudaimonic well-being (e.g., Kashdan, Biswas-Diener & King in press; Waterman, 2007) and Ryan et. al's (2008) suppositions advocating the engagement in health behaviours toward the promotion of eudaimonic forms of well-being (Ryff & Singer, 2008), it was hypothesized that those who engaged in greater LTPA would have greater eudaimonic and hedonic well-being than those who engaged in less LTPA. Specifically, those who reported higher LTPA would report greater forms of hedonic well-being and eudaimonic well-being.

A secondary aim of this investigation was to examine the mediational role of perceived psychological need satisfaction between LTPA and markers of well-being. On the basis of SDT (Deci & Ryan, 1985; 2002) and previous research (Vallerand & Losier,

1999; Vallerand & Ratelle, 2002), it is hypothesized that perceived psychological need satisfaction would mediate the LTPA and well-being relationship regardless of whether the measure reflects a hedonic or eudaimonic dimension.

Significance of Proposed Research

While literature examining the biomedical consequences of physical activity and bone health in osteoporotics is plentiful (Johnell & Hertzman, 2006), literature examining the impact of physical activity on psychological health is scant in comparison. Consequently, at least six notable lines of research warrant further inquiry. The areas span sample characteristics, measurement of study variables, analytic considerations, theoretical advancement, and health promotion considerations. First, the primary focus of investigations examining well-being on individuals with osteoporosis has centred on the impact of fractures as opposed to condition diagnosis or severity (e.g., Papaioannou et al., 2003; 2006). Given that 13% of men and 40% of women over the age of 50 are estimated to experience an osteoporosis-related fracture (Adachi et al., 2003), our knowledge of well-being in this population remains limited in scope and underdeveloped and the external validity of findings are limited to those who have experienced a fracture only. The present investigation will employ a more heterogeneous sample and be inclusive to all who self-report a physician diagnosis of osteoporosis regardless of fracture status.

Second, research examining the relationship between physical activity and well-being in those diagnosed with osteoporosis has generally focused on indices of ill-being (e.g., depression) or hedonic well-being as assessed through quality of life (Bianchi et al., 2005; Coelho et al., 1999). While this line of research has been meaningful, measuring ill-being is insufficient as the presence of ill-being does not guarantee high levels of

hedonic well-being due to the negative mood produced by condition diagnosis and its related implications (Keyes, et al., 2002; Ryan & Deci, 2001). Given that the bulk of the literature has examined quality of life indicators only, our knowledge pertaining to well-being in people with osteoporosis is limited. Quality of life indicators do not fully capture hedonic well-being because they do not measure affective states, a definitional aspect of hedonic well-being (Ryan & Deci, 2001). Indices of hedonic well-being as conceptualized as by the presence of positive affect and the absence of negative affect will further elucidate affective states experienced through participation in LTPA. It is important to fully encapsulate well-being as represented by both eudaimonic and hedonic forms as eudaimonic well-being defines what well-being is whereas subjective well-being (or hedonic well-being) describes why people are happy (Ryan & Deci, 2001). Through the assessment of hedonic markers, the affective dimension of well-being is considered. Eudaimonic well-being does not consider affective dimensions, however, consideration of eudaimonic markers in a population of individuals living with osteoporosis allows for illness to be present whereas, by definition, ill-being and hedonic well-being do not (Ryan & Deci, 2001). Moreover, available research indicates that it is the absence of eudaimonic well-being rather than the presence of ill or hedonic well-being that is linked with health and mortality (Clark & Watson, 1991; Huppert & Whittington, 2003).

Third, the bulk of the literature investigating well-being and physical activity in those diagnosed with osteoporosis has generally been limited to include measures of structured (or purposeful) exercise (Reno, Granito, Driusso, Cost, & Oishi, 2005) or fitness outcomes (Lombardi, Oliveira, Mayer, Jardim, & Natour, 2005) as opposed to LTPA. LTPA refers to any form of physical activity that is performed in the individuals'

leisure time that increases energy expenditure (Bouchard et al., 2006). The ability of structured exercise to demonstrate close relationships with physical and psychological health outcomes may be limited as exercise accounts for only a proportion of total energy expenditure (Tremblay, Esliger, Tremblay, & Colley, 2007). Despite the compelling evidence that positive health benefits can accrue from LTPA (Bouchard et al., 2006), research-examining people diagnosed with osteoporosis has largely considered only structured exercise (Hongo et al., 2007; Papaioannou et al., 2003). Therefore, an important research priority concerns the degree to which LTPA is associated with well-being.

Fourth, research examining factors influencing well-being in individuals diagnosed with osteoporosis has measured varied dimensions of physical activity (e.g., LTPA; Adachi et al., 2001; 2003; Dennison, Syddell, Statham, Sayer, & Cooper, 2006; Kotz, Deleger, Cohen, Kamigaki, & Kurata, 2004). However, in pursuit of the primary study objective (e.g., fracture status and well-being; Adachi et al., 2001; 2003), the effects of physical activity have been statistically controlled which negates the examination of its relationship with well-being. Despite the growth in literature supporting the associations between physical activity and psychological health (Fox et al., 2007), research examining psychological well-being and physical activity in those diagnosed with osteoporosis is limited in part due to researchers decision to statistically adjust for its influence.

Fifth, this line of inquiry has restricted analysis to a mere description of the association between physical activity and well-being. In their meta-analysis, Netz and colleagues (2005) advocated for future research to determine the mediating variables

underlying the link between physical activity and well-being such that physical activity programs can be successfully implemented in advanced age. It is important to test contentions that fulfillment of SDT's psychological needs serve as mediators (Vallerand & Losier, 1999; Vallerand & Ratelle, 2002) to enhance our understanding of the LTPA-well-being relationship and the mechanisms occurring within SDT (i.e., fulfillment of the psychological needs). Ryan and Deci (2001) have argued for the importance of the three psychological needs proposed within BNT as a useful framework for understanding eudaimonic well-being. Further, the bulk of the literature examining associations between physical activity and well-being has been limited to included either a global or a contextual measure of well-being. Using SDT (Deci & Ryan, 2002) and the Hierarchical Model of Intrinsic and Extrinsic Motivation (Vallerand, 2002), Vallerand (2002) has argued that there is a reciprocal interplay between motivation at a global, contextual and situational level. Consequently, conclusions derived from the extant literature were extended to elucidate mechanisms underlying the influence of physical activity on markers of psychological well-being.

Sixth, major health organizations (WHO, 1994; Osteoporosis Canada, 2008) have advocated for increases in physical activity for the prevention and management of osteoporosis as a cost effective treatment modality to improve bone health and well-being. Given these public health initiatives to increase well-being, further elucidation of the mechanisms that contribute to (or detract from) well-being in people diagnosed with osteoporosis is warranted. Valued public and personal health implications may result from sustained research on this underrepresented area of investigation. Ultimately, research-examining mechanisms that promote increased psychological well-being are

beneficial to people living with this condition given the decreased quality of life experienced by this population. Considering Canada's aging population, intervention strategies, which seek to improve the lives of individuals who have osteoporosis, are of utmost importance and warrant further investigation.

CHAPTER TWO: METHODS

Participants

Participants ($N = 190$) were individuals who either a) self-reported a diagnosis of osteoporosis by their physician (69.00%) or b) had a physician (31.00%) diagnosis of osteoporosis confirmed following a review of their medical charts. A minimum target sample size ($N = 85$) was determined based on an *a priori* power analysis using Cohen's (1992) guidelines assuming a fixed alpha ($\alpha = .05$), a desired power (.80), and a medium effect size ($d = .50$) consistent with research examining well-being[1]. Participant recruitment was guided by the following inclusion criteria: a self-reported or physician diagnosis of osteoporosis, over the age of 18 years, and able to read and converse in English.

Measures

Demographics. Demographic variables were queried for descriptive purposes including: birth date, height, weight, gender, marital status, ethnic origin, educational attainment, fracture history, and family history of osteoporosis (see Appendix M).

Health Status. Participants were asked to indicate a diagnosis of various comorbidities such as; heart disease, high blood pressure, cancer, bowel/Crohn's/colitis, diabetes or stomach ulcers. The above chronic conditions were selected based on their inclusion in the Canadian Community Health Survey (cycle 2.2) and were responded to in a dichotomous (Yes/No) format. Participants were also afforded the opportunity to report other physician diagnosed chronic conditions and physician prescribed medications in an open-ended format (see Appendix M).

Stages of Change for Physical Activity. The Stages of Change for Physical Activity (SOCPA; Mullan & Markland, 1997; see Appendix M) is a 5-item measure of a person's readiness to change health behaviours consistent with the Transtheoretical Model (TTM; Prochaska & DiClemente, 1984). The following definition of LTPA was provided "Any bodily movement produced by skeletal muscles that results in a substantial increase over the body's energy expenditure" followed by examples of activities consistent with this definition. Following the stem "according to the definition provided above, do you participate in LTPA" participants indicated which of five response options closely reflected their behaviour. One example item was "yes, I have been regularly engaged in health-enhancing physical activity but for less than 6 months." Consistent with the tenants of TTM, each stage of change was reflected by one item (Prochaska & DiClemente, 1984).

Eudaimonic Well-Being. The Subjective Vitality Scale (SVS; Ryan & Frederick, 1997; see Appendix M) is a measure of eudaimonic well-being consisting of 7-items assessing participant's perceptions of aliveness and energy. To assess global eudaimonic well-being, the following stem was provided "please respond to each of the following statements by indicating the degree to which the statement is true to you in general in your life". Participants were oriented to contextual eudaimonic well-being via the following stem "please respond to each of the following statements by indicating the degree to which the statement is true for you when you engage in health-enhancing physical activity". Each item was rated across a 7 point Likert-scale anchored at the extremes from 1 (not at all true) to 7 (very true). An example item is "I feel alive and

vital". Based on participant responses, an overall score is computed with higher scores reflecting greater eudaimonic well-being.

Bostic and colleagues (2000) have supported the 7-item scale through structural equation modeling processes ($\chi^2 = 50.51, p < .01$; GFI = 0.95; AGFI = 0.90; NFI = 0.91; RMSEA = 0.10; Bostic, Rubio, & Hood, 2000). Construct validity has been demonstrated with patterns of correlations between SVS and other measures of well and ill-being in the hypothesized direction (Edmunds et al., 2007; Ryan & Fredrick, 1997; Vallerand et al., 2007). Estimates of internal consistency (i.e., Cronbach α's > 0.81; Cronbach, 1951) in global (Edmunds et al, 2007; Wilson et al., 2006; Vallerand et al., 2007) and contextual (i.e., sport; Adie, Duda, & Ntoumanis, 2008) contexts have been demonstrated. When employed with older adults, estimates of internal consistency ($\alpha = 0.82$) for the SVS have been reported (Kasser & Ryan, 1999).

Hedonic Well-being. The Positive and Negative Affect Scale (PANAS; Watson, Clark & Tellegen, 1988) is a 20-item questionnaire assessing positive and negative affect (Crawford & Henry, 2004; Watson, et al., 1988; see Appendix M). As with eudaimonic well-being both global and contextual versions of this scale were used. Following global and contextual stems, "indicate to what extent you have felt this way during the past few weeks", and "indicate to what extent you generally feel this way when you engage in health-enhancing physical activity, that is, how you feel on average when you engage in health-enhancing physical activity" respondents were asked to indicate on a scale of 1 (very slightly or not at all) to 5 (very much) the extent to which they have experienced each emotion within that past couple of weeks. A sample item representing positive affect is "enthusiastic" and negative affect is "scared". Higher scores for positive affect are

reflective of the individual feeling enthusiastic, active and alert whereas higher scores for negative affect reflect greater perceptions of distress (Voogt et al., 2005).

Following Larson and Dieners' (1992) supposition that the original PANAS may not be an adequate measure of affect due to higher correlations between positive and negative affect in the elderly, Kercher (1995) conducted a psychometric investigation of the PANAS in this cohort. Based on Watson et al.'s (1988) initial work in college-aged people, 10-items reflecting positive (excited, enthusiastic, alert, inspired and determined) and negative (distressed, upset, scared, nervous and afraid) dimensions of affect typically experienced (Kercher, 1995) were selected. Confirmatory and exploratory factor analysis in Kercher's research replicated Watson et al., (1988) results, indicating structural and discriminant validity. Construct validity was further corroborated by research examining the use of the 10-item PANAS across the lifespan (Mackinnon et al., 1999) with invariance for age demonstrated. Coefficient alphas (Cronbach, 1951) for global (α's > 0.75) (Kercher, 1995; Mackinnon et al., 1999) and exercise contexts (α's > 0.85; Wilson et al., 2009) have been reported. Non-significant correlations between negative and positive affect (r = -0.02, p > .05) have been noted using the 10-item PANAS (Hilleras, Jorm, Herlitz & Winblad, 1998; Kercher, 1995) demonstrating divergent validity.

Leisure-Time Physical Activity. The Godin Leisure Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985; see Appendix M) is a 3-item measure of physical activity that assesses the frequency of mild, moderate and strenuous exercise lasting at least 15 minutes per session during a typical week. Instructions directed respondents to indicate the number of times in a typical 7-day period strenuous (e.g., heart beats rapidly), moderate (e.g., not exhausting) and mild activity (e.g., minimal effort) was

engaged. An omnibus score estimating metabolic equivalent units (METS) is then calculated using a formula [(Mild X 3) + (Moderate X 5) + (Strenuous X 9)] (Godin & Shephard, 1985).

Concurrent validity for the GLTEQ has been examined with higher MET estimates demonstrating positive correlations with estimates of cardiorespiratory fitness (i.e., VO_{2max}) and negative correlations with body composition (i.e., body fat) (Godin & Shephard, 1985). Higher GLTEQ scores have also been associated with higher estimates of energy expenditure derived from activity monitors ($r = 0.45$; Miller, Freedson & Kline, 1994). Moreover, a validation study in a sample of individuals with osteoporosis using the GLTEQ and tri-axial accelerometers found support for its use in this population (Wilson, Mack, Gunnell, Grattan, & Oster, 2009). Support for external validity has been demonstrated in various clinical populations examining associations between exercise and quality of life, with results in the expected direction (Karvinen, Courneya, North, & Venner, 2007; Motl & Snook, 2008).

Estimates of score stability have demonstrated test-retest reliability coefficients ranging from .24 to .96 (Godin & Shephard, 1985; Jacobs, Ainsworth, Hartman, & Leon, 1993; Sallis, Buono, Roby, Micale, & Nelson, 1993). An investigation examining the effects of social desirability on GLTEQ scores indicated minimal influence of social desirability associated with this instrument (Motl, McAuley, & DiStefano, 2005).

Psychological Needs. Psychological Need Satisfaction in Exercise Scale (PNSE; Wilson, Rogers, Rodgers & Wild, 2006; see Appendix M). Using Self-Determination Theory (SDT; Deci & Ryan, 1985; 2002) the PNSE was developed as an index of perceived psychological need satisfaction drawn specifically from exercise contexts.

Assessing perceptions of each of the three psychological needs proposed by Deci and Ryan (2002), the 18-item scale is anchored by 1 (False) and 6 (True) with higher scores reflective of greater perceptions of need fulfillment. A recent review by Wilson and colleagues (2008) has summarized the nature of construct validity support from scores derived from the PNSE. Consideration of content validity of the PNSE items supports the relevance and representation of the PNSE (Wilson et al., 2006), structural (Wilson et al., 2006) and generalizability validity (Wilson et al., 2006; Wilson, et al., in press). Recent literature has adapted the PNSE items to reflect different physical activity contexts (McDonough & Crocker 2007). Examination of goodness-of-fit statistics using confirmatory factor analytic procedures for the adapted version of the PNSE was slightly poorer than previous results in the original version (McDonough & Crocker, 2007). Cronbach (Cronbach, 1951) estimates of internal consistency have ranged from 0.84 - 0.96 (Wilson et al., 2008) across studies using this instrument.

Given the focus of the present investigation on LTPA as opposed to exercise, the stem and relevant items of the PNSE were modified to reflect the contextual change. An original stem statement anchors each item in terms of how participants usually felt while exercising (i.e., "The following statements represent different feelings people have when they exercise. Please answer the following questions by considering how you typically feel while you are exercising."). Following the modified stem (i.e., "The following statements represent different feelings people have when they engage in physical activity. Please answer the following questions by considering how you typically fell when you engage in physical activity") participants responded to items representing perceived autonomy, competence and relatedness experienced when participating in LTPA. Sample

modified items characterizing each construct included: (a) "I feel good about the way I am able to complete challenging physical activities" (Perceived Competence; 6 items), (b) " I feel free to participate in physical activity in my own way" (Perceived Autonomy; 6 items) and (c) "I feel connected to the people who I interact with while we are physically active together (Perceived Relatedness; 6 items).

Procedures

This study employed a non-experimental, cross sectional research design. Funding for this project was secured through external (Social Sciences and Humanities Research Council of Canada; Mack, Wilson, Crocker & Kowalski, 2007-2010) and internal (the Brock University Advancement Fund; Mack & Wilson, 2008) sources. Following ethical clearance (see Appendix A), participant recruitment began in two phases. All recruitment followed recommendations derived from Dillman's (2007) "Tailored Design Method" to minimize biases associated with different recruitment methods. A detailed list of recruitment strategies can be found in Appendices B-L.

The first phase of recruitment consisted of study announcements on global osteoporosis websites (e.g., The National Osteoporosis Society, The International Osteoporosis Foundation), the placement of recruitment posters in the Niagara area, presentations to local agencies (e.g., YWCA) and e-mails to doctors requesting their assistance in participant recruitment. E-mail invitations were sent to participants who participated in a previous study targeting individuals diagnosed with osteoporosis. E-mail's to osteoporosis organizations (e.g., Osteoporosis Canada Chapters and BC Osteofit) were sent and organizations were requested to disseminate study information to their members. For participants contacted through electronic venues (i.e., list serves,

websites or e-mails), a link to a secured internet-based survey was provided. Participants recruited through non-electronic venues were provided with self-addressed pre-stamped questionnaire packages with explicit instructions on how to complete and return the survey.

The second phase of recruitment took place at a bone health specialist clinic in Hamilton (Ontario). Following doctor consultations, the principal investigator was invited into the treatment room to discuss study participation with the individual. After disseminating information about the study and addressing any questions, the individual was given a self-addressed, pre-stamped envelope containing study details. For those who gave consent, confirmation of osteoporosis diagnosis and other relevant variables (e.g., fracture status, T-score etc.) was made through their medical chart.

All participants were given a letter of invitation, informed consent and the questionnaire package and supplied with contact information for inquiries. Completion of the questionnaire took approximately 20-25 minutes. Upon study completion, a $5.00 donation was made on behalf of the participant to either Osteoporosis Canada, the local Osteoporosis Canada Chapter to which they belong or a bone health organization of their choice (e.g., The National Osteoporosis Foundation). Participants were provided with a debriefing form such that they could receive a summary report of the major findings of this study.

Data Analysis

Data analysis proceeded in sequential stages. First, preliminary data analysis was conducted in order to identify data entry error, patterns of missing data, compliance with statistical assumptions and determination of statistical differences between those who

self-reported or had a confirmed physician diagnosis of osteoporosis. Cases were removed from subsequent analysis if information beyond informed consent was not provided, a diagnosis of osteoporosis not reported, or the individual indicated no engagement in LTPA as assessed through the GLTEQ. Psychological variables were then screened for missing values. For cases with partial missing data (i.e., less than 50%), within-person mean substitution was employed. This technique has been recommended by Hawthorne and Elliot (2005) when imputing missing data in cross-sectional research. Boxplots were run on LTPA scores and identified outliers were removed (Tabachnick & Fiddell, 2007). Scatterplots with lines of best fit and LOESS estimations were constructed to determine bivariate normality between measures of LTPA (i.e., GLTEQ), well-being (i.e., global and contextual SVS and PANAS) and perceived need satisfaction (i.e., competence, autonomy and relatedness). Appropriate parametric (e.g., independent samples *t*-tests) and non-parametric (e.g., chi-squared analysis) were calculated on demographic, health, LTPA, well-being and need satisfaction variables to determine if there was a statistical difference between those who self-reported or had a confirmed physician diagnosis of osteoporosis. Effect sizes (Cohen's *d*; Cohen, 1988 and phi coefficients; Grissom & Kim, 2005) were calculated and interpreted to determine the magnitude of practical significance.

Second, descriptive statistics were calculated on study variables and determination of univariate normality through examination of skewness and kurtosis was undertaken for GLTEQ scores, global and contextual SVS and PANAS and PNSE scores. Third, consideration of structural validity and reliability estimates were examined on variables serving as mediators and outcome variables. To examine structural validity, a

series of instrument-specific measurement models were tested using confirmatory factor analytic (CFA) procedures using AMOS (Arbuckle, 1997). Global model fit was evaluated by examining the χ^2, Comparative Fit Index (*CFI*), Incremental Fit Index (*IFI*), Tucker-Lewis Index (*TLI*), Root Mean Square Error of Approximation (*RMSEA*) and Standardized Root Mean Square Residual (*SRMSR*) as recommended by West, Finch, and Curran (1995). Following guidelines suggested by Hu and Bentler (1999) and Marsh, Hau, and Wen (2004), *CFI*, *IFI* and *TLI* values exceeding 0.90 and 0.95 were considered acceptable and excellent fit indices. *RMSEA* values less than 0.05 and *SRMSR* values less than 0.08 were typically considered indicative of satisfactory to excellent model fit (Browne & Cudeck, 1993; Hu & Bentler, 1999). Estimates of internal consistency (Cronbach's α; Cronbach, 1951) were computed to determine the reliability of the global and contextual SVS and PANAS and the PNSE scores.

Fourth, bivariate correlations were calculated between indices of LTPA, eudaimonic and hedonic well-being, and perceived need satisfaction to determine patterns of associations. Confidence intervals were calculated to provide an additional source of information related to null hypothesis testing (Thompson, 2001). Lastly, multiple mediation of the fulfillment of the three psychological needs between the LTPA-well-being relationships was tested using Preacher and Hayes' (2007) bootstrapping procedure to test multiple mediator models. Bootstrapping is a non-parametric resampling procedure that creates a new sample size based on replacement of cases from the original dataset (Preacher, & Hayes, 2008). The recommended bootstrap sample of 5000 ($k = 5000$; Preacher & Hayes, 2008) was used for the current analysis. The bootstrapping procedure is superior to conventional causal models (Baron and Kenny,

1986) or the Sobel test (Sobel, 1982, 1986) because the aforementioned procedures require a normally distributed population and have low power (Preacher & Hayes, 2008). Bootstrapping produces a 95% bias corrected and accelerated confidence interval (BCa CI; Efron, 1987; Efron & Tibshirani, 1993) that is asymmetrical which in turn reduces the Type I error rates. Mediation (or an indirect effect) occurs if the BCa CI does not contain zero (Preacher & Hayes, 2008). Specific indirect effects are also examined through the use of BCa CIs to examine the unique contribution of each potential mediator in the model.

CHAPTER THREE: RESULTS

Preliminary Data Analysis

Of the 245 respondents providing data, usable data was derived for 190 individuals. Upon closer examination, 14 cases were removed, as responses beyond informed consent were not offered, 8 were removed because they did not indicate a diagnosis of osteoporosis and 18 were deleted because they reported no engagement in LTPA (i.e., self-reported expending 0 METS). Finally, examination of boxplots rendered 15 cases as outliers based on GLTEQ scores. As a result of the above procedures, hypothesis testing was conducted on a final sample size of 190. Missing values analysis was conducted to determine if patterns of missing data were random. Results of the analysis revealed no concerns with missing data for demographic and health status questions and individual items of the global and contextual SVS and PANAS as no more than 5% of the data were missing (Tabachnick & Fidell, 2007). Non-response for the PNSE ranged from 2.60% to 11.60%. Of particular interest, items reflecting the psychological need for relatedness displayed a notable pattern of missing data (all items > 10.50% missing values). Missing data was imputed consistent with Hawthorne and Elliot's (2005) recommendations for global and contextual SVS and PANAS and the PNSE. In the case that more than 50% of the data for a particular scale was missing, this participant was excluded from analysis involving concepts represented by that particular scale.

Descriptive statistics were calculated for all demographic and health status variables (see Table 1), LTPA, well-being and PNSE scores (see Table 2). BMI was leptokurtotic, and number of years since condition diagnosis and number of prescribed

medications were positively skewed and leptokurtotic (Glass & Hopkins, 1996). Results of well-being and need satisfaction variables revealed minimal concerns over normality (skewness ranged from -0.65 to 1.70 and kurtosis ranged from -0.69 to 1.38) on all but two scales. Closer examination revealed that contextual level negative affect (NA) and perceived autonomy were leptokurtotic (7.04 and 3.64 respectively; see Table 2). No apparent violations to bivariate normality were noted following visual inspection of lines of best fit derived from individual participant responses.

Given that this sample consisted of self-report and confirmed physician diagnoses of osteoporosis, appropriate parametric (i.e., independent *t*-tests), non-parametric (i.e., chi-squared), and effect size analyses were calculated for all demographic, health status, LTPA, well-being and perceived need satisfaction variables (see Tables 3 & 4). Inspection for differences in demographic and health status variables revealed a significant difference between self-report and confirmed condition diagnosis for education ($\chi^2 = 11.19, p = 0.03$, phi = .24; see Table 3). Interpretation of post-hoc analyses demonstrated non-significant ($p > .05$) pairwise differences. Participants self-reporting a diagnosis of osteoporosis reported engaging in greater LTPA in comparison to those participants whereby the condition was confirmed ($t = 3.26, p = .00, d = .49$; see Table 4).

Sample Characteristics and Descriptive Statistics

Of the 190 ($M_{age} = 68.14$; $SD_{age} = 11.54$ $n_{female} = 164$) participants, 131 self-reported a physician diagnosis of osteoporosis and 59 had a confirmed physician diagnosis of osteoporosis. The majority of this sample reported being married or in a common-law relationship (56.30%), being of Caucasian or white ethnic origin (85.30%)

and having completed a university or college degree (37.40%; see Table 1). According to Health Canada classifications (2009), this sample was on average classified as a normal weight (M = 23.29 kg/m^2; SD = 4.00 kg/m^2; 65.00%) while 25.70% were overweight, 5.50% were underweight and 3.80% were obese. The average number of years since being diagnosed with osteoporosis was 7.65 years and approximately 55.26% had experienced a fracture. Over half of the respondents (53.70%) reported a family history of osteoporosis and reported currently taking on average 3.48 (SD = 7.65) prescription medications. High blood pressure was the most frequently reported comorbidity however on average the majority of this sample reported no diagnosis of heart disease, diabetes, high blood pressure, Crohn's/colitis/bowel disease, stomach ulcer or cancer (see Table 1).

The majority of participants indicted they were engaged in regular physical activity behaviour with 83.70% in the maintenance and 6.00% in the action stage according to the classification system embedded in the TTM (Prochaska & DiClemente, 1984). The preparation, contemplation and pre-contemplation stages were endorsed by 4.30%, 3.30% and 2.70% respectively. The participants in this study reported expending on average 26.56 (SD = 15.53) METS per week as measured by the GLTEQ. On average, this sample reported moderate hedonic (M_{PAglobal} = 3.39; SD_{PAglobal} = 0.74; $M_{\text{PAcontextual}}$ = 3.53, $SD_{\text{PAcontextual}}$ = 0.80) and eudaimonic ($M_{\text{SVSglobal}}$ = 4.79; $SD_{\text{SVSglobal}}$ = 1.30; $M_{\text{SVScontextual}}$ = 5.08; $SD_{\text{SVScontextual}}$ = 1.26) well-being and low negative affect (M_{NAglobal} = 1.80; SD_{NAglobal} = 0.85; $M_{\text{NAcontextual}}$ = 1.33; $SD_{\text{NAcontextual}}$ = 0.61; see Table 2). Finally, on average, the participants indicated the fulfillment of the psychological needs for autonomy (M = 5.20; SD = 1.31), relatedness (M = 4.76; SD = .98) and competence (M = 3.45; SD = 1.40; see Table 2) in physical activity settings.

Validity and Reliability Estimates

A series of CFA's were conducted to investigate the structural validity of scores derived from instrument-specific latent variable measurement models. In total three multidimensional correlated latent variable measurement models (PNSE, PANAS global and PANAS contextual) and two uni-dimensional latent variable measurement models (SVS global and SVS contextual) were examined. Despite elevated *RMSEA* values on all scales, inspection of the global modal fit indices associated with four of the measurement models (global and contextual SVS, contextual PANAS and PNSE) revealed no grave concerns with structural validity of sample responses (see Table 5). Although all measurement models had elevated *RMSEA* values, Marsh, Hau and Wen (2004) argue that Hu and Bentler's (1999) cut off criteria were best used when examining complex nested models as opposed to simple models such as those used in this study. Examination of the χ^2 statistic on all scales revealed a significant deviation from normal however, the χ^2 is sensitive to small sample sizes and non-normal distributions (Hoyle & Panter, 1995). Goodness of fit indexes for the global and contextual SVS, contextual PANAS and PNSE revealed an acceptable fit of the data to the model (*CFI*'s and *TLI*'s > 0.90, *IFI*'s > 0.90 and *SRMSR* < 0.08). Results of the CFA analysis for the global PANAS revealed concerns over structural validity with *CFI*, *IFI* and *TLI* values below 0.84. Moreover, the *RMSEA* point estimate (0.17) was above conventional standards for acceptable fit (see Table 5). Estimates of internal consistency (Cronbach's α; Cronbach, 1951) were calculated for test scores derived from well-being and perceived psychological need fulfillment, with α's ranging from 0.85 to 0.97 (see Table 6).

Patterns of Associations. Pearson bivariate correlations were calculated between all indices of hedonic and eudaimonic well-being and need satisfaction (see Tables 6 & 7). A pattern of small-to-strong correlations in the expected direction was found between indices of hedonic and eudaimonic well-being (*r's* ranges from -0.27 to 0.75, $p < .001$). Greater subjective vitality was associated with greater positive affect and less negative affect. Positive affect demonstrated a pattern of negative correlations with negative affect. A pattern of small-to-moderate correlations between indices of perceived need satisfaction was found (*r's* ranged from 0.23 to 0.45 see Table 6).

With consideration to the pattern of association between perceived psychological need satisfaction and well-being a pattern of small-to-moderate correlations was found. Greater perceived need fulfillment was associated with greater global and contextual subjective vitality and positive affect (*r's* ranged from 0.21 to 0.47, $p < .01$) and less global and contextual negative affect (*r's* ranged from -0.22 to -0.36, $p < .01$). Perceived competence was more strongly related to global and contextual subjective vitality and contextual positive affect whereas perceived autonomy was more strongly related to less global negative affect and more global positive affect and finally, perceived relatedness was more strongly related to contextual negative affect (see Tables 6 & 7).

Main findings

Is LTPA Associated with Well-Being? Pearson bivariate correlations were calculated and effect sizes interpreted to determine patterns of associations between LTPA, global and contextual subjective vitality, positive affect and negative affect (see Tables 6 & 7). Results revealed a pattern of positive weak-to-small correlations between LTPA and contextual subjective vitality ($r = 0.22$, $p < .01$) and contextual positive affect

(r = 0.24, p < .01; see Table 7). LTPA was not statistically significantly associated with global indices of subjective vitality or positive affect or negative affect.

Fulfillment of Psychological Needs as Mediators in the LTPA-Well-Being Relationship

Eudaimonic Well-Being

Subjective Vitality. Results of the bootstrapping procedure to test for multiple mediation in the relationship between LTPA and global subjective vitality revealed that the model ($R^2_{adj.}$ = 0.28) was mediated by the fulfillment of the three psychological needs (point estimate = 0.0087; BCa CI = 0.0020 to 0.0165; see Table 8 & Figure 1). Further analysis revealed that perceived competence emerged as the only contributor to the model (point estimate = 0.0080; BCa CI = 0.0034 to 0.0140). The relationship between LTPA and contextual subjective vitality indicated that satisfaction of competence, autonomy and relatedness served as mediating variables (point estimate = 0.0097; BCa CI = 0.0030 to 0.0171; $R^2_{adj.}$ = 0.37; see Table 9 & Figure 2). Detailed analysis indicated that perceived competence was the only significant contributor to the model above and beyond perceived relatedness and autonomy (point estimate = 0.0093; BCa CI = 0.0049 to 0.0153). As such, the fulfillment of the three psychological needs mediated the relationship between LTPA and global and contextual subjective vitality.

Hedonic Well-Being

Positive Affect. Examination of results derived from the bootstrapping procedure to test for multiple mediation indicated that LTPA and global positive affect was not mediated by the fulfillment of competence, autonomy and relatedness with a point estimate of 0.0027 and BCa CI = -0.0008 to 0.0067 (see Table 10 & Figure 3). However, the model did account for 14.00% (p < 0.001) of the variance. Results derived from the

multiple mediation analysis on LTPA and contextual positive affect revealed that the fulfillment of the three psychological needs mediated the relationship (point estimate = 0.0070, BCa CI = 0.0025 to 0.0122; $R^2_{adj.} = 0.42$; see Table 11 & Figure 4). Closer examination of the specific indirect effects suggests that perceived competence was the only significant contributor to the model (point estimate = 0.0065; BCa CI of 0.0037 to 0.0108; see Table 11).

Negative Affect. Results of the mediation analysis between LTPA and global negative affect suggest that the fulfillment of competence, autonomy and relatedness mediated the relationship (point estimate = -0.0047; BCa CI = -0.0098 to -0.0008; $R^2_{adj.} = 0.18$; see Table 12 & Figure 5). Inspection of the specific indirect effects demonstrated that perceived competence was the only variable to contribute uniquely to the model (point estimate = -0.044; BCa CI = -0.0098 to -0.0014). Similar findings were noted when global negative affect served as the outcome variable (point estimate = -0.0029; BCa CI = -0.0066 to -0.0004; $R^2_{adj.} = 0.11$; see Table 13 & Figure 6). Specific indirect effects demonstrated that the fulfillment of competence (or lack thereof) contributed uniquely to the model (point estimate = -0.0026; BCa CI = -0.0057 to -0.0006). As such, the satisfaction of the needs for competence, autonomy and relatedness served as mediators between LTPA and contextual and global negative affect.

CHAPTER FOUR: DISCUSSION

Previous research suggests that engagement in LTPA has a small (albeit meaningful) association with well-being (Fox, 2002). The purpose of the present investigation was to determine the association between LTPA and well-being in a sample of people diagnosed with osteoporosis. Using SDT (Deci & Ryan, 1985; 2002) as a guiding framework a secondary purpose was to delineate the potential mechanisms through which LTPA may be associated with well-being. Based on BNT (a sub-theory of SDT), it was hypothesized that the fulfillment of the three psychological needs for competence, autonomy and relatedness would mediate the relationship between LTPA and well-being. Results of correlation analysis suggested that LTPA was significantly correlated with contextual markers of eudaimonic and hedonic well-being. Further, mediational analysis suggested that LTPA has an indirect effect on hedonic and eudaimonic markers of well-being through the fulfillment of the three psychological needs. In particular, perceived competence emerged as a unique contributor above and beyond autonomy and relatedness in the LTPA-well-being relationship. This investigation complements and extends previous research in at least two ways. First, it demonstrated that LTPA is positively associated with hedonic and eudaimonic markers of well-being in people living with osteoporosis and second, it suggests that the fulfillment of the needs for competence, autonomy and relatedness may act as intervening variables in this relationship.

Comparison of Study Participants to those of Existing Research

Descriptive statistics derived from relevant study variables in this investigation appear consistent with those reported in previous research. When considering test scores

from the GLTEQ, comparable engagement in LTPA was observed with other investigations involving individuals with chronic conditions including osteoporosis (Wilson et al., 2009), breast cancer (Courneya & Friedenreich, 1999) and multiple sclerosis (Snook, Motl, & Gliottoni, 2009). Support for the divergent validity of GLTEQ test scores are noted with the present sample in comparison with those from undergraduate female students with no known health conditions (Wilson et al., 2008; 2009) as older adult populations have been found to engage in less LTPA than younger cohorts (Gilmour, 2007). Consideration of well-being markers indicated that participants reported moderate-to-high levels of well-being (i.e., subjective vitality and positive affect) and low levels of negative affect. This is consistent with other well-being research on individuals with osteoporosis (Papaioannou et al., 2003; 2006) and the general population regardless of age, disability and income (Diener & Diener, 1996).

LTPA and Well-Being in Those Diagnosed with Osteoporosis

The primary research question of this investigation was to examine the association between LTPA and hedonic (e.g., more positive and less negative affect) and eudaimonic (e.g., subjective vitality) well-being in a sample of individuals living with osteoporosis. Consistent with existing literature examining non-clinical, adult populations (Fox, 2002) and older adults (Fox et al., 2007; Netz et al., 2005), and providing support for the study hypotheses, a small statistically significant correlation was found between LTPA and contextual positive affect and subjective vitality. Despite the magnitude of association, small effects are meaningful given that small effects over time could accumulate to become larger effects (Prentice & Miller, 1992). Similar results were noted between LTPA and global indices of well-being. However it is noted that the magnitude

of association between these variables was weak and not statistically significant. The finding that greater LTPA is associated with greater subjective vitality and positive affect is consistent with existing literature in healthy university students (Wilson et al., 2006), athletes (Reinboth et al., 2004; 2006) and obese adults (Edmunds et al., 2007). As such, greater LTPA was associated with more hedonic and eudaimonic well-being in people who are living with osteoporosis.

Contrary to previous research (Edmunds et al., 2007; Wilson et al., 2009) and the study hypotheses, the relationship with LTPA and negative affect was not in the expected direction. The relationship was weak and not statistically significant and given the results of the confidence interval, interpretation should be made with caution. Results from the correlation analysis revealed that engagement in LTPA was positively associated with contextual and global negative affect. Previous research has demonstrated a negative association between exercise and negative affect (Wilson et al., 2009) however, this finding is equivocal (McDonough & Crocker, 2007; Tuson & Sinyor, 1993). As exercise related affect is a multifaceted complex phenomenon influenced by individual differences (Backhouse, Ekkekakis, Biddle, Foskett, & Williams, 2007), emerging research is challenging the current stigma that exercise makes you "feel better" with authors arguing that in some instances, exercise can induce displeasure and negative affect (Backhouse et al., 2007). One line of inquiry into the effects of exercise on affect has examined the impact of exercise intensity (Biddle & Ekkekakis, 2005). Researchers postulate that there is an affective response to exercise intensity such that the more intense the exercise is the more likely displeasure will increase (Acevedo, Kraemer, Haltom, & Trynjecki, 2003; Bixby, Spalding, & Hatfield 2001; Ekkekakis, Hall, & Petruzzello, 2004; Hall,

Ekkekakis, & Petruzzello, 2000). Due to study design and the measurement of LTPA, it is difficult to know if this was the case in the present investigation. However, dose-response considerations with respect to LTPA intensity and well-being offer potential avenues for future inquiry. Another postulate stemming from the finding that LTPA was positively associated with negative affect surrounds the nature of need satisfaction. A recent study using SDT as a guiding framework found that when participants who engaged in physical activity did not feel autonomous, there were negative repercussions on the affect they experienced as a consequence of need thwarting (Vazou-Ekkekakis & Ekkekakis, in press). Results of this study revealed that perceived autonomy was negatively related to LTPA, which is suggestive that participants in this study did not have a sense of autonomy that in turn could have influenced the affect they experienced.

Ryan and Deci (2001) have argued for the consideration of both eudaimonic and hedonic markers of well-being in research. Research examining well-being in individuals living with osteoporosis has typically used measures of ill-being (Coelho et al., 1999) or hedonic well-being (Bianchi et al., 2005). Notwithstanding the importance of this line of inquiry, continued insight into the mechanisms promoting well-being as represented by both hedonic and eudaimonic indices of well-being is warranted given their differential impact on health outcomes (Ryff et al., 2006). By incorporating both measures of affect and subjective vitality (hedonic and eudaimonic well-being respectively), this investigation aimed to capture both the affective states of well-being and the enduring aspects of well-being, thus providing a fuller representation of well-being. Correlation analyses suggested that in general, people with osteoporosis who engaged in greater

LTPA had greater hedonic (i.e., positive affect) and eudaimonic (i.e., subjective vitality) well-being.

Extrapolating from existing research (Deiner & Deiner, 1996; Fox et al., 2007), contentions that well-being should be assessed at both global and contextual levels have been forwarded. Results from this study revealed that contextual level hedonic (i.e., positive affect) and eudaimonic well-being (i.e., subjective vitality) were more strongly correlated to LTPA than were the global measures of well-being. This is consistent with findings in a study by Fox et al. (2007) who found that measures of well-being that were contextual produced stronger coefficients than those that were produced from general well-being scales.

BNT and LTPA

Consistent with results of a systematic review in exercise contexts (Wilson et al., 2008), perceived competence emerged with the strongest magnitude of correlation with LTPA. Deci and Ryan (2002) contend that satisfaction of all three psychological needs is necessary for well-being. Results of this investigation demonstrate that the magnitude of association between LTPA and satisfaction of the needs for autonomy and relatedness was negligible, with confidence intervals spanning zero. This finding is consistent with McDonough and Crocker's (2007) results. However, the bulk of research examining LTPA and need satisfaction using healthy university students has found a stronger magnitude of correlation between LTPA and perceived autonomy and relatedness than that observed in this investigation (Wilson et al., 2008; 2009; Wilson & Muon, 2008). Longitudinal investigations have noted that need satisfaction in exercise contexts is dynamic, with increases in the need for relatedness observed over time in a structured

exercise intervention in obese adults (Edmunds et al., 2007). Suggestive of a dose-response threshold for the need satisfaction-well-being relationship, Edmunds et al. (2007) and Wilson et al. (2008) had samples that were engaging in greater LTPA than that engaged in by the present sample. Papaioannou et al. (2006) demonstrated that people diagnosed with osteoporosis needed at least six hours of exercise a week to see an impact on health-related quality of life. Future research should investigate the dose-response relationship between needs satisfaction and LTPA.

Ryan and Deci (2000) have argued that psychological need satisfaction is universal and salient across the lifespan and different cultures. However, the ways in which the three psychological are satisfied may differ across developmental periods or ages (Ryan & Deci, 2000). The majority of research in exercise and sport settings examining psychological need fulfillment and well-being outcomes has either used youth (Gagné et al., 2003) or young adult (Wilson et al., 2008) samples. The contradictory finding that LTPA is not significantly associated with perceived autonomy or relatedness may in part be attributable to the differing manners in which older adults diagnosed with osteoporosis fulfill their needs or the values they place on LTPA. It is plausible that older adults who engage in LTPA are doing so for different reasons than their younger counterparts (Rejeski & Mihalko, 2001). Moreover, the PNSE was originally designed to measure need satisfaction in exercise contexts. McDonough and Crocker (2007) also found a negligible relationship between perceived relatedness, autonomy and LTPA using a modified version of the PNSE. Autonomy consists of both affective autonomy (i.e., absence of feelings of pressure and tension) and decisional autonomy (i.e., feeling of choice; Houlfort, Koestener, Joussemet, Natel-Vivier, & Lekes, 2002). The autonomy

subscale within the PNSE may capture only decisional autonomy (Wilson et al., 2006) and may therefore not be as applicable to the present investigation in older adults engaging in LTPA. Studies have found mixed results concerning the fulfillment of the need for relatedness through exercise (Wilson et al., 2009). Researchers have advocated that the timing of questionnaire administration could influence results concerning satisfaction of the need for relatedness (Wilson et al., 2009). Future research investigating fulfillment of the need for relatedness through LTPA is needed.

The Process Through which LTPA may Influence Well-Being

Review articles (Netz et al., 2005; Rejeski & Mihalko, 2001) on physical activity and well-being in older adults have documented the importance of future research to determine mediating variables in the physical activity and well-being relationship. A secondary aim of this project was to determine the underlying link between LTPA and well-being. Although there appears to be a general consensus on the effect of physical activity engagement on psychological health, the underlying mechanism through which this effect is transmitted is largely unknown (Fox, 2002). Using BNT as a guiding framework, and Vallerand's (1999) suppositions that the fulfillment of the three psychological needs for competence, autonomy and relatedness may serve as mediating variables, it was hypothesized that the satisfaction of the three psychological needs would mediate the relationship between LTPA and well-being regardless of the type of well-being. Consistent with interpretations advocated by Preacher and Hayes (2008), results of the bootstrapping procedure to test for indirect effects (i.e., mediation) revealed that fulfillment of all three psychological needs had a total indirect effect on the relationships

between LTPA and global and contextual markers of well-being save for global positive affect.

Consideration of the specific indirect effects (i.e., the unique influence of each individual psychological need) revealed that perceived competence was the only statistically significant contributor, above and beyond perceived autonomy and relatedness. Closer examination of the data suggests that there may be a suppressor effect occurring within the multiple mediation model (Preacher & Hayes, 2008). Data derived from the present investigation demonstrated that perceived autonomy typically had a point estimate-nearing zero whereas perceived relatedness generally had a slightly larger point estimate than perceived autonomy. Statistically, perceived relatedness may serve as a suppressor variable (Pedhauzer, 1982). Given that a suppressor variable correlates with the error of another predictor (i.e., perceived competence), the suppressor variable enhances its predictive power to the detriment of its own. Perceived competence may therefore have had such a strong effect on the model that it washed out the unique effects contributed by perceived relatedness (Preacher & Hayes, 2007). Given the inconsistent findings between theoretical suppositions advanced by Deci and Ryan (2002) and the findings specific to the unique contribution of autonomy and relatedness, continued inquiry into the role of perceived autonomy and relatedness in physical activity contexts represents an important research priority.

Although no studies to date have examined the multiple mediational role of the fulfillment of the three psychological needs between the relationship of LTPA and well-being, two studies have investigated the role of perceived need satisfaction as possible mediators between the social environment (i.e., autonomy supportive coaches) and well-

being (Adie et al., 2008; Reinboth et al., 2006). In line with this investigation, and theoretical tenants advanced by Deci and Ryan (2000) and Mageau and Vallerand (2003) both the aforementioned investigations found that fulfillment of all three needs served as mediators however the specific indirect effects of each need differed. Reinboth and colleagues (2006) found that perceived relatedness and autonomy were significant mediators whereas Adie and colleagues (2008) found perceived competence and autonomy to be significant mediators of subjective vitality. It is important to note that the aforementioned studies both used participants who were engaged in a team sport setting whereby the coach was the focal point of the social environment. The focus of this research was on individual people who engaged in LTPA, and as such, fulfilling the need for relatedness may not have been a direct aim of LTPA engagement in this population. Furthermore, the independent variable was LTPA, not a motivational climate created by coaches (Reinboth et al., 2006). The contradictory finding that perceived autonomy did not significantly contribute to the mediational model makes statistical sense based on the results of the correlation analysis. LTPA was negatively correlated with perceptions of autonomy in this group of participants.

Certain researchers have advocated that there must be a significant total effect of the independent variable on the dependent variable (i.e., *c* path) for the mediation analysis to continue (Baron & Kenny, 1986). In this investigation, the *c* path for the relationship between LTPA, global subjective vitality and global and contextual negative affect are all non-significant while the results of the bootstrapping procedure suggest that there was indirect effect. Preacher and Hayes (2008) and Mackinnon and Fairchild (2007) argue that this step (i.e., a significant *c* path) is irrelevant to the test of mediation analysis

and that there are many cases in which an independent variable can influence a dependent variable through intervening variables. Such cases include the case of a suppressor effect. Results of the mediational analysis in the present investigation suggest that perceived relatedness may have had a suppressor effect on perceived competence, and as such, may be responsible for the finding of a non-significant direct effect of LTPA on well-being. Preacher and Hayes, (2007) also contend that the test of mediation should be made based upon theoretical propositions. Given that this investigation used BNT as a framework to examine mediation, interpretation of the results of the analysis in the presences of a non-significant direct path is warranted.

Preacher and Hayes (2008) bootstrapping procedure to test for multiple mediation served as the analytic tool to test for mediation in this investigation. Alternative methods exist for testing multiple mediator models with the most common being the causal steps approach (Baron & Kenny, 1986). Adopting this approach, four criteria based on statistical significance are used to determine if mediation is present (Baron & Kenny, 1986). Limitations of the causal steps approach including its reliance on statistical significance, below-expected Type 1 error rates, low power, and the inability to calculate confidence intervals for the population effect have resulted in recommendations against its use (Preacher & Hayes, 2008). Another method of assessing mediation is the product of coefficients test (i.e., the Sobel test) whereby a point estimate of the indirect effect and its standard error is calculated (Sobel, 1982). The Sobel test relies on a normal distribution of the independent and dependent variables. As this assumption is often violated (Preacher & Hayes, 2008), statisticians have advocated for advanced mathematical procedures that are less reliant on assumptions and able to generate more

accurate conclusions (MacKinnon & Fairchild, 2007). In attempt to overcome limitations identified for the causal steps approach and Sobel test, Preacher and Hayes (2008) advocate for the use of the bootstrapping procedure to test for multiple mediation. The bootstrapping procedure makes no assumptions specific to sampling distributions, enables researchers to use smaller sample sizes with greater accuracy in results, and generates confidence intervals that are asymmetric. Further, Preacher and Hayes (2008) advocate that theory should guide researcher decision into the inclusion of multiple mediators.

BNT and Well-being

The magnitude (Cohen, 1988) of correlations between indices of well-being and need satisfaction was small-to-moderate and in the expected direction with perceived competence demonstrating the strongest magnitude of association with global and contextual subjective vitality and contextual positive affect. Fulfillment of the need for autonomy was more strongly associated with global PANAS scores. Lastly, perceived relatedness was most strongly correlated to contextual negative affect. Corroborating these finding, numerous studies in exercise and sport settings (Reinboth, et al., 2004; Wilson et al., 2008) have found perceived competence to be most strongly correlated to indices of well-being and perceived relatedness to be the weakest. Deci and Ryan (2000) posit that feelings of relatedness are required to begin the internalization process but that feelings of competence and autonomy are needed to be more fully self-determined and thus adhere to an exercise program. Given that the majority of the participants in this study were classified as in the maintenance and action stages of physical activity

participation according to TTM (Prochaska & DiClemente, 1984), this finding is not surprising.

Ryan (1995) has argued that an important aspect of research pertains to testing BNT in domain specific areas. From a statistical standpoint, domain-specific research reduces error variance and maximizes reliability (Ryan, 1995). The practical reason for domain specific research is that it offers a better understanding of how a general principle works in a specific domain where special forces are acting (Ryan, 1995). For example, Deci and Ryan (2002) articulate that satisfaction of all three psychological needs are important but that the manner in which they are satisfied may vary by context and situation (Ryan, 1995). The present investigation adopted both contextual and global measures of well-being to determine the association with need satisfaction in LTPA contexts. Consistent with existing literature (Wilson et al., 2006; 2009), exercise-related need satisfaction was significantly related to measures of exercise-related well-being and general well-being.

Limitations

While this study provides unique insight into the association between LTPA, hedonic and eudaimonic well-being and psychological need fulfillment, study limitations must be considered. Results of this study are only true for this sample. It is only with replication can the external validity of study findings can be determined. Study design limits conclusions concerning the causality of the relationship between LTPA and hedonic and eudaimonic well-being. The cross-sectional design of this study also limits conclusions pertaining to mediation. Mediation analysis is considered to be a causal model because the mediator is believed to cause the outcome variable (Baron & Kenny,

1986; Mackinnon & Fairchild, 2007). Unless the data are derived from experimental studies, mediation cannot be assumed. Instead, researchers using cross-sectional data are encouraged to indicate that what was observed is consistent with what we would expect to see if the paths were in fact causal (Kraemer, Stice, Kazdin, Offord, & Kurata, 2001).

Despite the growth in literature examining the influence of physical activity on physical and psychological health outcomes (Fox & Wilson, 2008), physical activity measurement remains plagued with problems (Welk, 2002). The most commonly used method of assessing physical activity is self-report questionnaires (Welk, 2002). However limitations associated with this mode of evaluation are acknowledged. Limitations include: misinterpretation of questions, recall bias and social desirability. Notwithstanding these limitations, self-report measures can be an acceptable measure of physical activity behaviour (Welk, 2002) with support for GLTEQ scores noted in using motion accelerometry in a sample of individuals with osteoporosis (Wilson et al., 2009).

Previous research attests to the difficulties pertaining to the measurement of psychological need satisfaction in general (Sheldon, 2002) and in exercise contexts (Wilson et al., 2003) more specifically. The measure of need satisfaction used in this investigation was originally designed to measure need fulfillment specifically in exercise contexts. As such the instrument was modified to represent LTPA. Results of the confirmatory factor analysis indicated some concerns around the structural validity of the modification with elevated *RMSEA* values. Corroborating the current findings of the reduced model fit through CFA of the PNSE after modification to represent physical activity, McDonough and Crocker (2007) also noted a somewhat compromised fit with an elevated *RMSEA* value after making a similar modification.

The use of exercise-specific affect instruments is a controversial issue (Ekkekakis & Petruzzello, 2000). Critics argue that unless there is evidence that exercise produces a unique affective state (Ekkekakis & Petruezzello, 2000), using domain-specific measures of affect may obfuscate research. Given the contradictory findings surrounding negative affect and results of the CFA analysis for measuring global affect, future research may wish to investigate this finding through the use of alternative measures of affect (e.g., the Subjective Exercise Experiences Scale; McAuley & Courneya, 1994). It would also be interesting to investigate the link between exercise intensity and affective responses in people who are living with osteoporosis to determine if intensity of the exercise differentially impacts affective responses.

Finally, this investigation was guided by BNT. BNT was chosen as the theoretical framework given Deci and Ryan's (2002) contentions that perceived need satisfaction has universal positive outcomes on psychological well-being. Despite the importance of theory driven research, by limiting the research investigation to only one theory, other potential variables could have been neglected. For example, Bandura has argued the importance of self-efficacy and environmental factors within Social Cognitive Theory (Bandura 1997). In addition to using SDT as a guiding framework, researchers have begun to incorporate other psychological theories to explain exercise behaviours (Chatzisarantis, Hagger, & Brickell, 2008). By using a multi-theory driven research design, further elucidation of potential mechanisms responsible for the mediating relationship between LTPA and well-being may have been derived.

Future Directions

The use of mediation analysis in this investigation provided a description of possible mechanisms through which LTPA may be associated with well-being. Extending this line of inquiry, future research would do well to conduct longitudinal or experimental studies in which variables are measured over time such that causal claims could be made. Such a research design would offer greater strength to the claim that fulfillment of BNT's three psychological needs serve as mediators (Vallerand et al., 1999) and would provide more credence to the interpretation of the mediation analysis (Preacher & Hayes, 2007).

LTPA represents only a proportion of all the energy expended throughout the day during and individuals' leisure time (Bouchard et al., 2006). Health-enhancing physical activity (HEPA) represents any form of physical activity that increases energy expenditure without causing undue harm (Bouchard et al., 2006). Measures of HEPA encapsulate but are not limited to; LTPA, structured exercise and activities at work, school, home and commuting. Future research may wish to extend beyond physical activity performed only in leisure times to include measures of HEPA in a sample of people with osteoporosis. Future research may also look into dose-response thresholds to determine the influence of differing intensities, frequencies and durations on well-being outcomes.

Despite the broad appeal of LTPA as a vehicle to improve health outcomes, there is no gold standard method available to measure physical activity (Welk, 2002). Future research interested in examining the LTPA-well-being relationship may wish to use a more objective measure of physical activity. Research is suggestive that recall of low-to-moderate intensity activities (e.g., daily walking) is more problematic when completing self-report questionnaires (Pitta, Troosters, Probst, et al., 2006). Individuals living with

osteoporosis are more likely to engage in low-to-moderate intensities of physical activity than vigorous activity (Wilson et al., 2009). Activity monitors have been shown to assess low intensities of physical activity more accurately than self-report measures due to the continual monitoring of the device (Parker, Stratch, & Swartz, 2008; Pitta et al., 2006). Using accelerometers to more accurately quantify light-to-moderate activities is especially important in populations with chronic diseases who do not engage in a lot of strenuous activity (Pitta et al., 2006). Future research may wish to continue this line of inquiry into the measurement of physical activity in people with osteoporosis and use accelerometer technology to assess physical activity more objectively in this population.

Given the results of the CFA's with respect to the scores derived from the PNSE and the global PANAS, and Messick's (1995) contentions that validation is an ongoing process, future research should examine the psychometric properties of scores from all the scales used in this study, especially the PANAS in a sample of individuals diagnosed with osteoporosis. Using Messick's construct validation approach, future research should continue to investigate the consequential validity (i.e., determine if there are positive or negative consequences), and extend the present results to investigate substantive (e.g., continued insight into theoretical postulates) and external validity. Messick's framework of validation also calls for the investigation of the generalizability of the findings. The participants in this study were relatively homogeneous (e.g., mostly Caucasian, exercisers, normal BMI etc.) and as such, future research may wish to examine LTPA, well-being and need satisfaction across different groups such as different ethnicities, socio-demographic backgrounds and other populations without osteoporosis.

Preacher and Hayes (2007) argue that there are always other possible mediators in a relationship. Future research would do well to extend this line of inquiry and explore other potential underlying variables that influence the LTPA- eudaimonic well-being relationship. Researchers have argued that there may be more than three psychological needs (Sheldon, Elliot, Kim, & Kasser, 2001). Sheldon and colleagues (2001) have tested other candidate psychological needs (e.g., self-esteem, self-actualization) and found that self-esteem emerged as a possible fourth psychological need. Further, Wilson et al. (2006) found self-actualization to be strongly correlated to well-being. In line with contentions from Sheldon et al. (2001), future research should investigate other psychological needs in addition to competence, autonomy and relatedness. This line of inquiry should employ quantitative and qualitative research designs including interviews and open-ended questions to elucidate other possible mechanisms.

Practical Implications

Extending existing literature, the importance of this study contributed to the ever-growing body of literature implicating the importance of physical activity to psychological health. In comparison to previous investigations (e.g., Bianchi et al., 2005; Fox et al., 2007; Papaioannou et al., 2003; 2006), the uniqueness of this investigation emanates from the conceptualization of well-being as both maximizing pleasure (i.e., hedonic well-being) and the development of human potentials (i.e., eudaimonic well-being). Also novel was the consideration of possible mechanisms through which the effect of physical activity to well-being is carried.

Being diagnosed with osteoporosis has been associated with physical (e.g., reduced activities of daily living, increased fracture risk; Adachi et al., 2001; Bianchi et

al., 2005) and psychological implications (e.g., reduced quality of life; Sawka et al., 2005). Physical activity has been advocated as one plausible mechanism to assist with the physical and psychological consequences associated with condition diagnosis (Osteoporosis Canada, 2008; WHO, 1994). Results derived from this investigation suggest that LTPA may be one non-pharmacological treatment method associated with increases in well-being in people with osteoporosis. Physical activity represents an important avenue for treatment given its positive association with psychological and biomedical outcomes (Fox, 2002). The cost-effectiveness and importance of physical activity as a treatment modality to improve bone health and well-being (Johnell & Hertzman, 2006) cannot be ignored.

Well-being was measured by both hedonic (i.e., positive affect) and eudaimonic (i.e., subjective vitality) well-being. Both contextual positive affect and subjective vitality were positively associated with LTPA engagement in people diagnosed with osteoporosis. Waterman (2007) argued that pursuits associated with hedonic well-being represent happiness but provide little information as to why happiness was experienced. Through consideration of eudaimonic well-being, a perspective on what is necessary for ongoing happiness is elucidated. Research has demonstrated that seeking hedonic pleasures is unsustainable, whereas eudaimonic pursuits are sustainable and enduring (Steger, Kashdan, & Oishi, 2008; Waterman, 2007). Practically, results from this study suggest engagement in LTPA is associated with both forms of well-being (e.g., positive affect and subjective vitality) and that LTPA may be important to psychological well-being because it offers opportunities to experience hedonic well-being (i.e., happiness) and eudaimonic well-being (i.e., enduring well-being).

Despite the growing wealth of literature examining the influence of exercise on well-being in people who have been diagnosed with osteoporosis (Bianchi et al., 2005; Chien, Yang, & Tsauo, 2006; Gunnell et al., 2009; Hongo et al., 2007; Papaioannou et al., 2003; 2006), sample characteristics and the type of physical activity assessed has been restricted. Less than a quarter of males and less than half of females diagnosed with osteoporosis experience an osteoporotic fracture in their lifetime (Adachi et al., 2001). By including only participants who have experienced a fracture (Papaioannou et al., 2006), investigations excluded over half the population who have been diagnosed with osteoporosis. The present investigation was inclusive to all regardless of fracture status, rendering greater external validity of study findings. Consequently, LTPA may represent an appropriate target for everyone living with osteoporosis as a means of improving well-being.

Exercise is defined as a form of physical activity typically performed repeatedly over time with a specific external objective (i.e., improving fitness; Bouchard et al., 2006). LTPA is any form of physical activity performed in leisure time that increases energy expenditure (Bouchard et al., 2006). Exercise only accounts for a percentage of energy expended throughout the day (Tremblay et al., 2008), and therefore may not fully capture the relationship between activity and well-being. Research in the past has typically investigated structured exercise (Hongo et al., 2007; Papaioannou et al., 2003; Renno et al., 2005) or physical fitness (Lombardi et al., 2005) outcomes. Data derived from the Canadian Community Health Survey (2005) reveals that those who have been diagnosed with osteoporosis endorse engagement in activities such as walking, gardening or yard work as opposed to activities such as sports (e.g., baseball) or structured exercise

(e.g., aerobics class). Activities more frequently endorsed by individuals with osteoporosis in the CCHS (2005) are more consistent with the definition of LTPA adopted in the present investigation as opposed to structured exercise (Bouchard et al., 2007). As a result, a more robust depiction of the association between LTPA and well-being was documented. In an effort to promote psychological health in individuals with osteoporosis, one practical extension emanating from this research may be to consider recommending physical activities that not only contribute to psychological health but that are more likely to be adopted as one component of a condition management plan.

The majority of research examining the association between physical activity and well-being in the general population (Fox et al., 2007) and those diagnosed with osteoporosis (Papaioannou et al., 2003; 2006) has been atheoretical. Calls for theory driven research in this domain (Netz et al., 2005; Rejeski & Mihalko, 2001) to assist in determining mediating variables in this relationship have been forwarded. The present investigation used a theoretical framework (SDT; Deci & Ryan, 2002) to elucidate possible mediating variables in the relationship between physical activity and well-being. According to Ryan and colleagues (2008), the fulfillment of the three psychological needs for competence (e.g., feeling effective), autonomy (e.g., feeling volitional) and relatedness (e.g., feeling connected to others) may serve as intervening or mediating variables. Results from the current investigation suggest that the fulfillment of the three psychological needs served as mediators in the LTPA – well-being relationship. Of particular importance was the perceived need for competence which contributed to the relationship above and beyond autonomy and relatedness. Satisfaction of the three psychological needs have also been shown to be related to more self-determined forms of

regulation (McDonough & Crocker, 2007; Wilson et al., 2008). Research has demonstrated that physical activity participation is related to more internalized forms of behaviour regulation such as intrinsic and identified regulation (Wilson et al., 2008). Taken together, results from previous SDT based research and the present investigation suggest that one plausible method to facilitate physical activity participation in people diagnosed with osteoporosis is to provide opportunities for individuals to fulfill their psychological needs through exercise. Through consideration of the structural supports, individual differences in perceptions of autonomy support, structure and involvement may be targeted to increase perceptions of need fulfillment in this population. Developing contexts that help the individual to satisfy their basic psychological needs through LTPA can produce more self-determined motivation, which in turn could increase well-being (Deci & Ryan, 2002). Moreover, more self-determined motivation is associated with greater adherence to physical activity (Wilson, Mack, & Grattan, 2008).

Health practitioners involved with individuals living with osteoporosis may wish to incorporate findings from previous SDT based research (Wilson et al., 2008) and those of the present investigation. Physical activity programs that provide opportunities for participants to fulfill their psychological needs may promote well-being. A review article by Rodgers and Loitz (2008) outlined methods of fostering needs satisfaction in physical activity contexts. Briefly, practitioners were encouraged to foster competence through celebrating meaningful successes, using clear and appropriate communication techniques and through being respectful of the individual's attempts. Autonomy support can be garnered through providing opportunities for choice and options and avoiding coercive

language. Finally, relatedness can be fostered through working in groups and communication (Rodgers & Loitz, 2008).

Overall, results from this investigation suggest that LTPA is positively associated with well-being. More specifically, results indicated that LTPA is positively associated with contextual positive affect and subjective vitality. There was not a significant association between LTPA and negative affect or global measures of positive affect and subjective vitality. Given the association between LTPA and well-being, one path to maintain or improve well-being is through participation in LTPA. Health practitioners who are seeking to improve psychological well-being in people living with osteoporosis, may wish to encourage engagement in a physical activity program. More specifically, a physical activity program that supports the participants needs for competence, autonomy and relatedness. Such an activity program may consist of activities that allow participants to engage in optimally challenging tasks, while feeling a sense of choice in which activities they perform and engaging in activities with a friend, or group in order to enhance a sense of connection.

Conclusion

Results derived from this investigation suggest that there is a positive association between LTPA and well-being in people who are living with osteoporosis. The fulfillment of the psychological needs for competence, autonomy and relatedness may serve as intervening variables in the relationship between LTPA and well-being. As such, intervention programs that seek to improve the psychological well-being of people who have been diagnosed with osteoporosis may wish to use a physical activity program that specifically facilitates the fulfillment of the needs for effectiveness (i.e., competence),

choice (i.e., autonomy) and belonging (i.e., relatedness). Physical activity represents an important avenue to help improve well-being in people who are living with osteoporosis.

Definitions

Autonomy: A feeling of sense of volition and agency in a particular behaviour such that actions originate from an internal locus of causality (deCharms, 1968).

Basic Needs Theory (BNT): A mini theory or Self-Determination Theory (Deci & Ryan, 2002) created to understand the role of competence, autonomy and relatedness needs in relation to motivation, goals, health and well-being (Deci & Ryan, 2002).

Competence: Interacting effectively within the environment while successfully completing challenging tasks (White, 1959).

Eudaimonic Well-being: Living a complete human life, or realizing human potentials (Ryan & Deci, 2001).

Exercise: A form of physical activity typically performed repeatedly over time with a specific external objective (i.e. improving fitness) (Bouchard et al., 2006).

Hedonic Well-being: (also known as subjective well-being) Happiness, as represented by the presence of life satisfaction, positive affect, and the absence of negative affect (Ryan & Deci, 2001; Ryan et al., 2008).

Ill-being: The presence of illness such as mental disorders (e.g., depression) or health-related ailments (e.g., disease and disability).

Leisure-Time Physical Activity: Any activity that increased energy expenditure that is performed in an individuals leisure time (Bouchard et al., 2006).

Negative Affect: Experiencing unpleasant emotions and moods (Diener, 2000).

Organismic Integration Theory (OIT): A differentiated approach to understanding extrinsic motivation. The quality of extrinsic motivation lies along a continuum from less self-determined (i.e., extrinsic and introjected regulations) to more self-

determined (e.g., identified, integrated, intrinsic) motivations (Deci & Ryan, 2002).

Osteoporosis: A skeletal disease that is characterized by reduced bone density and an increased risk of fractures. A diagnosis of osteoporosis is defined as bone mineral density 2.5 standard deviations below the average attained by healthy sex and race-matched adults (WHO, 1994).

Physical Activity: Bodily movement produced by skeletal muscles that results in increased energy expenditure (Bouchard et al., 2006).

Positive Affect: Experiencing pleasant emotions and moods (Diener, 2000).

Psychological Health: A state of well-being in which as individual realizes his or her own abilities, can cope with the normal stress of life, can work productively and fruitfully, and is able to make a contribution to his or her community (WHO, 2005).

Psychological Needs: The three basic needs (competence, autonomy and relatedness) are thought to be universal, innate and necessary for growth and thus have a direct relation with well-being (Deci & Ryan, 2002; Ryan & Deci, 2001).

Relatedness: The feeling of a meaningful connection or belonging with one's social milieu (Baumeister & Leary, 1995).

Subjective Vitality: The psychological and physical energy available to the self for life pursuits (Ryan & Frederick, 1997).

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Footnote

1. Physical activity-well-being research has typically reported small-to-moderate effects. The targeted sample size is based on a liberal (i.e., moderate) strength of association between study variables. Participant recruitment employed varied strategies and incentives designed to maximize participant recruitment. As such, participant recruitment continued beyond the targeted sample size with consideration towards statistical power. Regardless of recruitment, the analytic strategy presented considered both testing and interpretation of statistical and practical significance.

Table 1

Descriptive Statistics for Demographic and Health Status Variables

Variable	M	SD	Skewness	Kurtosis
Age	68.14	11.54	-0.11	1.76
BMI	23.29	4.00	0.33	5.22
Years since diagnosis	9.41	15.83	4.98	26.14
Number of Fractures	1.15	1.59	2.14	5.59
Number of Prescribed Medications	3.48	7.65	10.89	135.51
SOC	1.35	0.92	2.76	6.85
	%			
Gender				
Male	13.70			
Female	86.30			
Marital Status				
Married/Common Law	56.30			
Widowed	17.90			
Separated/Divorced	15.30			
Single/Never Married	9.50			
Ethnic Origin				
Aboriginal	0.00			
Caucasian/White	85.30			
Asian	12.60			
Other	1.60			

Education	
Some High School	13.70
High School Diploma	32.10
University/College Degree	37.40
Graduate Degree	14.20
Family History of Osteoporosis	
Yes	53.70
No	40.00
Fracture Status	
Yes	55.30
No	43.20
Comorbidities	
Heart Disease	
Yes	10.00
No	75.30
Diabetes	
Yes	5.30
No	80.00
High Blood Pressure	
Yes	27.40
No	64.20
Crohn's/colitis/bowel	
Yes	13.20

No	74.70
Stomach Ulcer	
Yes	8.40
No	77.40
Cancer	
Yes	13.70
No	73.20

Note. Sample size ranges from 163 to 190 based on participant responses. BMI = Body Mass Index (kg/m^2); SOC = Stages of Change for Physical Activity.

Table 2

Descriptive Statistics for Psychological Scales and Physical Activity

Variable	M	SD	Skewness	Kurtosis
1. GLTEQ	26.56	15.53	0.76	-0.11
3. SVS_G	4.79	1.30	-0.30	-0.69
4. SVS_C	5.08	1.26	-0.53	-0.45
5. PA_G	3.39	0.74	-0.47	0.31
6. PA_C	3.53	0.80	-0.65	0.47
7. NA_G	1.80	0.85	1.38	1.38
8. NA_C	1.33	0.61	2.58	7.04
9. Competence	3.45	1.31	-0.21	-0.74
10. Autonomy	5.20	0.98	-1.70	3.64
11. Relatedness	4.76	1.40	-1.25	0.81

Note. Sample sizes range from 169 to 190 based on participant responses. GLTEQ = Godin Leisure-Time Physical Activity; G = Global; C = Contextual; SVS = Subjective Vitality; PA = Positive Affect; NA = Negative Affect.

Table 3

Mean Difference Between Self-Reported and Confirmed Osteoporosis for Demographic and Health Status Questions

Variable	Self-Reported Osteoporosis		Confirmed Osteoporosis				
	M	*SD*	*M*	*SD*	*t*	*p*	*d*
Age	68.33	12.19	67.72	10.05	0.33	0.74	0.05
Years with Osteoporosis	9.02	16.84	10.28	13.43	-0.51	0.61	0.08
Number of Fractures	1.11	1.66	1.24	1.43	-0.49	0.62	0.08
BMI	23.31	3.68	23.24	4.65	0.10	0.92	0.02
SOC	1.29	0.79	1.50	1.16	-1.24	0.22	0.21
	%		%		χ^2	*p*	phi
Gender					0.77	0.38	0.06
Male	12.21		16.95				
Female	87.79		83.05				
Marital Status					7.56	0.11	0.20
Married/Common Law	52.67		64.41				
Widowed	18.32		16.95				
Separated/Divorced	14.50		16.95				
Single/Never Married	12.98		1.69				
Ethnic Origin					2.34	0.51	0.11
Aboriginal	0.00		0.00				
Caucasian/White	86.26		83.05				
Asian	12.21		13.56				

Other	1.53	1.69			
Education			11.19	0.03	0.24
Some High School	10.69	20.34			
High School Diploma	31.30	33.90			
University/College Degree	41.98	27.12			
Graduate Degree	15.27	11.86			
Family History of			12.76	0.02	0.26
Osteoporosis					
Yes	53.40	54.24			
No	44.27	30.51			
Fracture			4.34	0.11	0.15
Yes	51.91	62.71			
No	47.33	33.90			
Comorbidities					
Heart Disease			1.43	0.49	0.09
Yes	9.92	10.17			
No	73.28	79.66			
Diabetes			1.46	0.48	0.09
Yes	5.34	5.08			
No	77.86	84.75			
High Blood Pressure			0.32	0.85	0.04
Yes	27.48	27.12			
No	63.36	66.10			

Crohn's/colitis/bowel			2.29	0.32	0.11
Yes	12.98	13.56			
No	72.52	79.66			
Stomach Ulcer			2.19	0.33	0.11
Yes	6.87	11.86			
No	77.10	77.97			
Cancer			2.12	0.35	0.11
Yes	12.21	16.95			
No	72.52	74.58			

Note. For Chi-Squared analysis, not all cells have 5% or more of cases. BMI = Body Mass Index (kg/m^2); SOC = Stage of Chance for Physical Activity. Sample size ranges from 109 to 131 for self-report osteoporosis and 53 to 59 for confirmed osteoporosis based on participant responses. *d* = effect size (Cohen, 1988); phi = phi coefficient (Grissom & Kim, 2005).

Table 4

Mean Differences Between Self-Reported and Confirmed Osteoporosis for LTPA, Well-Being and Need Satisfaction

Variable	*Self-Reported Osteoporosis* *M (SD)*	*Confirmed Osteoporosis* *M (SD)*	*t*	*p*	*d*
GLTEQ	28.76 (16.26)	21.69 (12.58)	3.26	0.00	0.49
PA_G	3.42 (0.76)	3.32 (0.71)	0.90	0.37	0.14
PA_C	3.56 (0.82)	3.47 (0.74)	0.67	0.50	0.12
NA_G	1.83 (0.90)	1.75 (0.74)	0.57	0.57	0.10
NA_C	1.31 (0.58)	1.38 (0.68)	-0.74	0.46	0.11
SVS_G	4.85 (1.33)	4.65 (1.21)	0.99	0.32	0.16
SVS_C	5.11 (1.29)	5.01 (1.18)	0.51	0.61	0.08
Competence	3.56 (1.28)	3.20 (1.36)	1.72	0.09	0.27
Autonomy	5.17 (1.02)	5.25 (0.87)	-0.49	0.63	0.08
Relatedness	4.85 (1.30)	4.51 (1.63)	1.41	0.16	0.23

Note. Sample size for self-reported osteoporosis ranged from 121 to 131 and for confirmed osteoporosis ranged from 48 to 59 based on participant responses. GLTEQ = Godin Leisure-Time Physical Activity; G = Global; C = Contextual; SVS = Subjective Vitality; PA = Positive Affect; NA = Negative Affect. *d* = Effect Size (Cohen 1988).

Table 5

Global Indices of Model Fit Across the Instrument-Specific Data

Instrument	χ^2	*df*	*p-value*	*CFI*	*IFI*	*TLI*	*SRMSR*	*RMSEA (90% CI)*
1. SVS_G	52.74	14	.00	0.95	0.96	0.93	0.04	0.12 (0.09-0.16)
2. SVS_C	38.36	14	.00	0.97	0.97	0.95	0.03	0.10 (0.06-0.14)
3. PANAS_G	210.68	34	.00	0.84	0.84	0.79	0.08	0.17 (0.15-0.19)
4. PANAS_C	89.54	34	.00	0.96	0.96	0.94	0.04	0.09 (0.07-0.12)
5. PNSE	413.53	132	.00	0.93	0.93	0.91	0.06	0.11 (0.10-0.13)

Note. G = Global; C = Contextual; SVS = Subjective Vitality Scale; PANAS = Positive and Negative Affect Schedule; PNSE = Psychological Need Satisfaction in Exercise Scale; *CFI* = Comparative Fit Index; *IFI* = Incremental Fit Index; *TLI* = Tucker-Lewis Index *SRMSR* = Standardized Root Mean Square Residual; *RMSEA* = Root Mean Square Error of Approximation; *CI* = Confidence Interval for relevant point estimates.

Table 6

Pearson Bivariate Correlations and Estimates of Internal Consistency Between Global Study Variables

Variable	1	2	3	4	5	6	7
1. GLTEQ	--						
2. SVS_G	0.12 (-0.07-0.26)	0.90					
3. PA_G	0.11 (-0.03-0.25)	0.69 (0.57-0.73)	0.85				
4. NA_G	0.06 (-0.08-0.20)	-0.41 (-0.52--0.28)	-0.27 (-0.40--0.13)	0.89			
5. Competence	0.35 (0.22-0.47)	0.39 (0.26-0.51)	0.28 (0.14-0.41)	-0.26 (-0.39--0.12)	0.94		
6. Autonomy	-0.02 (-0.17-0.13)	0.36 (0.22-0.48)	0.33 (0.19-0.45)	-0.36 (-0.48--0.23)	0.23 (0.08-0.36)	0.95	
7. Relatedness	0.05 (-0.10-.012)	0.38 (0.24-0.50)	0.21 (0.06-.035)	-0.29 (-0.42--0.15)	0.38 (0.24-0.50)	0.45 (0.32-0.56)	0.97

Note. Sample size ranges from 165 to 186 based on participant responses. GLTEQ = Godin Leisure-Time Physical Activity; G = Global; SVS = Subjective Vitality Scale; PA = Positive and NA = Negative Affect Schedule; Estimates of internal consistency (Cronbach's α, Cronbach, 1951) are located along the diagonal. All *r's* > |0.27 | significant at $p < .001$ (one-tailed). All *r's* ≥ |0.21| but less than |0.27| significant at $p < .01$ (one tailed). Values in parentheses represent 95% Confidence Intervals

Table 7

Pearson Bivariate Correlations and Estimates of Internal Consistency Between Contextual Study Variables

Variable	1	2	3	4	5	6	7
1. GLTEQ	--						
2. SVS_C	0.22 (0.09-0.36)	0.89					
3. PA_C	0.24 (0.10-0.37)	0.75 (0.68-0.81)	0.90				
4. NA_C	0.03 (-0.12-0.17)	-0.46 (-0.57--0.34)	-0.37 (-0.49--0.24)	0.94			
5. Competence	0.35 (0.22-0.47)	0.47 (0.35-.058)	0.52 (0.41-0.62)	-0.24 (-0.37--0.10)	0.94		
6. Autonomy	-0.02 (-0.17-0.13)	0.46 (0.34-0.56)	0.44 (0.31-0.55)	-0.22 (-0.36--0.08)	0.23 (0.08-0.36)	0.95	
7. Relatedness	0.05 (-0.10-0.12)	0.34 (0.20-0.47)	0.44 (0.31-0.55)	-0.27 (-0.40--0.12)	0.38 (0.24-0.50)	0.45 (0.32-.056)	0.97

Note. Sample size ranges from 167 to 185 based on participant responses. GLTEQ = Godin Leisure-Time Physical Activity; C = Contextual; SVS = Subjective Vitality Scale; PA = Positive and NA = Negative Affect Schedule; Estimates of internal consistency (Cronbach's α, Cronbach, 1951) are located along the diagonal. All *r's* > |0.34 | significant at $p < .001$ (one-tailed). All *r's* ≥ |0.22| but less than |0.34| significant at $p < .01$ (one tailed). Values in parentheses represent 95% Confidence Interval

Table 8

Bootstrapped Indirect Effects of Leisure-Time Physical Activity on Global Subjective Vitality Through Mediators

Variable	Point Estimate	BCa CI	R^2adj.
Total	0.0087	0.0020-0.0165	0.28***
Competence	0.0080	0.0034-0.0140	
Autonomy	-0.0001	-0.0028-0.0023	
Relatedness	0.0007	-0.0011-0.0044	

Note. Number of bootstrap resamples = 5000. BCa CI = Bias Corrected and Accelerated Confidence Intervals. *** $p < .001$.

Table 9

Bootstrapped Indirect Effects of Leisure-Time Physical Activity on Contextual Subjective Vitality Through Mediators

Variable	Point Estimate	BCa CI	R^2adj.
Total	0.0097	0.0030-0.0171	0.37***
Competence	0.0093	0.0049-0.0153	
Autonomy	0.0002	-0.0040-0.0036	
Relatedness	0.0002	-0.0005-0.0027	

Note. Number of bootstrap resamples = 5000. BCa CI = Bias Corrected and Accelerated Confidence Intervals. *** $p < .001$.

Table 10

Bootstrapped Indirect Effects of Leisure-Time Physical Activity on Global Positive Affect Through Mediators

Variable	Point Estimate	BCa CI	R^2adj.
Total	0.0027	-0.0008-0.0067	0.14***
Competence	0.0027	-0.0004-0.0058	
Autonomy	0.0000	-0.0021-0.0017	
Relatedness	0.0000	-0.0004-0.0017	

Note. Number of bootstrap resamples = 5000. BCa CI = Bias Corrected and Accelerated Confidence Intervals. *** $p < .001$.

Table 11

Bootstrapped Indirect Effects of Leisure-Time Physical Activity on Contextual Positive Affect Through Mediators

Variable	Point Estimate	BCa CI	R^2adj.
Total	0.0070	0.0025-0.0122	0.42***
Competence	0.0065	0.0037-0.0108	
Autonomy	0.0000	-0.0022-0.0019	
Relatedness	0.0050	-0.0008-0.0024	

Note. Number of bootstrap resamples = 5000. BCa CI = Bias Corrected and Accelerated Confidence Intervals. *** $p < .001$.

Table 12

Bootstrapped Indirect Effects of Leisure-Time Physical Activity on Global Negative Affect Through Mediators

Variable	Point Estimate	BCa CI	R^2adj.
Total	-0.0047	-0.0098--.0008	0.18***
Competence	-0.0044	-0.0089--.0014	
Autonomy	-0.0001	-0.0021-.0021	
Relatedness	-0.0003	-0.0023-.0004	

Note. Number of bootstrap resamples = 5000. BCa CI = Bias Corrected and Accelerated Confidence Intervals. *** $p < .001$.

Table 13

Bootstrapped Indirect Effects of Leisure-Time Physical Activity on Contextual Negative Affect Through Mediators

Variable	Point Estimate	BCa CI	R^2adj.
Total	-0.0029	-0.0066--0.0004	0.11***
Competence	-0.0026	-0.0057--0.0006	
Autonomy	0.0000	-0.0011-0.0007	
Relatedness	-0.0003	-0.0020-0.0004	

Note. Number of bootstrap resamples = 5000. BCa CI = Bias Corrected and Accelerated Confidence Intervals. *** $p < .001$.

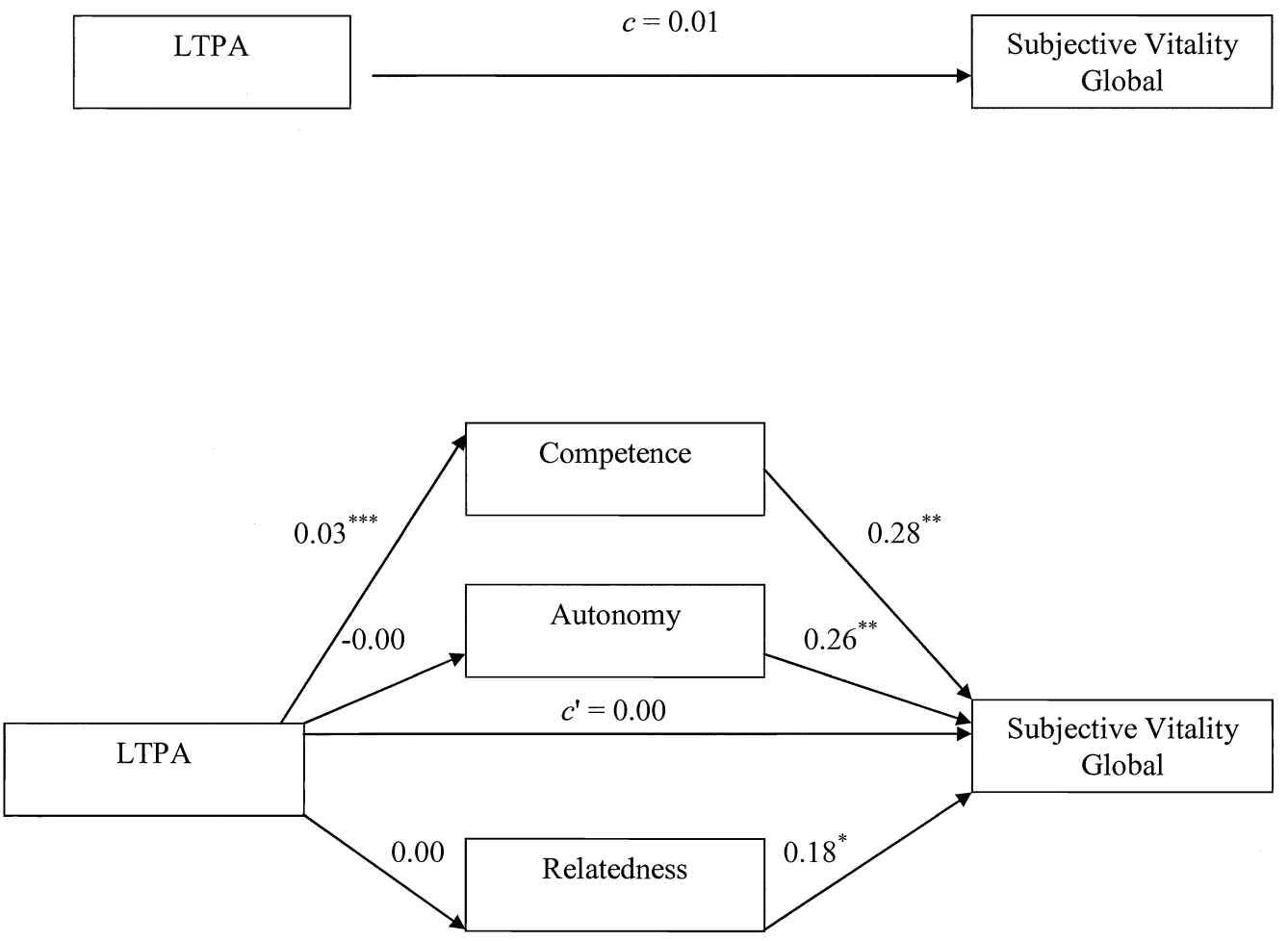

Figure 1. Multiple Mediation Model for Effects of LTPA on Global Subjective Vitality. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. Numbers represent unstandardized path coefficients. c = total effect of LTPA on global subjective vitality; c' = direct effect of LTPA on global subjective vitality.

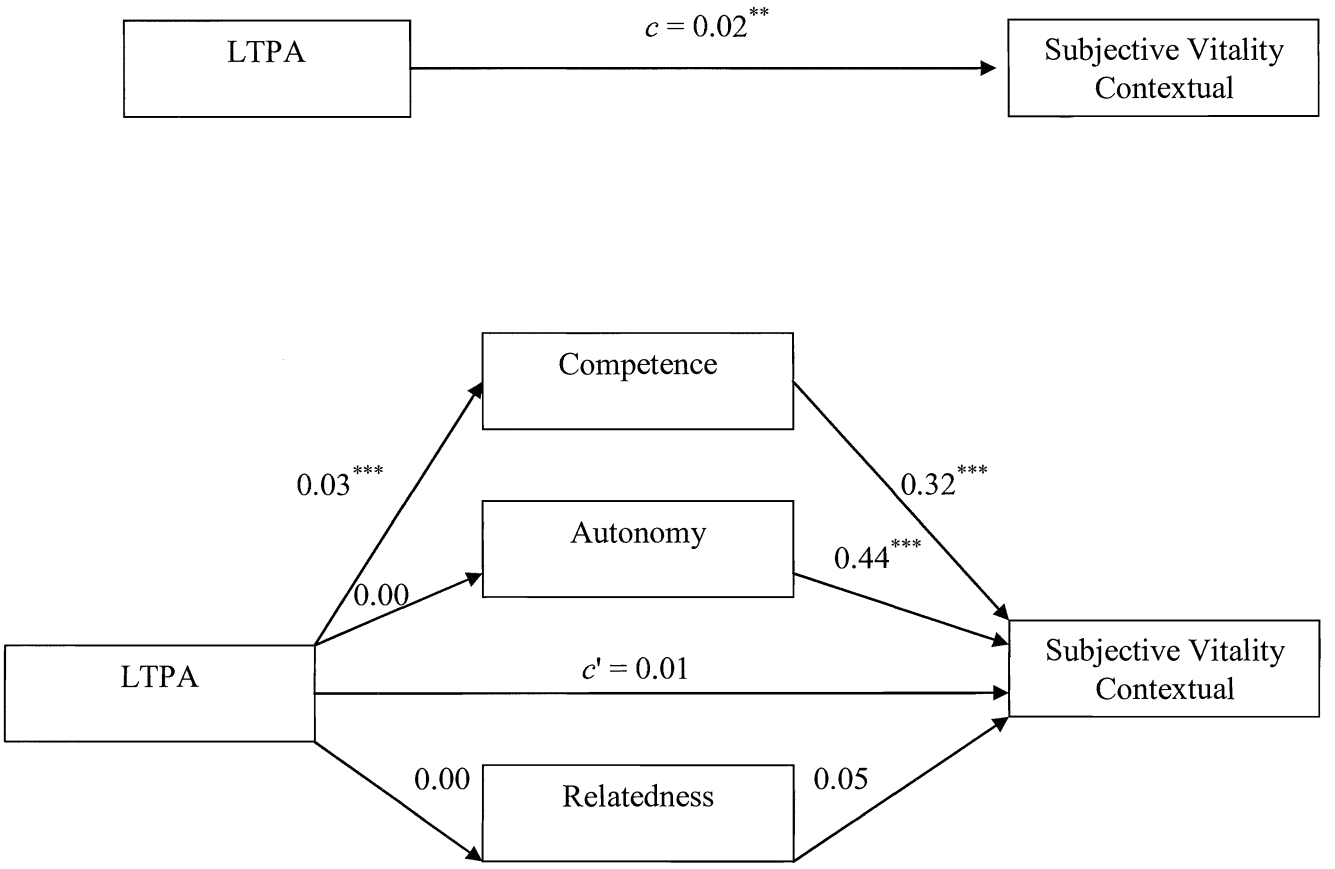

Figure 2. Multiple Mediation Model for Effects of LTPA Contextual Subjective Vitality. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. Numbers represent unstandardized path coefficients. c = total effect of LTPA on contextual subjective vitality; c' = direct effect of LTPA on contextual subjective vitality.

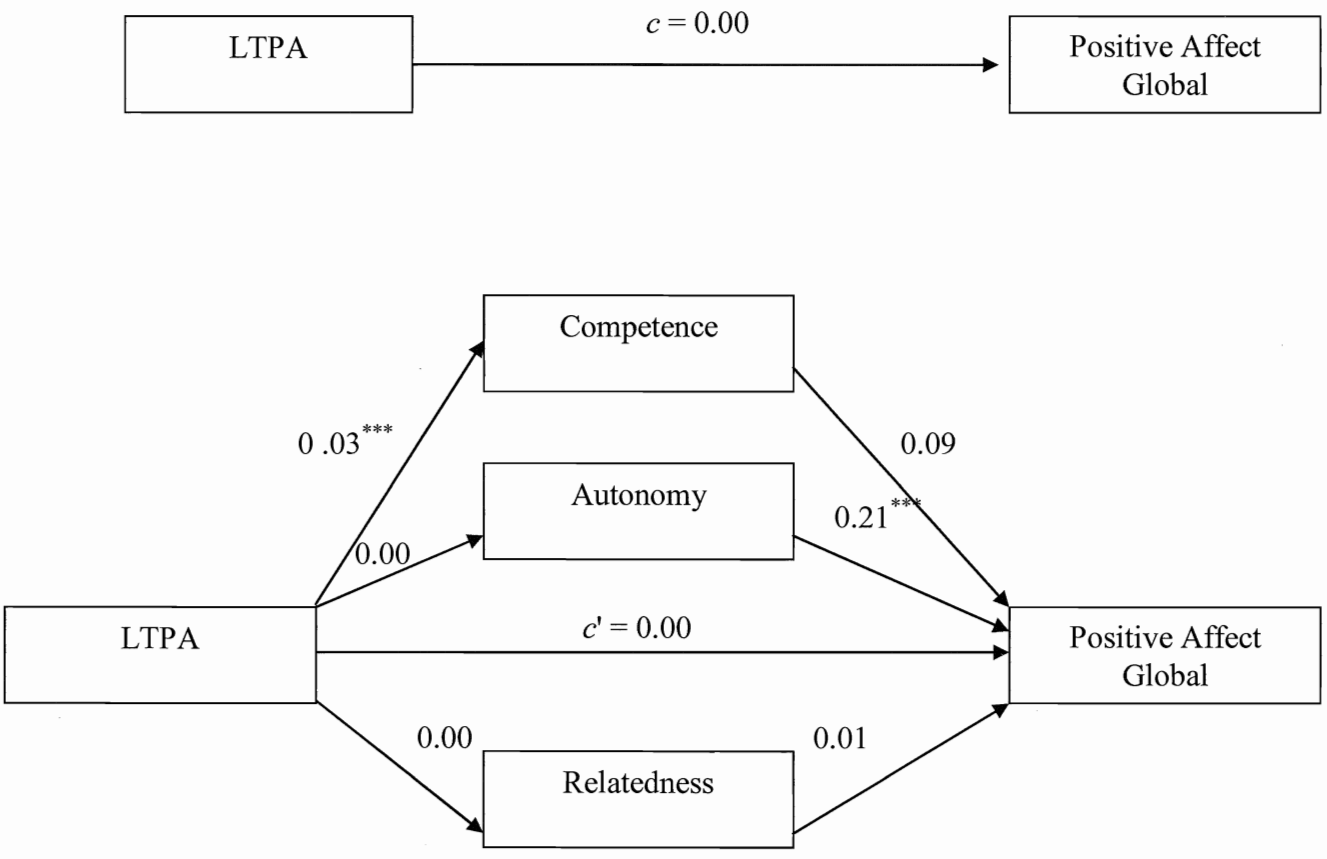

Figure 3. Multiple Mediation Model for Effects of LTPA on Global Positive Affect. $^{*}p <$ .05, $^{**}p < .01$, $^{***}p < .001$. Numbers represent unstandardized path coefficients. c = total effect of LTPA on global positive affect; c' = direct effect of LTPA on global positive affect.

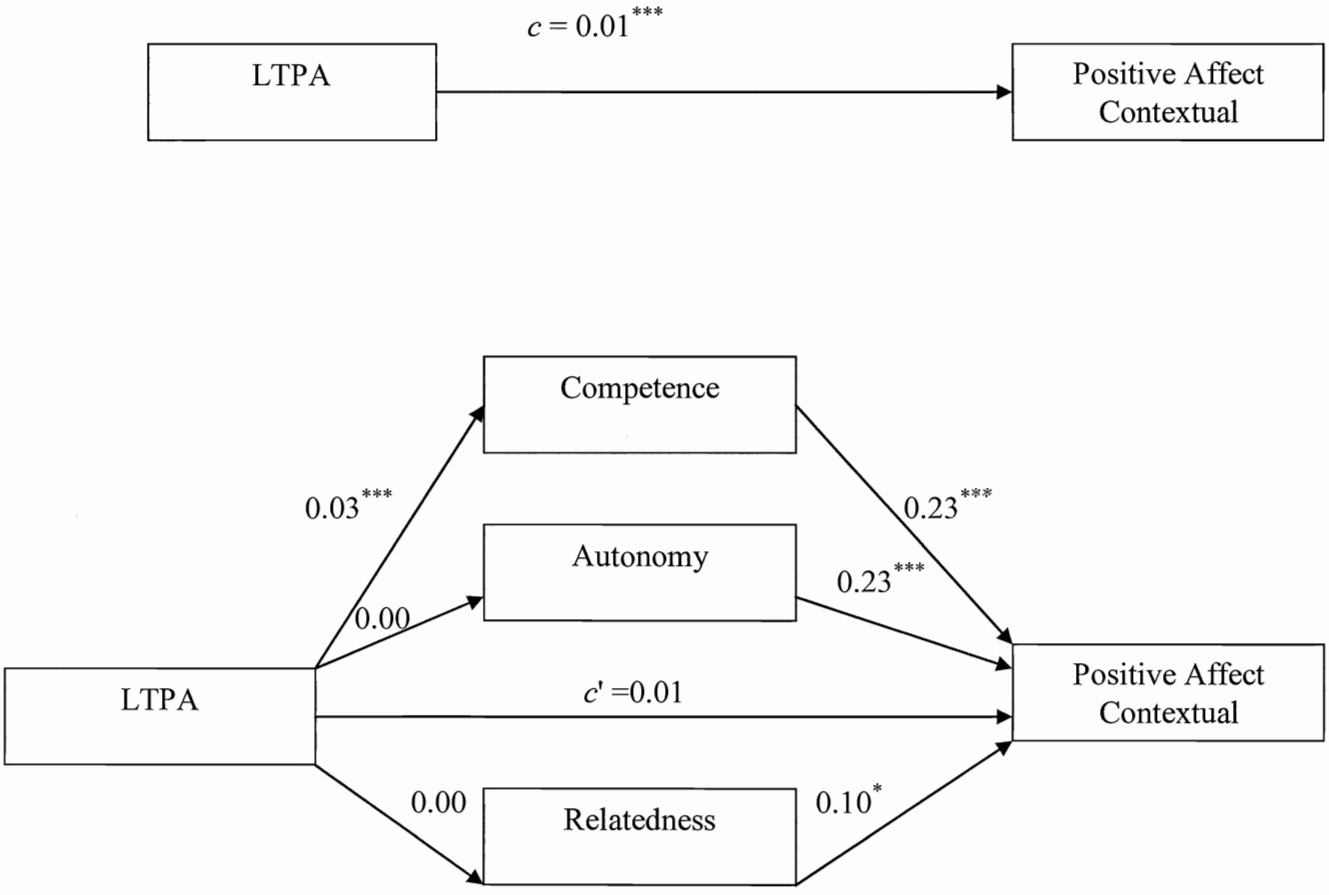

Figure 4. Multiple Mediation Model for Effects of LTPA on Contextual Positive Affect. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. Numbers represent unstandardized path coefficients. c = total effect of LTPA on contextual positive affect; c' = direct effect of LTPA on contextual positive affect.

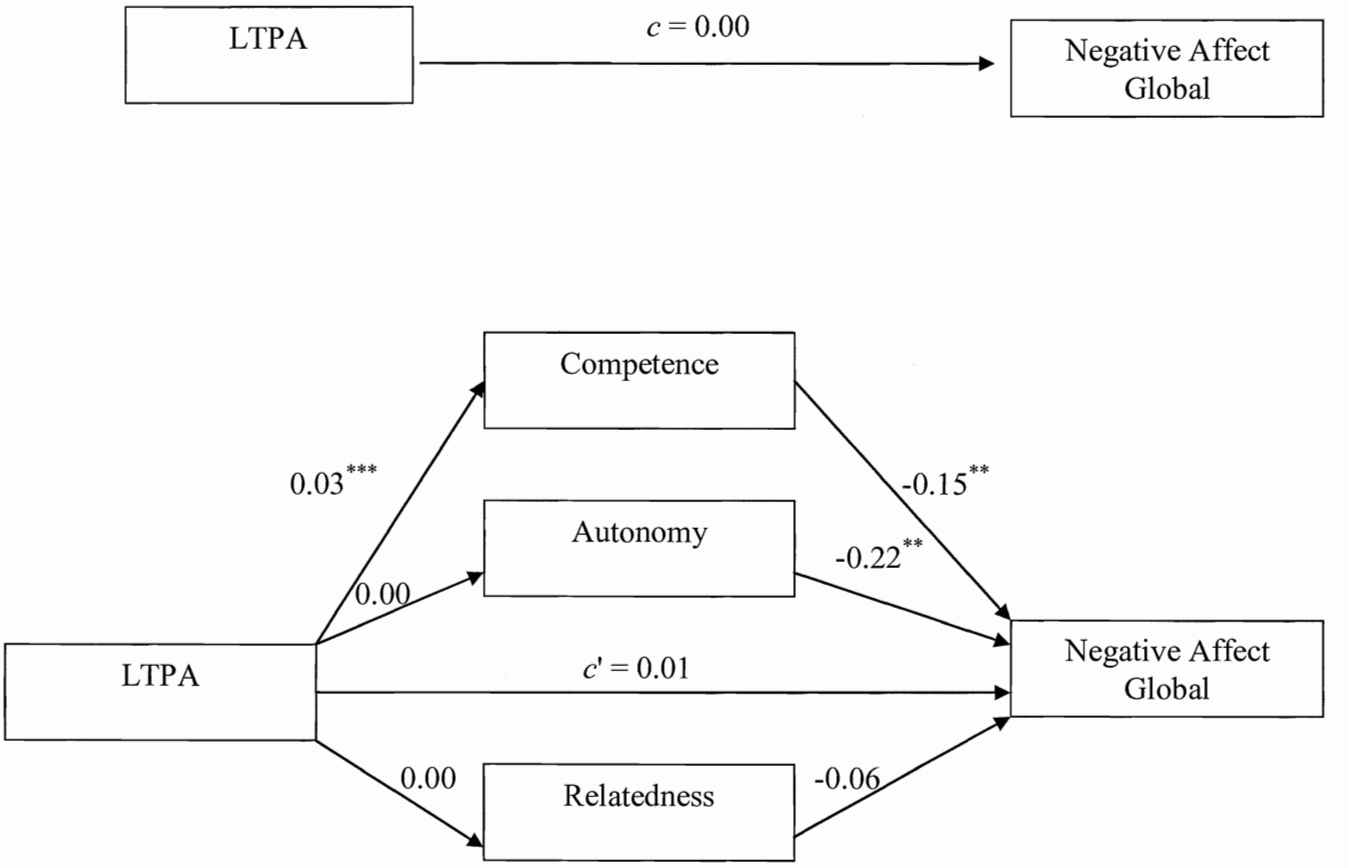

Figure 5. Multiple Mediation Model for Effects of LTPA on Global Negative Affect. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. Numbers represent unstandardized path coefficients. c = total effect of LTPA on global negative affect; c' = direct effect of LTPA on global negative affect.

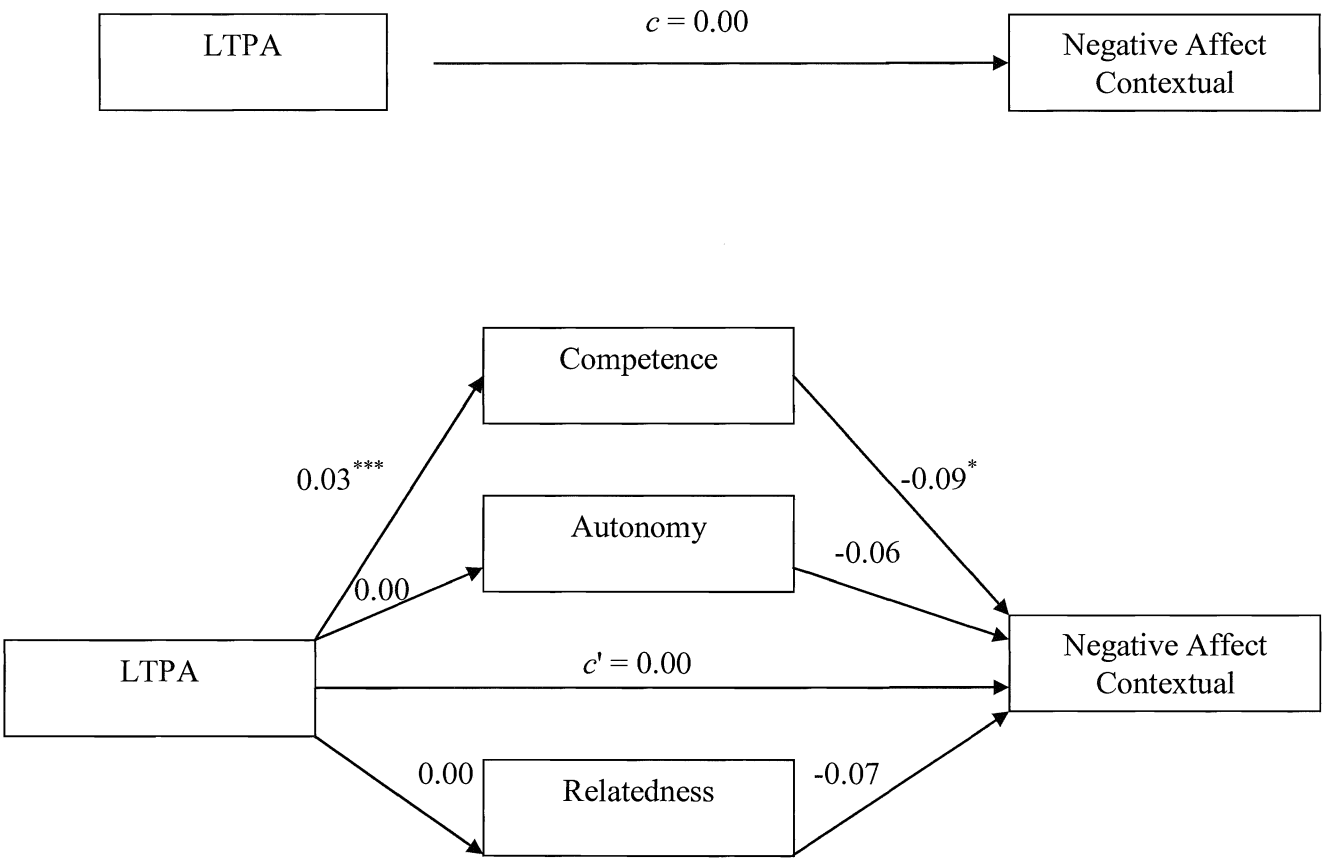

Figure 6. Multiple Mediation Model for Effects of LTPA on Contextual Negative Affect. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. Numbers represent unstandardized path coefficients. c = total effect of LTPA on contextual negative affect; c' = direct effect of LTPA on contextual negative affect.

Appendix A

Research Ethics Board Clearance Letter

DATE: September 19, 2008

FROM: Michelle McGinn, Chair

Research Ethics Board (REB)

TO: Dr. Diane E. MACK, Physical Education & Kinesiology

Katie Gunnell

FILE: 08-049 MACK/GUNNELL

TITLE: Markers of well-being in Canadian osteoporotics: The influence of physical activity

The Brock University Research Ethics Board has reviewed the above research proposal.

DECISION: Accepted as Clarified with Note

- **In order to uphold confidentiality, please ask the organizations to send out study packages on your behalf.**

This project has received ethics clearance for the period of **September 19, 2008 to August 31, 2009** subject to full REB ratification at the Research Ethics Board's next scheduled meeting. The clearance period may be extended upon request. ***The study may now proceed.***

Please note that the Research Ethics Board (REB) requires that you adhere to the protocol as last reviewed and cleared by the REB. During the course of research no deviations from, or changes to, the protocol, recruitment, or consent form may be initiated without prior written clearance from the REB. The Board must provide

clearance for any modifications before they can be implemented. If you wish to modify your research project, please refer to http://www.brocku.ca/researchservices/forms to complete the appropriate form Revision or Modification to an Ongoing Application. Adverse or unexpected events must be reported to the REB as soon as possible with an indication of how these events affect, in the view of the Principal Investigator, the safety of the participants and the continuation of the protocol.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of any research protocols.

The Tri-Council Policy Statement requires that ongoing research be monitored. A Final Report is required for all projects upon completion of the project. Researchers with projects lasting more than one year are required to submit a Continuing Review Report annually. The Office of Research Services will contact you when this form *Continuing Review/Final Report* is required.

Please quote your REB file number on all future correspondence.

MM/an

Research Ethics Office

Brock University

Office of Research Services, MC D250A

500 Glenridge Avenue, St. Catharines, ON L2S 3A1

Phone 905-688-5550 ext. 3035

Fax 908-688-0748

Email: reb@brocku.ca

http:/www.brocku.ca/researchservices/Ethics_Safety/Humans/Index.php

Appendix B

Pre-Contact E-mail (Recruitment of Participants Expressing Interest From a Prior Study)

Good Morning/Afternoon,

I am contacting you on behalf of Diane E. Mack who is a faculty member in the Department of Physical Education and Kinesiology in the Faculty of Applied Health Sciences at Brock University. Last summer, you participated in Dr. Wilson and Dr. Mack's research study; "Osteoporosis and Physical Activity". The reason I am contacting you today is because you previously expressed interest in participating in future research by this research team. In one week's time you will receive an e-mail containing information pertaining to a study that is entitled, "Physical Activity and Well-Being in Osteoporotics." The study is designed to enhance our understanding of physical activity and well-being in people diagnosed with osteoporosis. Should you choose to participate, the information that you provide will help us gain a greater understanding of the role afforded by physical activity in the treatment and management of osteoporosis and associated health conditions. Your participation in this study would be voluntary and involve completing a questionnaire on one single occasion.

We will contact you in one-week and invite you to participate in our study. For further information please contact the study coordinator for this project listed below:

Ms. Katie Gunnell
E-Mail: Katie.gunnell@brocku.ca
Telephone: 905-688-5550 ext. 5564

Thank you for your time and consideration. This study has been reviewed and received ethics clearance through Brock University's Research Ethics Board (File 08-049). Funding for this study has been provided by the Social Sciences and Humanities Research Council of Canada and the Brock University Advancement Fund.

Appendix C

Pre-Contact E-mail (Sent to Osteoporosis Organizations)

Dear <Insert Name of Organization>,

I am contacting you on behalf of Dr. Diane E. Mack who is a faculty member in the Department of Physical Education and Kinesiology in the Faculty of Applied Health Sciences at Brock University. Dr. Mack and Ms. Gunnell are conducting a study entitled, "Physical Activity and Well-Being" The study is designed to enhance our understanding of physical activity and well-being in people diagnosed with osteoporosis or osteopenia. The impact that physical activity may have on the treatment and management of bone health will be further examined.

From you, we are requesting permission to invite members of your organization to participate in our study. Member participation can come in the form of a) an e-mail contact list of members; b) bulk mailing with self-addressed, stamped envelopes to you such that you may distribute them to your members, or c) the opportunity to introduce our study at one of your scheduled meetings.

In an effort to show our appreciation for your time, those who complete the questionnaire will have the opportunity to select either Osteoporosis Canada or a local Osteoporosis Canada Chapter to receive a 5-dollar donation. Your participation is completely voluntary. Of your members, we will be requesting that they complete a series of questions that will take approximately 20-25 minutes of their time on one occasion. Your endorsement is voluntary and all of the contact information that you provide will remain confidential which means that we will not be sharing your members personal contact information with any other person or party in such a manner that they could be identified as a consequence of participating in this project.

For further information please contact the study coordinator for this project listed below:

Ms. Katie Gunnell
E-Mail: Katie.gunnell@brocku.ca
Telephone: 905-688-5550 ext. 5564

Thank you for your time and consideration. This study has been reviewed and received ethics clearance through Brock University's Research Ethics Board (File 08-049). Funding for this study has been provided by the Social Sciences and Humanities Research Council of Canada and the Brock University Advancement Fund.

Appendix D

Letter of Invitation (Electronic Recruitment)

Dear <Insert Name>,

Good morning/evening. This e-mail is your invitation to participate in Diane E. Mack and Katie Gunnell's research study entitled "Physical Activity and Well-Being". The purpose of this study is to examine the association of physical activity and well-being in those diagnosed with osteoporosis or osteopenia. Attention to this important health behaviour and the association with well-being is important for our understanding of healthy active living in people with osteoporosis/osteopenia. The impact that physical activity may have on the treatment and management of bone health will be further examined.

Your involvement would be greatly appreciated. The following criteria will be used to determine participant eligibility for this study:

1. Currently have osteoporosis or osteopenia (physician diagnosed)
2. 18 years of age or older
3. Able to read and converse in English

If you choose to participate, we will request that you complete a series of questions via a secured internet-site designed specifically for this study that will take approximately 20-25 minutes of your valuable time. One sample question is: " during a typical 7-day period, how many times on average do you do the following kinds of exercise for more than 15 minutes during your free time?" In an effort to show our appreciation for your time, those who complete the questionnaire will have the opportunity to select either Osteoporosis Canada or a local Osteoporosis Canada Chapter to receive a 5-dollar donation. Your participation is voluntary and all of the information that you provide will remain confidential which means that we will not be sharing your personal information with any other person or party in such a manner that you could be identified as a consequence of participating in this study.

If you wish to participate, please follow the link below.

http://www.surveymonkey.com

If you know anyone (i.e., friends/family/contacts) that is eligible, we ask that you discuss this research with them to determine their interests in volunteering to participate. Those individuals interested in participation should then contact the research team to volunteer.

For further information, or instructions on how you can participate, please contact the study coordinators using the information provided below:

Ms. Katie Gunnell
E-Mail: Katie.gunnell@brocku.ca
Telephone: 905-688-5550 ext. 5564

Thank you for your time and effort. This study has been reviewed and received ethics acceptance through Brock University's Research Ethics Board (File 08-049). Funding for this study was provided by the Social Sciences and Humanities Research Council of Canada and the Brock University Advancement Fund.

Appendix E

Letter of Invitation (Mail-in Recruitment)

Dear Participant,

Good morning/evening. This letter is your invitation to participate in Diane E. Mack and Katie Gunnell's research study entitled "Physical Activity and Well-Being". The purpose of this study is to examine the association of physical activity and well-being in those diagnosed with osteoporosis or osteopenia. Attention to this important health behaviour and the association with well-being is important for our understanding of healthy active living in people with osteoporosis/osteopenia. The impact that physical activity may have on the treatment and management of bone health will be further examined.

Your involvement would be greatly appreciated. The following criteria will be used to determine participant eligibility for this study:

1. Currently have osteoporosis or osteopenia (physician diagnosed)
2. 18 years of age or older
3. Able to read and converse in English

If you choose to participate, we will request that you complete the informed consent form and series of questions enclosed in this envelope. When complete, simply place the informed consent and questionnaire into the self-addressed and stamped envelope and drop it in to any mail deposit box. It will take approximately 20-25 minutes of your valuable time. One sample question is: " during a typical 7-day period, how many times on average do you do the following kinds of exercise for more than 15 minutes during your free time?" In an effort to show our appreciation for your time, those who complete the questionnaire will have the opportunity to select either Osteoporosis Canada or a local Osteoporosis Canada Chapter to receive a 5-dollar donation. Your participation is voluntary and all of the information that you provide will remain confidential which means that we will not be sharing your personal information with any other person or party in such a manner that you could be identified as a consequence of participating in this study.

If you know anyone (i.e., friends/family/contacts) that is eligible, we ask that you discuss this research with them to determine their interests in volunteering to participate. Those individuals interested in participation should then contact the research team to volunteer.

For further information, or instructions on how you can participate, please contact the study coordinator using the information provided below:

Ms. Katie Gunnell
E-Mail: Katie.gunnell@brocku.ca

Telephone: 905-688-5550 ext. 5564

Thank you for your time and effort. This study has been reviewed and received ethics acceptance through Brock University's Research Ethics Board (File 08-049). Funding for this study was provided by the Social Sciences and Humanities Research Council of Canada and the Brock University Advancement Fund.

Appendix F

Letter of Invitation (Recruitment through Bone Health Specialist)

Dear Participant,

Good morning/evening. This letter is your invitation to participate in Diane E. Mack and Katie Gunnell's research study entitled "Physical Activity and Well-Being". The purpose of this study is to examine the association of physical activity and well-being in those diagnosed with osteoporosis or osteopenia. Attention to this important health behaviour and the association with well-being is important for our understanding of healthy active living in people with osteoporosis/osteopenia. The impact that physical activity may have on the treatment and management of bone health will be further examined.

Your involvement would be greatly appreciated. The following criteria will be used to determine participant eligibility for this study:

1. Currently have osteoporosis or osteopenia (physician diagnosed)
2. 18 years of age or older
3. Able to read and converse in English

If you choose to participate, we will request that you complete the informed consent form and series of questions enclosed in this envelope. When complete, simply place the informed consent and questionnaire into the self-addressed and stamped envelope and drop it in to any mail deposit box. It will take approximately 20-25 minutes of your valuable time. One sample question is: " during a typical 7-day period, how many times on average do you do the following kinds of exercise for more than 15 minutes during your free time?" Confirmation of the medical information requested in the survey package will be requested from Dr. Adachi's medical staff. Only information directly relevant to the study purpose will be requested (e.g., osteoporosis or osteopenia diagnosis, fracture history). Information contained in your medical file not directly relevant to the stated purpose will remain confidential. In an effort to show our appreciation for your time, those who complete the questionnaire will have the opportunity to select either Osteoporosis Canada or a local Osteoporosis Canada Chapter to receive a 5-dollar donation. Your participation is voluntary and all of the information that you provide will remain confidential which means that we will not be sharing your personal information with any other person or party in such a manner that you could be identified as a consequence of participating in this study.

If you know anyone (i.e., friends/family/contacts) that is eligible, we ask that you discuss this research with them to determine their interests in volunteering to participate. Those individuals interested in participation should then contact the research team to volunteer.

For further information, or instructions on how you can participate, please contact the study coordinator using the information provided below:

Ms. Katie Gunnell
E-Mail: Katie.gunnell@brocku.ca
Telephone: 905-688-5550 ext. 5564

Thank you for your time and effort. This study has been reviewed and received ethics acceptance through Brock University's Research Ethics Board (File 08-049). Funding for this study was provided by the Social Sciences and Humanities Research Council of Canada and the Brock University Advancement Fund.

Appendix G
Informed Consent (Mail-in Recruitment)

Title of Study: Physical Activity and Well-Being
Principal Researcher: Dr. Diane E. Mack, Associate Professor, Department of Physical Education and Kinesiology
Co-Investigator: Katie E. Gunnell, MA Candidate, Faculty of Applied Health Sciences

You are invited to participate in a study that involves research. The purpose of this study is to examine the physical activity behaviours and well-being of people with osteoporosis or osteopenia.

- I have received and read the letter of information provided to me through members of the research team conducting the research.
- I understand that participation will involve completing an 85-item questionnaire that will take approximately 20-25 minutes on a single occasion.
- The purpose of this investigation is to determine the association between physical activity and well-being in people diagnosed with osteoporosis or osteopenia.
- I understand that no known psychological or physical risks are associated with participation.
- I understand that background information requests the disclosure of personal information.
- I understand that there is no obligation to answer any question that I feel is invasive, offensive or inappropriate.
- I understand that members of the research team have secured procedures to ensure participant confidentiality.
- I understand that all personal information will be kept strictly confidential and that all information will be coded so that the name of the individual participants will not be associated with my specific answers.
- I understand that my participation in this study is voluntary and that I may withdraw from the study at any time and for any reason without penalty by informing a member of the research team of my decision.
- I understand that a 5-dollar donation will be made by the researchers to either Osteoporosis Canada or my local Osteoporosis Canada Chapter upon my completion of the study.
- I understand that only members of the research team named above will have access to the data. Data will be entered on a computer stored in a locked office at Brock University.
- I understand that data will be destroyed five years following completion of the study.

- I understand that participants gain a better understanding of the role of physical activity and well-being in those with osteoporosis/osteopenia.
- I understand that the results of this study will be distributed in academic journal articles and conference presentations and a summary of the results will be made available to the participants in this study.
- As indicated by my consent below, I acknowledge that I am participating feely and willingly.

I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time. Please print a copy of this form for your own records.

Name (please print):		Date:
Signature:		
If you have any questions about this study or require further information, please contact Ms. Gunnell at Katie.gunnell@brocku.ca or (905) 688-5550 ext. 5564. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (File 08-049). If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905)- 688-5550 ext. 3035 or reb@brocku.ca		

Appendix H

Informed Consent (Electronic Recruitment)

Title of Study: Physical Activity and Well-Being
Principal Researcher: Dr. Diane E. Mack, Associate Professor, Department of Physical Education and Kinesiology
Co-Investigator: Katie E. Gunnell, MA Candidate, Faculty of Applied Health Sciences

You are invited to participate in a study that involves research. The purpose of this study is to examine the physical activity behaviours and well-being of people with osteoporosis or osteopenia.

- I have received and read the letter of information provided to me through members of the research team conducting the research.
- I understand that participation will involve completing a 85-item questionnaire that will take approximately 20-25 minutes on a single occasion.
- The purpose of this investigation it to determine the association between physical activity and well-being in people diagnosed with osteoporosis or osteopenia.
- I understand that no known psychological or physical risks are associated with participation.
- I understand that background information requests the disclosure of personal information.
- I understand that there is no obligation to answer any question that I feel is invasive, offensive or inappropriate.
- I understand that members of the research team have secured procedures to ensure participant confidentiality.
- I understand that all personal information will be kept strictly confidential and that all information will be coded so that the name of the individual participants will not be associated with my specific answers.
- I understand that my participation in this study is voluntary and that I may withdraw from the study at any time and for any reason without penalty by exiting the survey using the instructions on screen.
- I understand that a 5-dollar donation will be made by the researchers to either Osteoporosis Canada or my local Osteoporosis Canada Chapter upon my completion of the study.
- I understand that only members of the research team named above will have access to the data. Data will be entered on a secured Internet site and will be downloaded onto a computer stored in a locked office at Brock University.
- The electronic interface storing your data is based in the United States and therefore is subject to American Homeland Security laws such as the Patriot Act.

- I understand that data will be destroyed five years following completion of the study
- I understand that participants gain a better understanding of the role of physical activity and well-being in those with osteoporosis/osteopenia.
- I understand that the results of this study will be distributed in academic journal articles and conference presentations and a summary of the results will be made available to the participants in this study.
- As indicated by my consent below, I acknowledge that I am participating feely and willingly.

I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask question in the future. I understand that I may withdraw this consent at any time. Please print a copy of this form for your own records.

☐	I consent to participate in this study by checking this box	Date:
If you have any questions about this study or require further information, please contact Ms. Gunnell at Katie.gunnell@brocku.ca or (905) 688-5550 ext. 5564. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (File 08-049). If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905)- 688-5550 ext. 3035 or reb@brocku.ca		

Appendix I

Informed Consent (Recruitment Through Bone Health Specialist)

Title of Study: Physical Activity and Well-Being
Principal Researcher: Dr. Diane E. Mack, Associate Professor, Department of Physical Education and Kinesiology
Co-Investigator: Katie E. Gunnell, MA Candidate, Faculty of Applied Health Sciences

You are invited to participate in a study that involves research. The purpose of this study is to examine the physical activity behaviours and well-being of people with osteoporosis or osteopenia.

- I have received and read the letter of information provided to me through members of the research team conducting the research.
- I understand that participation will involve completing an 85-item questionnaire that will take approximately 20-25 minutes on a single occasion.
- The purpose of this investigation is to determine the association between physical activity and well-being in people diagnosed with osteoporosis or osteopenia.
- I understand that no known psychological or physical risks are associated with participation.
- I understand that background information requests the disclosure of personal information.
- I understand that there is no obligation to answer any question that I feel is invasive, offensive or inappropriate.
- I understand that members of the research team have secured procedures to ensure participant confidentiality.
- I understand that all personal information will be kept strictly confidential and that all information will be coded so that the name of the individual participants will not be associated with my specific answers.
- I understand that confirmation of the medical information requested in the survey package will be requested from Dr. Adachi's medical staff. Only information directly relevant to the study purpose will be requested (e.g., osteoporosis or osteopenia diagnosis, fracture history).
- I understand that my participation in this study is voluntary and that I may withdraw from the study at any time and for any reason without penalty by informing a member of the research team of my decision.
- I understand that a 5-dollar donation will be made by the researchers to either Osteoporosis Canada or my local Osteoporosis Canada Chapter upon my completion of the study.

- I understand that only members of the research team named above will have access to the data. Data will be entered on a computer stored in a locked office at Brock University.
- I understand that data will be destroyed five years following completion of the study.
- I understand that participants gain a better understanding of the role of physical activity and well-being in those with osteoporosis/osteopenia.
- I understand that the results of this study will be distributed in academic journal articles and conference presentations and a summary of the results will be made available to the participants in this study.
- As indicated by my consent below, I acknowledge that I am participating feely and willingly.

I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time. Please print a copy of this form for your own records.

Name (please print):		Date:
Signature:		
If you have any questions about this study or require further information, please contact Ms. Gunnell at Katie.gunnell@brocku.ca or (905) 688-5550 ext. 5564. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (File 08-049). If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905)- 688-5550 ext. 3035 or reb@brocku.ca		

Appendix J
Debriefing Form

Brock University, Faculty of Applied Health Sciences
Debriefing Form

If you wish to receive a summary of the major findings from this study, please provide either your mailing address or your e-mail in the space provided below:

E-mail Address: _____

OR

Mailing Address: _____

_____

_____

_____

_____

Appendix K

Recruitment Poster

Osteoporosis

Physical Activity & Well-Being

Purpose

To determine the association between lifestyle physical activity and well-being

Requirements

- Participants must have been diagnosed with osteoporosis or osteopenia
- Participation involves a total time commitment of 20 minutes

Charitable donation

For those participating, a charitable donation will be made to either Osteoporosis Canada or your local osteoporosis chapter

For more information, interested individuals can contact:

- ***Dr. Diane Mack*** .... (905) 688-5550 x 4360 .... dmack@brocku.ca
- ***Ms. Katie Gunnell*** .... (905) 688-5550 x 5564 .... katie.gunnell@brocku.ca

This project has been reviewed and received ethics clearance through the Research Ethics Board (REB) at Brock University (File: 08-049). If you have questions pertaining to this study, or would like a copy of the study's major findings, please contact a member of the research team listed above or the Brock University's REB at (905) 688-5550 x 3035.

Thank you for your interest in our research project.

This study is funded by the Social Sciences and Humanities Research Council of Canada.

Brock University | **Faculty of Applied Health Sciences**
Department of *Physical Education & Kinesiology*

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905-688-5550 ext. 5564

Appendix L

Recruitment Strategy

Ontario:

Contact Information	Dates/responses/what they did
Hamilton Chapter: Lesley Hughes (905)-525-5398 hamilton@osteoporosis.ca	1st-September 22. 2nd-October 16 3rd- October 25
London Thames Valley Chapter: Teresa Cristiano-Flanagan (519)-457-0624 london-thamesvalley@osteoporosis.ca	1st-September 22 2nd-October 16 3rd- October 25
Mississauga Chapter: Annette Maggs mississauga@osteoporosis.ca	1st-September 22 2nd-October 16 3rd- October 25
Niagara Chapter (905)-227-9646 niagara@osteoporosis.ca	1st-September 22
Ottawa Chapter: Christine Thomas (613)-729-8489 ottawa@osteoporosis.ca	1st-September 22, responded September 23. I replied to them Sept 23 3rd- October 25
Peterborough Chapter: Val McRae 1866-376-2776 peterborough@osteoporosis.ca	1st-September 22 2nd-October 16 wrote back October 16 to wait for OC 3rd- October 25
Toronto Chapters: Suzanna Cohen (416)-969-2663 ext. 275 toronto@osteoporosis.ca	1st-September 22 2nd-October 16 3rd- October 25
Sudbury Chapter: Terri Beauchamp (705)-522-2908 sudbury@osteoporosis.ca	1st-September 22 2nd-October 16 wrote back October 16 to wait for OC 3rd- October 25 wrote back, wait for after bone china tea on November 2. Wrote back October 27th and asked me to e-mail the electronic survey for the 2 that expressed interest.
Waterloo Wellington Chapter: Mairi McLean (519)-837-9420 waterloowellington@osteoporosis.ca	1st-September 22 2nd-October 16 3rd- October 25
Syme 55+Centre (416)-766-0388 (TO) syme55@bellnet.ca	1st-September 22
Cambridge Osteoporosis Support Group (519)-740-downtone@city.cambridge.on.ca	Contacted October 22
Health & Performance Centre (Geulph) (519)-821-4007 hpc@uoguelph.ca	1st-September 22 2nd October 16. Physio for young people. She suggested I try Eramosa Pysiotherapy Associates-Elora Bell Account

	mailto:jacquelinesinkeldam@bellnet.ca. I sent email to this person October 24
Osteoporosis Support Group Guelph (519)-823-8972 lbriggs@city.guelph.on.ca	1st-September 22 (e-mail came back)
Kitchener-Waterloo Osteoporosis Support Group (519)-741-2505 urbancap@city.kitchener.on.ca	Contacted October 22
Low Impact and Osteoporosis in Thornhill Helen Basch? exercise class 905-889-9802	Sent information and hard copy examples
Kathy Nesbitt Elgin St Thomas Health Unit. ask to place poster knesbitt@elginhealth.on.ca	1st-September 22 Contacted me October 30 asking if we are still looking for participants with osteo.
Christine Fulton christinefulton@hotmail.com	Contacted October 22
Bernadette J Clarke Recreation Facilities Clerk/Fitness Leader Community Wellness Programs (osteofit) bclarke@richmond.ca	1st-September 22. Responded October 14, will ask osteofit members
Bernard Betel Centre reception@betelcentre.org	1st-September 22 Will post our flyer in their community centre (September 24)
Ajax Pcikering Osteoporosis Support Group	osteosupportgroup@sympatico.ca Contacted October 24

Canada:

Contact Information	Dates/responses/what they did
Alberta Chapter: Loretta Brown (403)-237-7022 alberta@osteoporosis.ca	1st-September 22 2nd October 16 3rd- October 25
BC: Karen Coulson kcoulson@osteoporosis.ca	1st-September 22 2nd October 16 wrote back October 16 to wait for OC 3rd- October 25 wrote back Oct 27th, not doing it, doors are shutting in BC
Kelowna Chapter: Candace Cameron: (250)-861-6880, kelowna@osteoporosis.ca	1st-September 22 2nd October 16 3rd- October 25
Mid-Islan Chapter (BC): Lisa Leger (250)-951-0243 mid-island@osteoporosis.ca	1st-September 22 2nd October 16 3rd- October 25
North Shore Chapter (BC): Mary Hamm (604)-985-5430 northshore@osteoporosis.ca	1st-September 22 2nd October 16 3rd- October 25
Surrey/White Rock Chapter: Anita	1st-September 22. Will discuss at their meeting

Eccles (604)-535-6510 surrey-whiterock@osteoporosis.ca	October 10. 2nd October 16 3rd- October 25
Manitoba Chapter: Marian Kremers 1 (204)-772-3498 manitoba@osteoporosis.ca	1st-September 22 2nd October 16 3rd- October 25
New Brunswick Chapter: Debbie McAllister (506)-459-4901 Newbrunswick@osteoporosis.ca	1st-September 22 2nd October 16 3rd- October 25
Greater Moncton Chapter: Margaret Steven (506)-389-2214 greatermoncton@osteoporosis.ca	1st-September 22 2nd October 16 3rd- October 25
Nova Scotia Chapter: Elaine Books (902)-479-2115 novascotia@osteoporosis.ca	1st-September 22 2nd October 16 3rd- October 25
Prince Edward Island Chapter: Colleen Murray (902)-367-3933 pei@osteoporosis.ca	1st-September 22 2nd October 16 3rd- October 25
Quebec City Chapter: Julie Parrot/ELIZABETH SHAVER (418)-650-3475 sectiondequebec@osteoporosecanada.ca	1st-September 22 2nd October 16 wrote back October 16 to wait for OC 3rd- October 25 wrote back Nov. 6 saying only if in French. I sent her the electronic email anyways
Greater Montreal Chapter: July Katherine Bustos (514)-933-0310 montreal@osteoporosis.ca	1st-September 22 2nd October 16 wrote back October 16 to wait for OC 3rd- October 25- Note participating in Study
Regina Chapter: Carolann Louttit (306)-757-2663 regina@osteoporosis.ca	1st-September 22 2nd October 16 3rd- October 25 contacted me Feb 18th asking if it was too late. I gave her the option of online only.
Saskatoon Chapter: Elda Clarke (306)-931-2663 saskatoon@osteoporosis.ca	1st-September 22. Responded to me September 23 asking how to help (#'s). I responded asking her for estimate of #'s. Sent 20 questionnaires to them September 26th
BC Women's Osteofit Program (604)-875-2555 Debbi Cheong osteofit@cw.bc.ca	1st-September 22. Contacted me September 26 asking how many people we want. I emailed back September 26 sent second email Nov 11, she contacted me Nov 13 saying she wants to help but doesn't know how to distribute the surveys. Contacted me again Nov 20th asking if the donation can go to osteofit. Feb 9th, sent out 148 surveys to various

	osteofit programs

List Servers

Canadian Association for the advancement of women and sport and physical activity eNews letter Barb MacDonald bmacdonald@caaws.ca	1st-September 22 re-contact October 22. She wrote back October 22. I sent her the electronic invitation. Will include info in e-news
Ontario Women's Health Network enewsletters owhn@owhn.on.ca	1st-September 22, responded to me, will place add in e-digest. I sent her the letter of invitation Sept 24.
Action Canada for Population and Development (list serv) info@acpd.ca (613)-562-0880	1st-September 22 re-contact October 22
Canadian Women's Health Network: Brigit's Notes:Women's Health E-Bulletin cwhn@cwhn.ca	1st-September 22. Sept 26th, will post in brigit's notes and 'whats hot' on website.
Canadian Mental Health Association: mental health notes (biweekly news letter) news@ontario.cmha.ca	1st-September 22 re-contacted October 22. Scott Mitchell contacts me on October 23, asked how it related to mental health. I replied October 24
Ontario Health Coalition: ohc@sympatico.ca	1st-September 22. Re-contact October 22
Ontario Health Promotion e-Bulletin (OHPE) info@ohpe.ca (RDI Robyn Kalda r.kalda@opc.on.ca)	1st-September 22- Contacted September 24 can't run add
Rise-Up listserv awillats@sympatico.ca	1st-September 22, responded to me, will place add in news week September 29. I sent her the letter of invitation September 24
Women's Health Matters ebulliten bulletin@womenshealthmatters.ca	1st-September 22 responded, won't place in bulletin but free to post of discussion board posted on this board September 26
The healthline.ca e bulletin editor@sw.ccac-ont.ca	1st-September 22 October 22, responded to me Oct 29 saying she didn't know how to help, I wrote back Nov. 7 saying to place in ebulletin She wrote back saying no
Womennet newsletter info@womennet.ca	1st-September 22 re-contacted October 22
Ontario Health Communities e-news Coalition Jadie McDonnell jadiem@healthycommunities.on.ca	1st-September 24 re-contacted October 22. She wrote back I sent more information and letter of invitation October 23
Health in Common (Manitoba)	1st-September 24. Will post in

contact@healthincommon.ca e newsletter	enews/listerv. I send him letter of invite. September 24
Canadian Association for the Advancement of Women and Sport and Physical Activity (enetwork) caaws@caaws.ca	1st-September 24. Contacted me September 24 has forwarded info to someone else.
Winnipeg in motion e news getactive@winnipeginmotion.ca Deanna Betteridge dbetteridge@wrha.mb.ca	1st-September 24 re-contacted October 22. Put in enews letter November 2nd http://www.winnipeginmotion.ca/news/newsletters/?id=115
Coalition for active living e news info@activeliving.ca	1st-September 24 re-contacted October 22. She wrote back October 22, they do not have enews anymore.
Partners seeking solutions with seniors newsgroup slesperance@mts.net	1st-September 24 re-contacted October 22
Male Osteoporosis http://www.maleosteoporosis.org/ Jerry Donnelly maleosteop@yahoo.com	Posted letter of invitation on his website
National Women's Health Resource Center info@healthwomen.org	e-news. sent email October 18 2nd November 7
Bbchealth http://www.bbc.co.uk/health/	Sent email (form on website) October 18 asking for newsletter 2nd November 7
Health Boards http://www.healthboards.com/ adminmod@healthboards.com	Sent email asking to post on discussion board October 18th Nope 2nd November 7th Nope
Net doctor http://www.netdoctor.co.uk/ webmaster@netdoctor.co.u	Sent email asking to post on discussion board/ newsletter October 18th 2nd November 7th
cHealth http://chealth.canoe.ca/index.asp?relation_id=3431	Sent email (form on website) October 18 asking for newsletter. E-mail has been sent on to manager October 24
Society for Women's Health Research communications@womenshealthresearch.org	Sent October 22 for enews 2nd e-mail November 7th
Winnipeg Regional Health Authority jcare@wrha.mb.ca e-news	Sent nov. 7
Saskatchewan in motion info@saskatchewaninmotion.ca	Sent November 7th

US

Contact Information	Dates/responses/what they did
National Osteoporosis Foundation	Contacted October 16

patientform@nof.org	2nd November 7th
Pilates instructor in new york "incorporating movement" rebekah@incorporatingmovement.com rebekah rotstein	Sent invitation September 29
Osteoporosis Foundation info@osteofoundation.org (online support group)	Contacted October 16th 2nd November 7th
The National Osteoporosis Foundation Silver State Support Group Healthi-BONES@juno.com	Contacted October 22 e-mail came back
National Osteoporosis Foundation - Indianapolis Chapter lsnyder39128@sbcglobal.net	Contacted October 23 2nd November 7th email came back
NOF Southside Osteoporosis Support Group osteo1@sside-osteo-supportgrp.org	Contacted October 23. wrote back October 27 indicated that she would present it in March. I told her it would be closed and sent her the link anyways
Arizona Osteoporosis Coalition azockitty@aol.com	Contacted October 23 using form Wrote back, wanted more infor about brock

National Osteoporosis Society (UK)

info@nos.org.uk research@nos.org. Claire Bowring Medical Policy Officer	asked me for more information nov. 7th asked for more info Nove 20.bowring@nos.org.uk Posted on website December 3rd http://www.nos.org.uk/NetCommunity/Page.aspx?pid=297&srcid=658
Aberdeen & North East : Mrs. Anne Simpson a.simpson@nos.org.uk	Contacted October 16
Blackburn & Ribble Valley: Jill Beaumont j.beaumont@nos.org.uk	Contacted October 16
Chester & District: Catherine Johnson c.johnson@nos.org.uk	Contacted October 16
Isle of Man. Mrs. Jeanette Owen j.owen@nos.org.uk	Contacted October 16
Norwich: Miss Louise Sullivan l.sullivan@nos.org.uk	Contacted October 16
Bristol & Dristrict Mrs. Maureen Morrison m.morrison@nos.org.uk	Contacted October 16

Ceredigion NOS support group Sheila Jones tegfan60@btinternet.com	Contacted October 22
Osteoporosis Support Group- Burnley, Pendle and Rossendale. Using online form	Contacted October 22
Cumnock Osteoporosis Support Group jleach253@aol.com	Contacted October 22

Global

Contact Information	Dates/responses/what they did
King's Lynn Group (UK): Edith Finbow meetings edith.finbow@btinternet.com	Contacted October 16th
Osteoporosis Sydney Support Group enquiries@osteoporosis.com.au	Contacted October 16th 2nd November 7th
Leslie (story on internet) Leslie@ypgot.org her website http://lesann.tripod.com/	Contacted September 30 (sent link)
Coventry and District Osteoporosis Support Group Lynne Adams lynneadams2000@yahoo.co.uk	Contacted October 16th. Contacted me back October 24. Will tell people at a meeting on November 13. I sent her the link.
Irish Osteoporosis Society info@irishosteoporosis.ie.	Contacted October 16th 2nd November 7th contacted me Nov 18th asking for more info
Australian & New Zealand Bone & Mineral Society: Mrs. Ivone Johnson anzbms@racp.edu.au	Contacted October 16th. Wrote back October 21 will forward e-mail to members
Action for Health Bones Austria Gabriele.suppan@aon.at	Contacted October 16th 2nd November 7th
National Osteoporosis Foundation of South Africa	Contacted October 16th using form on internet http://www.osteoporosis.org.za/contact.htm 2nd November 7th November 9th- they put it on their website
Asian Pacific Osteoporosis Foundation Winny Lau enquiries@apof.org New: peggysiu@cuhk.edu.hk	Contacted October 16th. e-mail came back ☹ Using new email Nov 9
Osteoporosis New Zealand info@osteoporosis.org.nz	Contacted October 16th 2nd November 7th Nope

Osteoporosis Foundation of New Mexico E. Michael Lewiecki, MD, FACP LEWIECKI@aol.com	Contacted October 16th 2nd November 7th
Delhi Osteoporosis Foundation clinic@drchopra.com	Contacted October 16th e-mail came back ☹
Hong Kong Osteoporosis Foundation Mr. Anthony Kwok info@hkof.hk	Contacted October 16th 2nd November 7th
Osteoporosis in Scotland Mr. John Hughes john_hughes@merck.com	Contacted October 16 2nd November 7th Nov 9th Nope
European Calcified Tissue Society using online form http://www.ectsoc.org/ectsmailer.asp	Nov 9th
Women without osteoporosis aia@poshta.net	Nov 9th
European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO) esceoasbl@skynet.be	Nov 9th Contacted me nov. 17th and indicated they can put it in their newsletter sent to 9,000 members. they sent an email asking the head of their company if they can Nov 19. They sent out an e-mail to members sometime the week of November 24th. Many contacts came from that email.
International Society for Fracture Repair Amy Hoang Kim amyhoangkim@aol.com	Nov 9th
International Society for Clinical Densitometry info@iscd.org	Nov 9th
Mediterranean Society for Osteoporosis and Other Skeletal Diseases (MSOSD)	Nov 9th Contacted me November 15th and indicated that the could put the letter of invitation and forward it to their members
Emirates Osteoporosis Society emiratesosteo.society@gmail.com	Nov 9th
Osteoporosis Society of India osteoporosis_society_ india@hotmail.com	Nov 9th
Swedish Osteoporosis Society andreas.kindmark@medsci.uu.se	Nov 9th
Jamaica Osteoporosis Society vernab@cwjamaica.com	Nov 9th Phoned me Nov 10th asking for more details. Couldn't get a hold of after.
OsteoSwiss info@osteoswiss.ch	Nov 9th

Bone Research Society Dr. Colin Farquharson colin.farquharson@bbsrc.ac.uk	Nov 9th Nope
IOF using form	Nov 9th Nov 10, sent me an emailed saying members are 186 medical and patient societies from 90 countries... they put it in their newsletter
Evelyn Farrelly, Osteoporosis Nurse Specialist	Sent email dec. 3 inquiring about study.

Internet Postings:

Contact Information	Dates/responses/what they did
http://dailystrength.org/c/Osteoporosis/support-group (online disucssion)	Posted on their website October 14
http://www.mdjunction.com/forums/osteoporosis-discussions (online group)	September 26 asked if I could join.
Senior net discussion boards: http://www.seniornet.org/jsnet/ index.php?option=com_smf&Itemid=26	Posted online September 26 http://www.seniornet.org/jsnet/index. php?option=com_smf&Itemid=26&topic =12.new#new
Women's-Health.com Discussion	Sent an e-mail asking to post on health forum October 17. Can't post on this site. They wanted us to write a blog every day
WebMd, webmdcommunity@webmd.net	Sent an e-mail asking to post on health forum October 18 2nd November 7th
UMass Memorial Osteoporosis Support Group calendar@worcestermag.com	Sent e-mail asking to send invitation October 22
Every Day Health editor@everydayhealth.com	October 22 news/discussion board
Healia media@healia.com http://communities.healia.com/	October 22 discussion board Wrote back - no
http://goldbamboo.com/forum/	Posted on discussion board October 23
Health Boards adminmod@healthboards.com	Not allowed to post
Topix discussion board http://organizedwisdom.com/helpbar/index.html?return=http://organizedwisdom.com/Osteoporosis_Support_Groups_and_Forums&url=www.topix.com/forum/health/osteoporosis	Sent email using form October 23

http://organizedwisdom.com/helpbar/index.html?return=http://organizedwisdom.com/Osteoporosis_Support_Groups_and_Forums&url=www.revolutionhealth.com/forums/bones-joints-muscles/osteoporosis	Posted here October 23
Osteopenia3 http://www.osteopenia3.com/index.html	Contacts enews using form October 24

Internet Support Groups

osteoporosis support group - puget sound osteoporosis center DR. SUSAN NATTRASS psosteo@aol.com	Contacted October 22 2nd email November 7th
Facebook: "Fight for a cure: osteoporosis- the Silent Disease"	Posted on Discussion board September 27

Seniors Centres in St. Catharines

Anchor Pointe 540 Ontario Street St. Catharines, ON L2N 7S2 Phone: (905) 938-7070	Made Presentation and handed out 10 surveys
West St Catharines Senior Citizens Centre 117 Chetwood Street St Catharines, ON 905-684-0993	Put up poster
St Catharines and District Retirees Association 905-684-0952	Sent poster to be posted in workshop
Dunlop Senior Association 80 Dunlop Drive St Catharines, ON 905-685-6668	Posted poster

Appendix M
Questionnaire

Physical Activity & Well-being

About This Study

This confidential questionnaire is about what varied types of physical activity you do. There are no right or wrong answers to any of these questions. Please read all questions carefully and answer each one according to what is true for you. This is a very thorough questionnaire. Consequently some questions may appear similar to each other.

Section 1: This first part of the questionnaire is designed to describe the people participating in this study. All information received is held in confidence. Please provide your...

What is your country of residence? _____

Date of Birth MM/DD/YYYY _____

Height _____ Feet/inches _____ Metres

Weight _____ Pounds (lbs) _____ Kilograms (Kgs)

Please check one of the following...

1. What is your gender?

❑ Male ❑ Female

2. What is your current marital status?

❑ Married/ Common Law ❑ Widowed ❑ Separated/ Divorced ❑ Single/ Never married

3. How would you describe your ethnic origin?

❑ Aboriginal ❑ Caucasian/White ❑ Asian ❑ Other

4. What is your highest level of education completed?

❑ Some High School completed ❑ High School Diploma ❑ University/ College degree ❑ Graduate Degree

5. Have you *been physician* diagnosed with...
❑ Osteoporosis ❑ Osteopenia

6. Please estimate the number of years (or months) since you were diagnosed by a physician with either osteoporosis or osteopenia:
_____ years *or* _____ months

7. Have you been diagnosed with a fracture in your lifetime?

❑ Yes ❑ No

If yes, how many?
And in what location(s)? _____
_____
_____

8. Do you have a family member who has been diagnosed with osteoporosis?

❑ Yes ❑ No

9. Have you been physician diagnosed with any of the following health conditions (please circle yes or no please):

Yes/No	Heart disease	Yes/No	Bowel/Crohns/colitis
Yes/No	Diabetes	Yes/No	Stomach Ulcer
Yes/No	High Blood Pressure	Yes/No	Cancer

10. Please indicate what physician prescribed medications, including those taken for osteoporosis, you are currently taking:
Prescribed Medication(s): _____

_____

Other medical conditions? _____
(if so, please list) _____

Section 2: The following statements pertain to your participation in health-enhancing physical activity. For the purposes of these statements, health-enhancing physical activity is defined as...

⇒ Any bodily movement produced by the skeletal muscles that result in a substantial increase over the body's energy expenditure.

⇒ Health-enhancing physical activity can, in addition to and instead of, structured and planned exercise and sports can also be comprised of other forms of physical activity such as commuting, running errands on foot or bicycle, and leisure time hobbies.

According to the definition provided above, do you participate in health-enhancing physical activity?	
Yes, I **have been** regularly engaged in health-enhancing physical activity for **more than 6 months**	❑
Yes, I **have been** regularly engaged in health-enhancing physical activity but for **less than 6 months**	❑
No, but I **intend** to engage in health-enhancing physical activity in the **next 30 days**	❑
No, but I **intend** to engage in health-enhancing physical activity in the **next 6 months**	❑
No, and I do not **intend to engage in health enhancing physical activity** in the next 6 months	❑

Section 3: These questions pertain to feelings people typically have in their life. Please respond to each of the following statements by indicating the degree to which the statement is true for you in general in your life. Use the following scale:

	1 Not at all true	2	3	4 Some what true	5	6	7 Very true
1. I feel alive and vital.	❑	❑	❑	❑	❑	❑	❑
2. I don't feel very energetic.	❑	❑	❑	❑	❑	❑	❑
3. Sometimes I feel so alive I just want to burst.	❑	❑	❑	❑	❑	❑	❑
4. I have energy and spirit.	❑	❑	❑	❑	❑	❑	❑
5. I look forward to each new day.	❑	❑	❑	❑	❑	❑	❑
6. I nearly always feel alert and awake.	❑	❑	❑	❑	❑	❑	❑
7. I feel energized.	❑	❑	❑	❑	❑	❑	❑

Section 4: This scale consists of a number of words and phrases that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you have felt this way during the past few weeks. Use the following scale:

	1 Very slightly or not at all	2 A little	3 Moderately	4 Quite a bit	5 Extremely
1. Excited	❑	❑	❑	❑	❑
2. Enthusiastic	❑	❑	❑	❑	❑
3. Alert	❑	❑	❑	❑	❑
4. Inspired	❑	❑	❑	❑	❑
5. Determined	❑	❑	❑	❑	❑
6. Distressed	❑	❑	❑	❑	❑
7. Upset	❑	❑	❑	❑	❑
8. Scared	❑	❑	❑	❑	❑
9. Nervous	❑	❑	❑	❑	❑
10. Afraid	❑	❑	❑	❑	❑

Section 5: *These questions pertain to feelings people typically have when they engage in health-enhancing physical activity. Please respond to each of the following statements by indicating the degree to which the statement is true for you <u>when engage in health-enhancing physical activity</u>. Use the following scale:*

	1 Not at all true	2	3	4 Some what true	5	6	7 Very true
1. I feel alive and vital.	❑	❑	❑	❑	❑	❑	❑
2. I don't feel very energetic.	❑	❑	❑	❑	❑	❑	❑
3. Sometimes I feel so alive I just want to burst.	❑	❑	❑	❑	❑	❑	❑
4. I have energy and spirit.	❑	❑	❑	❑	❑	❑	❑
5. I look forward to each new day.	❑	❑	❑	❑	❑	❑	❑
6. I nearly always feel alert and awake.	❑	❑	❑	❑	❑	❑	❑
7. I feel energized.	❑	❑	❑	❑	❑	❑	❑

Section 6: This scale contains a number of words describing different feelings and emotions. Indicate to what extent YOU generally feel this way when YOU engage in health enhancing physical activity. That is, how you feel on average when you <u>engage in health-enhancing physical activity</u>.

	1 Very slightly or not at all	2 A little	3 Moderately	4 Quite a bit	5 Extremely
11. Excited	❑	❑	❑	❑	❑
12. Enthusiastic	❑	❑	❑	❑	❑
13. Alert	❑	❑	❑	❑	❑
14. Inspired	❑	❑	❑	❑	❑
15. Determined	❑	❑	❑	❑	❑
16. Distressed	❑	❑	❑	❑	❑
17. Upset	❑	❑	❑	❑	❑
18. Scared	❑	❑	❑	❑	❑
19. Nervous	❑	❑	❑	❑	❑
20. Afraid	❑	❑	❑	❑	❑

Please proceed to the next page...

*Section 7: Think about an **average week** in the past months. Please indicate how many days per week you performed the following activities, how much time on average you were engaged in this, and (if applicable) how strenuous this activity was for you?*

COMMUTING ACTIVITIES (ROUND TRIP)	Days per week	Average time per day (hours/minutes)	Effort (circle please)
Walking to/from work or school			slow/moderate/fast
Bicycling to/from work or school			slow/moderate/fast
Not Applicable			

LEISURE TIME ACTIVITIES	Days per week	Average time per day (hours/minutes)	Effort (circle please)
Walking			slow/moderate/fast
Bicycling			slow/moderate/fast
Gardening			slow/moderate/fast
Odd Jobs			slow/moderate/fast
Sports (Please write down yourself) e.g., tennis, fitness, skating, swimming, dancing			
1.			slow/moderate/fast
2.			slow/moderate/fast
3.			slow/moderate/fast
4.			slow/moderate/fast

HOUSEHOLD ACTIVITIES	Days per week	Average time per day (hours/minutes)
Light Household Work (e.g., cooking, washing dishes, ironing, child care)		
Intense Household Work (e.g., scrubbing floor, walking with heavy shopping bags)		

ACTIVITIES AT WORK AND SCHOOL	Average time per day (hours/minutes)
Light Work (sitting/standing with some walking, e.g., a desk job)	
Intense Work (regularly lifting heavy objects at work)	
Not applicable	

*Section 8: During a typical **7-Day period** (a week), how many times on average do you do the following kinds of exercise for **more than 15 minutes** during your free time (write in each space the appropriate number)*

Intensity of Activity	Times Per Week
• **Strenuous Exercise** (Heart beats rapidly) Examples of strenuous exercise include: running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling	
• **Moderate Exercise** (Not exhausting) Examples of moderate exercise include: fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing	
• **Mild Exercise**(Minimal effort) Examples of mild exercise include: yoga, archery, fishing from a river bank, bowling, horseshoes, golf, snow-mobiling, easy walking	

During a typical 7-day period (a week), in your leisure time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

Often	Sometimes	Never/Rarely
❑	❑	❑

Section 9: The following statements represent different feelings people have when they engage in physical activity. Please answer the following questions by considering how you typically feel when you engage in physical activity. Use the following scale:

	1 False	2 Mostly false	3 More False than True	4 More True than False	5 Mostly True	6 True
1. I feel that I am able to complete physical activities that are personally challenging	❑	❑	❑	❑	❑	❑
2. I feel confident I can do even the most challenging physical activities	❑	❑	❑	❑	❑	❑
3. I feel confident in my ability to perform physical activities that personally challenge me	❑	❑	❑	❑	❑	❑
4. I feel capable of completing physical activities that are challenging to me	❑	❑	❑	❑	❑	❑
5. I feel like I am capable of doing even the most challenging physical activities	❑	❑	❑	❑	❑	❑
6. I feel good about the way I am able to complete challenging physical activities	❑	❑	❑	❑	❑	❑
7. I feel free to do physical activity in my own way	❑	❑	❑	❑	❑	❑

8. I feel free to make my own physical activity program decisions	❑	❑	❑	❑	❑	❑
9. I feel like I am in charge of my physical activity program decisions	❑	❑	❑	❑	❑	❑
10. I feel like I have a say in choosing my physical activities that I do	❑	❑	❑	❑	❑	❑
11. I feel free to choose which physical activities I participate in	❑	❑	❑	❑	❑	❑
12. I feel like I am the one who decides what physical activities I do	❑	❑	❑	❑	❑	❑
13. I feel attached to my physical activity companions because they accept me for who I am	❑	❑	❑	❑	❑	❑
14. I feel like I share a common bond with people who are important to me when we do physical activity together	❑	❑	❑	❑	❑	❑
15. I feel a sense of camaraderie with my physical activity companions because we do physical activity for the same reasons	❑	❑	❑	❑	❑	❑
16. I feel close to my physical activity companions who appreciate how difficult physical activity can be	❑	❑	❑	❑	❑	❑
17. I feel connected to the people who I interact with while we do physical activity together	❑	❑	❑	❑	❑	❑
18. I feel like I get along well with other people who I interact with while we do physical activity together	❑	❑	❑	❑	❑	❑

Section 10: Below are a number of questions about your physical activity behaviour. The questions ask how you felt while engaging in physical activity. Try to recall to the best of your ability how you felt in general at the time. – your mood was probably related to the activity you were doing, but it may have occasionally been affected by other things as well.

Through your physical activity, how much were you...	Not at all						Very much
1. Doing something you believed in?	1	2	3	4	5	6	7
2. Developing a skill, learning, or gaining insight into something?	1	2	3	4	5	6	7
3. Pursuing excellence or a personal ideal?	1	2	3	4	5	6	7
4. Developing your potential?	1	2	3	4	5	6	7
5. Relaxing?	1	2	3	4	5	6	7
6. Experiencing pleasure?	1	2	3	4	5	6	7
7. Enjoying yourself?	1	2	3	4	5	6	7
8. Being entertained?	1	2	3	4	5	6	7

In an effort to show our appreciation for your participation in this valuable research, we would be happy to make a $5.00 donation to either Osteoporosis Canada, your local Chapter or another bone health organization of your choice. Please select **one** organization from the list below:

❑	Osteoporosis Canada	❑	Other: please indicate in the space provided the name of another Bone Health Organization (e.g., National Osteoporosis Society, National Osteoporosis Foundation, International Osteoporosis Organization):

_____

❑	Niagara Chapter	❑	Waterloo Wellington Chapter	❑	Greater Montreal Chapter
❑	Hamilton Chapter	❑	Regina Chapter	❑	Quebec City Chapter
❑	London & Thames Valley Chapter	❑	Saskatoon Chapter	❑	Nova Scotia Chapter
❑	Mississauga Chapter	❑	British Columbia Division	❑	Greater Moncton Chapter
❑	Ottawa Chapter	❑	Kelowna Chapter	❑	New Brunswick Chapter
❑	Peterborough Chapter	❑	Mid-Island Chapter	❑	Alberta Chapter
❑	Toronto & Area Chapter	❑	North Shore Chapter	❑	Manitoba Chapter
❑	Sudbury Chapter	❑	Surrey/White Rock Chapter	❑	PEI Chapter

Thank you for taking the time to participate in our study today. Your information is important to us. This project is funded by the Social Sciences and Humanities Research Council of Canada and the Brock University Advancement Fund.

Appendix N

List of Abbreviations

C	*Contextual*
G	*Global*
HEPA	*Health-Enhancing Physical Activity*
LTPA	*Leisure-Time Physical Activity*
NA	*Negative Affect*
PA	*Positive Affect*
PNSE	*Psychological Need Satisfaction*
SVS	*Subjective Vitality*