Research Quarterly for Exercise and Sport

Vol. 82, No. 4, pp. 794–798

Psychological Needs as Mediators? The Relationship Between Leisure-Time Physical Activity and Well Being in People Diagnosed With Osteoporosis

Katie E. Gunnell, Diane E. Mack, Philip M. Wilson, and J. D. Adachi

Key words: eudaimonia, self-determination theory, subjective vitality

Osteoporosis is a skeletal disease characterized by reduced bone mass and microarchitectural deterioration of bone tissue resulting in compromised bone strength, increased fracture risk, and reduced well being (World Health Organization, 1994). With evidence attesting to the positive effects of leisure-time physical activity (LTPA) on biomedical health in people with osteoporosis (Johnell & Hertzman, 2006), there have been calls to broaden the scope of health-related variables that LTPA may influence (Li, Chen, Yang, & Tsauo, 2009).

Previous studies examining the link between LTPA and well being in people with osteoporosis have been largely atheoretical (e.g., Papaioannou et al., 2003; Papaioannou et al., 2006), rendering the mechanisms via which LTPA influences well being speculative. Because literature has suggested the association between LTPA and well being may be indirect, as opposed to direct (Chodzko-Zajko et al., 2009; Motl & McAuley, 2009), greater attention to the mechanisms underpinning the LTPA-well being relationship is warranted. One theory that holds promise for explaining well being is Basic Psychological Needs Theory (BPNT; Deci & Ryan, 2002). Central to BPNT are the psychological needs for competence, autonomy, and relatedness that nurture psychological growth, integrity, and well being directly (Deci & Ryan, 2002). Deci and Ryan's contentions have been largely supported in exercise contexts, given that people who feel competent, autonomous, and related to others report greater well being and less ill-being (c.f., Wilson, Mack, Gunnell, Oster, & Gregson, 2008).

While insight has been gained into the LTPA-well being relationship for individuals living with osteoporosis (Papaioannou et al., 2003; Papaioannou et al., 2006), a number of issues warrant further investigation. First, the mechanisms underpinning the LTPA-well being relationship in individuals with a chronic health condition have generally been confined to self-efficacy, social support, and fatigue (McAuley, White, Rogers, Motl, & Courneya, 2010; Motl & McAuley, 2009). Considering additional mechanisms (i.e., psychological need fulfillment) would complement and potentially extend current evidence. Second, within BPNT, Ryan and Deci (2001) differentiated hedonic well being (HWB; maximizing pleasure) from eudaimonic well being (EWB; realizing human potentials). Previous research on individuals with osteoporosis focused primarily on HWB markers (Papaioannou et al., 2003; Papaioannou et al., 2006) despite evidence of distinctions between well being in its hedonic and eudaimonic forms (McGregor & Little, 1998; Ryff et al., 2006). Moreover, EWB has a stronger pattern of association with biomarkers of health than HWB (Ryff et al., 2006).

Thus, the primary aim of this investigation was to examine basic psychological needs satisfaction in explaining the LTPA-EWB relationship. Based on BPNT (Deci & Ryan, 2002), we hypothesized that perceived psychological need satisfaction would mediate the LTPA-EWB relationship.

Submitted: August 11, 2009
Accepted: August 12, 2010

Katie E. Gunnell is with the School of Human Kinetics at the University of British Columbia. Diane E. Mack and Philip M. Wilson are with the Department of Kinesiology at Brock University. J. D. Adachi is with the Faculty of Medicine at McMaster University.

Method

Participants

Participants (N = 190; n women = 164) were individuals (M age = 68.14 years, SD = 11.54) living with osteoporosis (n self-report = 131; n medically confirmed = 59). Most participants reported being Caucasian/White (85.30%) and married/common-law (56.30%), while 37.40% reported holding a university/college degree. Body mass index (BMI) approximated the healthy range (M = 23.29 kg/m^2; SD = 4.00). Average time since diagnosis was 9.41 years (SD = 16.84), with 55.30% of the sample reporting at least one fracture. Hypertension was the most frequently reported comorbidity (27.40%).

Measures

Demographic and Health Status. Participants reported their birth date, height, weight, gender, marital status, ethnic origin, and educational attainment. Health status was based on the number of years since receiving a diagnosis of osteoporosis, fracture history, and the presence of comorbidities. Comorbidities (e.g., high blood pressure, diabetes) included those queried in the Canadian Community Health Survey (2009).

Leisure-Time Physical Activity. The 3-item Godin Leisure-Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985) was completed to assess the frequency of mild (e.g., minimal effort), moderate (e.g., not exhausting), and strenuous (e.g., heart beats rapidly) LTPA lasting at least 15 min/session during a typical week. A total LTPA score was calculated on a ratio-level scale using the following formula: Σ([mild x 3] + [moderate x 5] + [strenuous x 9]). The weights assigned to GLTEQ scores were metabolic equivalent values that served as an index of energy expenditure.

Eudaimonic Well Being. Participants completed the 7-item Subjective Vitality Scale (SVS; Ryan & Frederick, 1997) as one marker of EWB assessing the energy available to create a rich and meaningful life (Ryan & Deci, 2008). Following the contextual 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 physical activity," each item was rated across a 7-point Likert-type scale anchored by 1 = not at all true to 7 = very true. A sample SVS item used in this study was "I feel alive and vital." Support for the construct validity of SVS scores as an index of EWB has been demonstrated in exercise settings (c.f., Edmunds, Ntoumanis, & Duda, 2007).

Psychological Needs. Participants completed the 18-item Psychological Need Satisfaction in Exercise Scale (PNSE; Wilson, Rogers, Rodgers, & Wild, 2006) adapted to physical activity contexts. Assessing each of the three psychological needs, the PNSE items are anchored by 1 = false and 6 = true, with higher scores reflecting greater need fulfillment. Structural and criterion validity and score reliability for each PNSE subscale has been documented in exercise settings (c.f., Wilson et al., 2008).

Procedures

After we secured ethical clearance to proceed with the study, participant recruitment took place via electronic venues (e.g., websites), posters placed in prominent locations around the community, and through a bone health specialist clinic. Inclusion criteria were: (a) over the age of 18 years, (b) ability to speak and read English, and (c) a diagnosis of osteoporosis. Participants recruited via electronic venues received a link to a secure internet-based

Table 1. Descriptive statistics, bivariate correlations, and estimates of internal consistency reliability

Variable	*M*	*SD*	Skew.	Kurt.	1	2	3	4	5
LTPA	26.56	15.53	0.76	-0.11	—				
EWB	5.08	1.26	-0.53	-0.45	.22* (.09–.36)	.89			
Perceived competence	3.45	1.31	-0.21	-0.74	.35** (.22–.47)	.47** (.35–.58)	.94		
Perceived autonomy	5.20	0.98	-1.70	0.64	-.02 (-.17–.13)	.46** (.34-.56)	.23* (.08–.36)	.95	
Perceived relatedness	4.76	1.40	-1.25	0.81	.05 (-.10–.12)	.34** (.20–.47)	.38** (.24–.50)	.45** (.32–.56)	.97

Note. M = mean; SD = standard deviation; Skew. = univariate skewness; Kurt. = univariate kurtosis; LTPA = leisure-time physical activity; EWB = eudaimonic well being; all bivariate correlations are Pearson correlations (r) in this table; sample size ranges from 167 to 185 based on participant responses; estimates of internal consistency (Cronbach's α, Cronbach, 1951) are located along the diagonal; information in parentheses reflects 95% confidence intervals surrounding r values.
*Significance at $p < .01$ (one-tailed).
**Significance at $p < .001$ (one-tailed).

survey to provide informed consent and data. Participants recruited through nonelectronic venues had an opportunity to ask questions before receiving a self-addressed, prestamped envelope containing all study materials including explicit instructions for completing and returning the survey. We received informed consent from participants. On study completion, a $5.00 donation was made to the bone health organization of the participants' choice.

Data Analysis

Descriptive statistics and reliability estimates using (Cronbach's coefficient α; Cronbach, 1951) were examined. Multiple mediation with bootstrapping procedures (i.e., a nonparametric resampling procedure; Preacher & Hayes, 2008) was used to examine the role of all three psychological needs in the LTPA-EWB relationship. The bootstrapping procedure has been identified as being superior to the causal steps approach or the product of coefficients test for mediation, as it yields greater statistical power, reduces the risk of Type I error, and does not assume a normal sampling distribution (Preacher & Hayes, 2008). The absence of zero in the 95% bias corrected and accelerated confidence interval (BCa CI), rather than interpretation of *p* values, is evidence for mediation when using bootstrapping ($k = 5{,}000$; Preacher & Hayes, 2008). Specific indirect effects and pairwise contrasts were examined by using BCa CIs to analyze the contribution and strength of each psychological need in the multiple mediator model analysis.

Results

Participants reported engaging in an average of 26.56 metabolic equivalents (METS; $SD = 15.53$; $R = 3$–77) per week (see Table 1). Interpretation of GLTEQ scores suggested individuals living with osteoporosis were less active compared to normative values (i.e., *M* METS = 45.80; Godin & Shephard, 1985) but similar to adults living with multiple sclerosis (*M* METS = 26.50; Motl & McAuley, 2009). On average, this sample reported high EWB (*M* SVS = 5.08; $SD = 1.26$) in LTPA contexts with perceived psychological needs fulfillment, on average, above the midpoint of the scale (see Table 1).

Bivariate correlations (see Table 1) indicated a pattern of weak-to-moderate positive relationships between study variables, except for the perceived autonomy-LTPA and perceived relatedness-LTPA correlations that approximated zero. Results of the bootstrapping procedure (see Table 2) revealed that fulfillment of the three psychological needs ($R^2_{adj} = 0.37$; point estimate = 0.0097; BCa CI = 0.0030 to 0.0171) mediated the LTPA-EWB relationship. Interpretation of the specific indirect effects indicated that perceived competence was the only significant contributor to the model (point estimate = 0.0093; BCa CI = 0.0049–0.0153). The pairwise contrasts corroborated this finding and indicated the specific effect of perceived competence was larger than that through autonomy (BCa CI = .0038–.0155) or relatedness (BCa 95%CI = .0047–.0155). The magnitude of the effects of perceived autonomy and relatedness on the LTPA-EWB relationship was comparable (BCa CI = -.0040–.0035).

Discussion

We used BPNT (Deci & Ryan, 2002) as a framework to identify potential mechanisms through which LTPA may promote feelings of EWB in a sample of individuals living with osteoporosis. Consistent with Deci and Ryan's (2002) assertions and analytic interpretations (Preacher & Hayes, 2008), three psychological needs mediated the LTPA-EWB relationship. Specific to LTPA contexts for individuals with osteoporosis, feelings of effectance and skill mastery defining perceived competence had the strongest effect in the model. The emergence of perceived competence as the dominant psychological need associated with well being outcomes is aligned with other BPNT (Deci & Ryan, 2002) research in exercise settings (Wilson et al., 2008). Experiences of close and secure bonding (i.e., relatedness) and volitional self-direction (i.e., autonomy) were less potent than perceptions of competence. Although the effect is small (Cohen, 1992), it is possible that perceived relatedness or autonomy suppressed a portion of this effect (Preacher & Hayes, 2008), as the degree to which mediators are correlated can attenuate specific indirect effects.

Deci and Ryan (2002) suggested that fulfilling the psychological needs for competence, autonomy, and relatedness were associated with greater well being. Results from the present investigation are consistent with BPNT

Table 2. Bootstrapped indirect effects of leisure-time physical activity on contextual subjective vitality through mediators

Variable	Point estimate	BCa CI	$R^2_{adj.}$
Total	.0097	.0030–.0171	.37*
Perceived competence	.0093	.0049–.0153	
Perceived autonomy	.0002	-.0040–.0036	
Perceived relatedness	.0002	-.0005–.0027	
C1	.0092	.0038–.0155	
C2	.0091	.0047–.0155	
C3	-.0001	-.0040–.0035	

Note. $k = 5{,}000$; BCa CI = bias corrected and accelerated confidence intervals; C1 = contrast between competence and autonomy; C2 = contrast between competence and relatedness; C3 = contrast between autonomy and relatedness.
*$p < .001$.

(Deci & Ryan, 2002) and further substantiate the role of perceived competence in the LTPA-EWB relationship among relatively inactive individuals who have osteoporosis. Future research may include (a) participants who engage in greater LTPA or (b) other health conditions to examine whether individual psychological needs play a more or less salient role in promoting and maintaining well being, depending on functional significance of the context (e.g., LTPA). Further, as variation in psychological need fulfillment outcomes has been demonstrated across time (e.g., Edmunds et al., 2007), the dynamic nature of need fulfillment is ripe for further inquiry to advance our understanding of how different LTPA experiences influence EWB.

While the results of this study hold theoretical and practical appeal, there were limitations. The use of purposive sampling procedures limited the data's external validity. Sampling methods that offer greater confidence in the generalizability of study findings and increased representation of men with osteoporosis are important avenues for future research. The cross-sectional study design limited the conclusions derived from the multiple mediation analysis (Preacher & Hayes, 2008). Future research would do well to conduct studies using multiwave designs for greater insight into the causal role of basic psychological needs in relation to well being. Finally, the present investigation relied exclusively on self-report methods, which are susceptible to response bias and distortion (Campbell & Fiske, 1959).

Based on the study evidence, intervention programs that seek to improve the well being of people living with osteoporosis may use programming applications that give people the opportunity to feel effective (i.e., competence). The role afforded to perceptions of autonomy and relatedness in promoting well being in LTPA contexts in individuals with osteoporosis warrants additional attention, as thwarting any of these psychological needs may result in ill as opposed to well being outcomes (Deci & Ryan, 2002).

References

Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin, 56,* 81–105.

Canadian Community Health Survey. (2009). *Methodological overview.* Retrieved from <http://p8090prod.library.utoronto.ca.libaccess.lib.mcmaster.ca/datalib/codebooks/cstdli/cchs/2001/summarye.pdf

Chodzko-Zajko, W. J., Proctor, D. N., Fiatarone Singh, M. A., Minson, C. T., Nigg, C. R., Salem, G. J.,...Skinner, J. S. (2009). Exercise and physical activity for older adults. *Medicine & Science in Sports & Exercise, 41,* 1510–1530.

Cohen, J. A. (1992). A power primer. *Psychological Bulletin, 112,* 155–159.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16,* 297–334.

Deci, E. L., & Ryan, R. M. (2002). Overview of self-determination theory: An organismic dialectical perspective. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 3–33). Rochester, NY: University of Rochester Press.

Edmunds, J. K., Ntoumanis, N., & Duda, J. L. (2007). Adherence and well being in overweight and obese patients referred to an exercise on prescription scheme: A self-determination theory perspective. *Psychology of Sport & Exercise, 8,* 722–740.

Godin, G., & Shephard, R. (1985). A simple method to assess exercise behavior in the community. *Canadian Journal of Applied Sport Science, 10,* 141–146.

Johnell, O., & Hertzman, P. (2006). What evidence is there for the prevention and screening osteoporosis? Copenhagen, Denmark: WHO Regional Office for Europe.

Li, W. C., Chen, Y. C., Yang, R. S., & Tsauo, J. Y. (2009). Effects of exercise programs on quality of life in osteoporotic and osteopenic postmenopausal women: A systematic review and meta-analysis. *Clinical Rehabilitation, 23,* 888–896.

McAuley, E., White, S. M., Rogers, L. Q., Motl, R. W., & Courneya, K. S. (2010). Physical activity and fatigue in breast cancer and multiple sclerosis: Psychosocial mechanisms. *Psychosomatic Medicine, 72,* 88–96.

McGregor, I., & Little, B. R. (1998). Personal projects, happiness, and meaning: On doing well and being yourself. *Journal of Personality & Social Psychology, 74,* 494–512.

Motl, R. W., & McAuley, E. (2009). Pathways between physical activity and quality of life in adults with multiple sclerosis. *Health Psychology, 28,* 682–689.

Papaioannou, A., Adachi, J. D., Winegard, K., Ferko, N., Parkinson, W., Cook, R. J., & McCartney, N. (2003). Efficacy of home-based exercise for improving quality of life among elderly women with symptomatic osteoporosis-related vertebral fractures. *Osteoporosis International, 14,* 677–678.

Papaioannou, A., Kennedy, C. C., Ioannidis, G., Brown, J. P., Pathak, A., Hangley, D. A.,...Adachi, J. D. (2006). Determinants of health-related quality of life in women with vertebral fractures. *Osteoporosis International, 17,* 355–363.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, Instruments, and Computers, 40,* 879–891.

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well being. *Annual Review of Psychology, 52,* 141–166.

Ryan, R., & Deci, E. L. (2008). From ego-depletion to vitality: Theory and findings concerning the facilitation of energy available to the self. *Social and Personality Psychology Compass, 2,* 702–717.

Ryan, R. M., & Frederick, C. M. (1997). On energy, personality and health: Subjective vitality as a dynamic reflection of well being. *Journal of Personality, 65,* 529–565.

Ryff, C. D., Dienberg Love, G., Urry, H. L., Muller, D., Rosenkranz, M. A., Friedman, E. M., & Singer, B. (2006). Psychological well-being and ill-being: Do they have distinct or mirrored biological correlates? *Psychotherapy & Psychosomatics, 75,* 85–95.

Wilson P. M., Mack, D. E., Gunnell, K. E., Oster, K. G., & Gregson, J. P. (2008). Analyzing the measurement of psychological need satisfaction in exercise contexts: Evidence, issues and future directions. In M. P. Simmons & L. A. Foster (Eds.),

Sport and exercise psychology research advances (pp. 361–391). Hauppauge NY: Nova Science Publishers.

Wilson, P. M., Rogers, W. T., Rodgers, W. M., & Wild, T. C. (2006). The psychological need satisfaction in exercise scale. *Journal of Sport & Exercise Psychology, 28*, 231–251.

World Health Organization. (1994). Assessment of fracture risk and its application to screening for postmenopausal osteoporosis: Report of a WHO Study Group. *WHO Technical Report Series, 843*.

Authors' Notes

The first three authors were supported by grants from the Social Sciences and Humanities Research Council of Canada during the preparation of this manuscript.

We thank the Social Science and Humanities Research Council of Canada and the Brock University Advancement Fund for providing funding for this research project. We are also grateful to the participants who willingly gave their time, Osteoporosis Canada–Niagara Chapter, The British Columbia Women's Hospital and Health Centre Osteofit Program, YWCA, The National Osteoporosis Society, The International Osteoporosis Foundation and the European Society on Clinical and Economic Aspects of Osteoporosis and Osteoarthritis for their support of this research. Please address correspondence concerning this article to Diane E. Mack, Department of Kinesiology, Behavioral Health Sciences Lab, Brock University, 500 Glenridge Ave, St. Catharines ON, Canada L2S 3A1.

E-mail: dmack@brocku.ca