Standage, M. and Gillison, F. and Ntoumanis, N. and Treasure, D. 2012. Predicting Students' Physical Activity and Health-Related Well-Being: AProspective Cross-Domain Investigation of Motivation Across School PhysicalEducation and Exercise Settings. Journal of Sport and Exercise Psychology. 34 (1): pp. 37-60.

Predicting Students' Physical Activity and Health-Related Well-Being: A Prospective Cross-Domain Investigation of Motivation across School Physical Education and Exercise Settings

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Submitted: xx January 2011

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Abstract

A three-wave prospective design was used to assess a model of motivation guided by self-determination theory (Ryan & Deci, 2008) spanning the contexts of school physical education (PE) and exercise. The outcome variables examined were health-related quality of life (HRQoL), physical self-concept (PSC), and 4-days of objectively assessed activity. Secondary school students (*n* = 494) completed questionnaires at 3 separate time-points and were familiarized with how to use a sealed pedometer. Results of structural equation modeling (SEM) supported a model in which perceptions of autonomy support from a PE teacher positively predicted PE-related need-satisfaction (autonomy, competence, and relatedness). Competence predicted PSC, whereas relatedness predicted HRQoL. Autonomy and competence positively predicted autonomous motivation towards PE, which in turn positively predicted autonomous motivation towards exercise (i.e., 4-day pedometer step-count). Autonomous motivation towards exercise positively predicted step-count, HRQoL, and PSC. Results of multi-sample SEM supported gender invariance. Suggestions for future work are discussed.

Keywords: self-determination theory, physical education, exercise, well-being

Numerous reports and position statements have highlighted that physical activity levels of young people within modern industrialized nations are below those thought to be required for health and well-being (e.g., Health Survey for England, 2008). Accordingly, researchers, government agencies, health professionals, and policy makers have all sought to better understand the determinants of young peoples' engagement levels. Although the antecedents to participation in physical activity are highly complex (e.g., see socio-ecological models; Sallis, Owen, & Fisher, 2008), the role of motivation and the processes that support, as oppose to forestall, high quality motivated engagement in physical activity settings is clearly an important avenue for empirical and applied investigation (Standage & Ryan, in press).

Research addressing motivated-related questions within physical activity settings has increasingly been guided by self-determination theory (SDT; Ryan & Deci, 2008). One line of SDT-related enquiry has been to focus on the role that school physical education (PE) plays in supporting students' motivation experiences, well-being, knowledge, and physical activity behavior (cf. Standage, Gillison, & Treasure, 2007). To date however, little work has examined whether there is a motivational transference from processes within the PE domain to students' more general exercise motivation and subsequently to their physical activity engagement (Hagger & Chatzisarantis, 2007). Moreover, research adopting this perspective has not examined whether such reasons for exercise engagement (and indirectly, motivational processes within PE) predict objectively assessed levels of activity and important markers of adolescent's overall health-related well-being such as Health-Related Quality of Life (HRQoL) and Physical Self-Concept (PSC). Addressing this void in the extant literature, a three-wave design was used to test a hypothesized model of associations guided predominantly by SDT and influenced by the trans-contextual model (TCM; Hagger & Chatzisarantis, 2007).

Self-Determination Theory and Motivational Processes within PE

A fundamental tenet within SDT is that when an individual's motivation is autonomous (viz., when people endorse their own actions and act with a full sense of volition because they find the activity to hold inherent interest and/or personal value; Ryan & Deci, 2006), they experience better psychological health, increased well-being, and more effective performance (Ryan & Deci, 2008).[1] A cogent body of past work in physical activity settings has supported this theoretical postulation by showing autonomous forms of motivation to be positively associated with adaptive outcomes such as greater psychological well-being, increased behavioral persistence, and indices reflective of more objectively assessed behavior/investment (see Standage & Ryan, in press, for a review).

Given the many positive concomitants associated with being autonomously motivated, an important line of empirical investigation within SDT has been to identify and test the social conditions and processes that support volitional and self-enacted engagement. Within SDT, social environments that are conducive to the satisfaction of three basic and innate psychological are hypothesized to be the fundamental nutriments to high quality motivation, wellness, and grow-oriented development (Ryan & Deci, 2008). These needs are for *autonomy* (i.e., self-endorsed and choiceful enactment), *competence* (i.e., interact effectively within the environment), and *relatedness* (i.e., feel close to, connected, and cared for by others) (Ryan & Deci, 2002). Empirical work across a wide array of life domains has supported the basic needs hypothesis espoused within SDT (see Ryan & Deci, 2008).

A social context that is germane to motivation from an SDT perspective and one that encompasses supports for the basic psychological needs has been labeled *autonomy-support* (i.e., environment which supports choice, initiation, and understanding; see Deci & Ryan, 2008). A number of empirical investigations have shown students' perceptions of autonomy-support, as provided by their PE teacher, to positively predict the satisfaction of autonomy, competence, and relatedness (see Standage et al., 2007). Accordingly, we hypothesized in the present work that perceptions of autonomy-support would positively predict the satisfaction of the basic needs for autonomy, competence, and relatedness (H_1).

Basic Needs within PE, Exercise Motivation, and Health-Related Outcomes

As already discussed, according to SDT one's optimal motivation, development, well-being and healthy functioning are facilitated to the extent that the basic needs for autonomy, competence, and relatedness are met within their social context (Ryan & Deci, 2008). Consistent with SDT, past work in PE settings has shown each basic psychological need to predict autonomous motivation towards PE (e.g., Standage, Duda, & Ntoumanis, 2003, 2006). Thus, in this work we therefore expected that the satisfaction of each need would positively predict autonomous motivation for PE (H_2).

Transference of Motivation towards PE to Leisure-Time Exercise Motivation

A central tenet of the TCM (Hagger & Chatzisarantis, 2007) is that autonomous motivation reported within one context (e.g., sport, exercise, PE) can affect motivation in a related context. The example tested in a number of iterations of the TCM by Hagger and his colleagues is the premise that students' autonomous motivation towards PE can positively predict their autonomous motivation to partake in leisure-time physical activity. Consistent with empirical support for this theoretical prediction (e.g., Hagger, Chatzisarantis, Barkoukis, Wang, & Baranowski, 2005), in the present work a positive path was hypothesized from autonomous motivation towards PE to autonomous leisure-time exercise motivation (H_3).

Exercise Motivation and Outcome Variables

The final link in the proposed model (Figure 1) is the hypothesis that autonomous motivation towards exercise will positively predict HRQoL, PSC, and the number of steps taken over a 4-day period (H_4). In what follows we discuss the theoretical reasoning for the association between autonomous motivation for exercise and each of the dependent variables.

HRQoL. Subsumed within one's more global quality of life (viz., "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" WHOQOL

Group, 1995, p. 1403), HRQoL is a multidimensional construct that reflects aspects of a person's life that relate directly to health, that impact on health, or can be affected by health interventions. As such it is very pertinent to physical activity-related settings such as exercise. HRQoL was measured in the present work by assessing the students' functioning in the following domains: *physical*, *emotional*, *social*, and *school*. According to SDT, autonomous motivation should positively link with overall indices of health and well-being such as HRQoL. This is because the regulation of behavior involves having a more integrated perception of the self, supportive of one's inherent tendencies towards psychological growth, development, and overall adjustment (cf. Ryan & Deci, 2008). An important measurement-related consideration however, relates to the differing levels of assessments. HRQoL is reflective of a more general (or global) perception of one's overall health/well-being whereas autonomous motivation towards exercise operates at a domain specific (or contextual) level. Within an hierarchical model of intrinsic and extrinsic motivation (HMIEM),Vallerand (1997) posits that outcomes will be stronger when the motivation and its consequence reside at the same level, yet this does not preclude transference of motivational effects, in a similar manner to those already discussed for the constructs of need satisfaction on motivation. Indeed, motivation experienced at a lower level of generality (e.g., contextual) may impact the next level up (e.g., global) in a "bottom-up" fashion in which repeated engagement in exercise for autonomous reasons may impact one's more global 'autonomous' motivation. Past work linking students' autonomous motivation towards PE and HRQoL has documented a positive association (Standage & Gillison, 2007). Moreover, Standage and Gillison reported positive associations between autonomous motivation and the social, school, physical, and emotional domains, suggesting exercise motivation to be pertinent to HRQoL.

Physical self-concept. An individual's PSC refers to global evaluation of his/her qualities and standing in the physical domain (Marsh & Redmayne, 1994). PSC is fairly stable over-time, and can influence decisions and perceptions across many physical activity contexts

(Marsh, 1990a, 1990b). As previously discussed, past work has reported a positive association between autonomous motivation towards exercise and perceptions of PSC (Wilson & Rodgers, 2002). For example, Wilson and Rodgers found autonomous forms of motivation to differentiate between adult female exercisers who were separated into ‘high’ and ‘low’ PSC groupings i.e., exercise motives correctly identified 83.3% and 88.9% of those in the high PSC and low PSC groups, respectively). When researchers (e.g., Standage & Gillison, 2007; Wilson & Rodgers, 2002) have specified links between motivation and self-concept (or self-esteem), they have drawn from the premise within SDT that autonomous motivation promotes an individual’s true self-esteem (viz., a stable and secure sense of self; see Deci & Ryan, 1995). Extending on this approach and applying it more precisely to the present work, it would seem logical that when students act in exercise settings through autonomous motivation they will pursue their physical-related aspirations and goals by fully devoting their personal resources and efforts. In being volitionally motivated, it makes further conceptual sense that while the students’ emotions may fluctuate as a function of success and failure, their perception of PSC will remain stable as they do not aggrandize or experience perceptions of physical worthlessness based on the continuous self-evaluation and comparison of physical abilities (see Deci & Ryan, 1995).

Physical activity. According to SDT, effortful and sustained involvement in exercise behaviour is most likely to occur when people act for autonomous reasons (Standage & Ryan, in press). A growing body of research involving adolescent populations has provided support for this hypothesis with autonomous motivation towards exercise being shown to positively predict self-reported exercise behaviour (e.g., Gillison, Standage, & Skevington, 2006). Moreover, and after controlling for the possible confounding effects of age and gender, Vierling, Standage, and Treasure (2007) found autonomous motivation towards physical activity to positively predict, albeit weakly, pedometer step-counts over a 4-day period. In our present work, we expected adolescents’ reported exercise motivation to predict their activity (i.e., as indexed by step-counts). Such reasoning is consistent with the tenets of SDT and past assessments within the domains of physical activity and PE (e.g., Lonsdale et al., 2009; Vierling et al., 2007).

The Present Study

To recapitulate, the purpose of the present work was to examine a motivational processes model (Figure 1) that (i) examines a motivational sequence of interrelationships organized by the tenets of SDT, (ii) pulls from the past work to assess the impact of autonomous motivation towards PE on autonomous motivation towards exercise (e.g., Hagger & Chatzisarantis, 2007), and (iii) draws from SDT and aspects of the HMIEM to explore the predictive utility of autonomous motivation towards exercise on HRQoL, PSC, and pedometer step-counts (4-day period). The tenability of the motivational processes specified within the model will be examined across gender and indirect effects will be examined.

Method

Participants

Complete data across the three data collection waves were obtained from 494 secondary school students (*M* age = 12.58 years; *SD* = .74). Students (201 boys, 291 girls, 2 gender not specified) were recruited from an original sample of 849 participants, from five state schools located in South West England. It should be noted that the notable reduction in sample size was due to participants not completing questionnaires at one or both of the subsequent data collections (i.e., being absent at Times 2 and/or 3) and/or not providing sufficient pedometer data (viz., due to not wearing/losing the unit). Multivariate Analyses of Variance showed no significant differences between the students who were retained for analyses and those omitted following the completion of Wave 1 measures (all p values > .05).

Procedure

Consent to conduct the study was issued from a local research ethics committee, letters were sent to parents to seek passive consent (i.e., responses were sought from those wishing their child to be withdrawn from the study), and written consent was obtained from the Head Teachers of each school who were asked to act in *loco parentis*. Informed consent was also obtained from the participants.

In this work, we adopted a three-wave design. At Time 1 (T1) participants responded to a multi-section inventory assessing motivational processes in school PE (i.e., perceptions of autonomy-support, autonomy, competence, relatedness, and PE motivation). One week later (Time 2), participants completed a questionnaire to assess their motivation towards exercise. At this time, participants were familiarized with a pedometer and provided with written and verbal instructions regarding the placement of the unit (i.e., on the waistband in the midline of the right thigh for the whole day, except when sleeping or showering/bathing). A sealed pedometer was then worn for 4 successive days. To ensure confidentiality and to permit the pedometer data to be matched to the questionnaire responses, each pedometer and participant were assigned a matching numerical code. At Time 3 (T3; i.e., one week after T2), participants completed the HRQoL and PSC questionnaires. The use of one-week intervals between the three data collections is consistent with past work (e.g., Hagger et al., 2005) and was used to minimize the amount of error variance introduced into the data due to the use of similar measures (e.g., autonomous motivation towards PE and exercise). This approach also permitted the contextualization of measures at each data collection (i.e., T1 = PE, T2 = exercise, T3 = health-related outcomes).

Measures

Autonomy-support. A modified version of the 6-item Learning Climate Questionnaire (LCQ; Williams & Deci, 1996) was used to assess the degree to which the students perceived their PE teacher to provide autonomy-support. Items were slightly amended to target the PE context. An example item is “the PE teacher encourages me to ask questions.” Responses were reported on a seven point Likert-type scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Cronbach alpha coefficients from past work have revealed internally reliable scores to be obtained from this scale (e.g., Standage, Duda, & Ntoumanis, 2005).

Autonomy. Autonomy was measured using a 5-item scale (Standage et al., 2003). Preceded by the stem "In this PE class…..", participants responded to items such as "I have some choice in what I want to do". Responses were made on a seven point Likert-type scale anchored by 1 (*strongly disagree*) to 7 (*strongly agree*). Evidence for the internal reliability of scores obtained from this scale has been supported in previous PE work with British children via Cronbach's alpha coefficients (Standage et al., 2003; Taylor & Ntoumanis, 2007).

Competence. Competence was assessed using the 5-item Perceived Competence subscale of the Intrinsic Motivation Inventory (IMI; McAuley, Duncan, & Tammen, 1989). Items were reworded to target the PE context (e.g., "I am pretty skilled at PE") and responses were indicated on a seven point Likert-type scale anchored by 1 (*strongly disagree*) to 7 (*strongly agree*). Cronbach alpha coefficients from previous PE based-research have shown internally reliable scores to be obtained from the competence subscale of the IMI (Ntoumanis, 2001; Standage et al., 2003).

Relatedness. Relatedness was assessed using the acceptance subscale of the Need for Relatedness Scale (Richer & Vallerand, 1998). The stem was modified in the present study to be PE-specific ("With the other students in my PE class I feel….") and was followed by five items such as "valued", "understood", and "supported." Responses were made on a seven-point Likert-type scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Internally reliable scores using this scale have been reported in previous PE work with British children (Standage et al., 2003, 2005; Taylor & Ntoumanis, 2007).

Autonomous motivation towards PE. The different types of motivational regulation as they pertain to PE were assessed using the Perceived Locus of Causality scale (PLOC; Goudas, Biddle, & Fox, 1994). The PLOC is a PE adaptation of Ryan and Connell's (1989) Self-Regulation Questionnaire to the PE context. Goudas et al. (1994) also adapted and added the amotivation scale from the Academic Motivation Scale (Vallerand et al., 1992) to the

PLOC. In their responses to the PLOC, participants were asked to respond to the items using the stem “I take part in this PE class….” Example items (4 for each subscale) are “because PE is fun” (intrinsic motivation), “because it is important for me to do well in PE” (identified regulation), “because I’ll feel bad about myself if I didn’t” (introjected regulation), “because I’ll get into trouble if I don’t” (external regulation), and “but I really don’t know why” (amotivation). Responses were made on a seven point Likert-type scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Support for the internal reliability of scores (via Cronbach’s alpha coefficients) and factorial structure (via confirmatory factor analysis) of this scale has emerged in previous work with British school children (e.g., Ntoumanis, 2005).

Autonomous motivation towards exercise. The Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, 2004) was used to assess the participants’ motivation for exercise. Scored using a 5-point Likert-type scale ranging from 0 (*not true for me*) to 4 (*very true for me*), the BREQ-2 consists of 19 items designed to tap an individual’s level of intrinsic motivation (e.g., “I exercise because it’s fun”), identified regulation (“I value the benefits of exercise”), introjected regulation (“I feel guilty when I don’t exercise”), external regulation (“I exercise because other people say I should”), and amotivation (“I don’t see why I should have to exercise”). Past work has provided support for the reliability of scores and factorial structure of the BREQ-2 (Markland & Tobin, 2004). Research has also supported the tenability of the measure to adolescent samples (e.g., Gillison et al., 2006).

Physical self-concept. Students’ PSC was assessed via two subscales of the Self-Description Questionnaire-I (SDQ-I; Marsh, Barnes, Cairns, & Tidman, 1984). Specifically, the physical abilities (i.e., the child’s self concept of their abilities in physical activities, sports, and games) and the physical appearance (viz., the child’s self-concept pertaining to their physical attractiveness compared with others, and how others think he/she looks) subscales were used to index PSC. Example items for the physical abilities and physical appearance, respectively, are “I can run a long way without stopping”, and “I have a good looking body." Responses are made on a scale ranging between 1 (*false*) to 5 (*true*). Research has supported the construct validity and internal consistency of this measure (Marsh, 1990a).

Health-related quality of life. HRQoL was assessed using the Pediatric Quality of Life Questionnaire (PedsQL 4; Varni et al, 1999). Past work has found the PedsQL 4 to be a reliable and valid measure of HRQoL in adolescent populations (Varni et al, 200). The PedsQL comprises 23 items that are split into four domains: physical functioning (8 items; e.g. "It is hard for me to run"), social functioning (5 items; e.g. "Other kids tease me"), emotional functioning (5 items; e.g. "I feel sad or blue"), and school functioning (5 items; e.g. "It is hard to pay attention in class"). Responses are made on a five point Likert scale, ranging from 0 (*never a problem*) to 4 (*almost always a problem*). Items were reversed-scored and linearly transformed to a 0 to 100 scale (i.e., 0 =100, 1 =75, 2, = 50, 3 = 25, and 4 = 0). Item scores were then divided by the number of item responses to provide a scale score. A total composite score was also calculated with higher scores indicating better HRQoL.

Physical activity (step-counts across 4-days). Physical activity in the form of step-counts was assessed via a pedometer. Specifically, the Yamax Digiwalker SW-351 (Yamax Corporation, Tokyo, Japan) was used in the present work. Past research has shown the Yamax Digiwalker to be among the most accurate and reliable models of pedometer (e.g., Crouter, Schneider, Karabulut, & Bassett, 2003). In this research, we obtained 4 days of activity during a school week from the students. This monitoring frame has been shown via past work to be a sufficient length of time to determine habitual activity levels, via pedometers, in child samples (i.e., ICC range = .69 to .91; see Tudor-Locke, McClain, Hart, Sisson, & Washington, 2009).

Results

Descriptive Statistics

Table 1 contains the means, standard deviations, and alpha coefficient values for all measures. Cronbach's alpha coefficients ranged from .80 to .91.

Structural Equation Modeling Analysis (SEM)

SEM with AMOS Version 18.0 (Arbuckle, 2009) was used to examine the adequacy of the proposed model (Figure 1). An inspection of the Mardia's Coefficient value (74.39, critical ratio = 29.26) revealed the data to depart from multivariate normality. Analyses were therefore conducted using the bootstrapping procedure with 5000 bootstrap replication samples based on the original sample, as the bootstrap-generated standard errors provide a more accurate indication of the stability of parameter estimates under conditions of non-normality (Bryne, 2010; Preacher & Hayes, 2008).

As the sample size in the present work was not sufficiently large to meet an acceptable minimum number of cases per estimated parameter (i.e., over 5; Bentler & Chou, 1987), we used a parceling technique (cf. Little, Cunningham, Shahar, & Widaman, 2002) that has been used in previous work testing similar complex models of motivational processes (e.g., Cox & Williams, 2008; Standage & Gillison, 2007). In this work, and with the exception of the latent factors of HRQoL and PSC which were indexed by four (viz., physical, emotional, social, and school) and two subscales (i.e., physical appearance and physical abilities) respectively, we randomly created parcels of items to form two indicators for each latent factor. For the motivation towards PE and exercise variables, SDT hypothesizes that the various regulations conform to a quasi-simplex pattern of associations in which motivational regulations are more strongly correlated which those adjacent along the self-determined continuum (e.g., intrinsic motivation and identified regulation) than with those which are more distal (e.g., intrinsic motivation and external regulation) (see Ryan & Connell, 1989). As this structure of associations was supported in the present data within the PLOC and BREQ-2 subscales, we assigned weights to the motivational regulations according to their respective location on the self-determination continuum (3 x intrinsic motivation, 2 x identified, -1 x introjected regulation, -2 x external regulation, -3 x amotivation).[3] Four indexes were then initially formed and these indexes subsequently randomly averaged into two indicators for SEM analyses.[4] In adopting this approach, our resultant ratio of slightly over 10 participants per each estimated parameter was adequate (Bentler & Chou, 1987).

To assess the adequacy of the measurement models to the data, we used a two-index presentation strategy (Hu & Bentler, 1999). This approach advances the use of the standardized root mean square residual (SRMR) coupled with one or more incremental or absolute indexes of fit. In this work, we chose to supplement the SRMR with the comparative fit index (CFI), the incremental fit index (IFI), and the root-mean square error of approximation (RMSEA). For the CFI and IFI, values of over .90 are indicative of an acceptable fit, whereas values of close to (or above) .95 represent an excellent fit between the model and data (Hu & Bentler). Values close to .08 (or lower) and .06 (or lower) for the SRMR and RMSEA respectively, are indicative of a well-specified model (Hu & Bentler).

The two-step model building approach, as advanced by Anderson and Gerbing (1988), was used to examine the tenability of the model to the data. In this process, Step 1 involves the testing of the measurement model via confirmatory factor analysis. Following the fixing of the uniqueness for the Physical Abilities subscale to zero to address a problem with a negative variance estimate (-.11), results revealed a good fit between model and the data [χ^2 (118) = 340.88, $p < .001$; CFI = .96; IFI = .96; SRMR = .04; RMSEA = .06]. The second stage of the model building approach pertains to an examination of the path model outlined in Figure 1. Results showed the model to provide a satisfactory fit to the data [χ^2 (141) = 657.43, $p < .001$; CFI = .92; IFI = .92; SRMR = .09; RMSEA = .09], however the modification indices revealed that there was room for improvement. Specifically, and similar to model modifications made in previous research (cf. Marsh, 1990b; Standage & Gillison, 2007), direct paths were added from (i) Relatedness to HRQoL and (ii) Competence to PSC. The path hypothesized from relatedness to autonomous motivation was not significant (β = .05, p = .25) and therefore was dropped from the model. This slightly amended model was subsequently reanalyzed. The new results showed the fit of the model to the data to be improved [χ^2 (140) = 421.14, $p < .001$; CFI = .95; IFI = .95; SRMR = .06; RMSEA = .06].

The standardized solution for the final model is shown in Figure 2.[4]

Indirect effects. Standardized indirect effects and the 95% upper and lower limits of bootstrap-generated bias-corrected confidence intervals (CI) of the indirect effects (cf. Shrout & Bolger, 2002) are reported in Table 2. The standardized indirect effects revealed that autonomy support had positive effects on autonomous motivation towards PE, autonomous motivation towards exercise, PSC, and HRQoL. Competence had positive indirect effects on autonomous motivation towards exercise, PSC, and HRQoL. Autonomy had positive indirect effects on autonomous motivation towards exercise, PSC, HRQoL, and total step-count (4-days). Positive indirect effects were shown for autonomous motivation towards PE on PSC and HRQoL (i.e., via autonomous motivation towards exercise). Lastly, indirect effects for autonomy-support, competence, and autonomous motivation towards PE on total step-count (4-days) approached significance.

Model invariance. We examined the tenability of the motivational processes specified within Figure 2 across gender. Specifically, we used a procedure outlined by Bryne (2009) in which increasingly constrained models are specified to examine the measurement (i.e., item loadings) and structural parameters (i.e., factor variances and covariances) across samples.[5] Results of multigroup SEM analyses showed the unconstrained model to provide an excellent fit to the data [χ^2 (280) = 580.26; CFI = .95; IFI = .95; SRMR = .07; RMSEA = .05]. In the next step the measurement weights were constrained to be equal, with results showing that an excellent fit to the data was maintained [χ^2 (291) = 594.18, p <.001; CFI = .95; IFI = .95; SRMR = .07; RMSEA = .05]. Next, the structural weights were fixed to be equal across gender. Again, results showed the model to maintain an excellent fit to the data across gender-specific samples [χ^2 (301) = 605.55; CFI = .95; IFI = .95; SRMR = .07; RMSEA = .05]. Lastly, support for the model to the data was supported when the structural covariances were constrained to be equal across samples [χ^2 (302) = 612.85; CFI = .95; IFI = .95; SRMR = .07; RMSEA = .05]. Aligned with the recommendation by Cheung and Rensvold (2002) that a value of ΔCFI smaller than or equal to 0.01 between two increasingly constrained models indicates a non-substantial decrease in model fit, our results (ΔCFI = .00) provide support for the gender invariance of the model shown in Figure 2.

Discussion

In this work, we used SEM to test hypotheses related to relationships specified within a motivational processes model. The model, couched within SDT, was based on data that spanned two distinct, yet related contexts (viz., school PE and exercise). Following some minor modifications, results were largely supportive of the model and our stated hypotheses. Results of multi-sample SEM supported the tenability of the motivational processes specified within Figure 2 across gender. Lastly, and in addition to testing hypotheses based on direct effects, results as they relate to indirect effects were explored and are discussed herein.

According to SDT, social contexts facilitate autonomous motivation, optimal functioning, and well-being to the degree to which they provide necessary support to individuals' basic needs (Deci & Ryan, 2008). Consistent with SDT, past work (e.g., Standage et al., 2006; Standage & Gillison, 2007; Taylor & Lonsdale, 2010), and as hypothesized (*H1*), perceptions of autonomy support positively predicted autonomy, competence, and relatedness. Moreover, standardized indirect effects revealed autonomy support to have positive indirect effects on autonomous motivation towards PE, autonomous motivation towards exercise, PSC, HRQoL, and total step-count (4-days) (p = .06, for the latter variable). Such findings are congruent with past work that has shown indirect effects for perceptions of PE teacher-created autonomy support on autonomous motivation towards PE (e.g., Hagger et al., 2009; Standage et al., 2006), autonomous motivation towards leisure-time exercise (e.g., Hagger et al., 2009), indices of global well-being (e.g., Standage & Gillison, 2007), and self-reported exercise behavior (e.g., Hagger et al., 2003). Collectively, the findings are therefore akin with past PE-related work that documents the motivational and well-being benefits associated with interacting with autonomy-supportive teachers.

Within SDT, the basic psychological needs are specified as fundamental nutriments to autonomous engagement, growth, and wellness (Ryan & Deci, 2008). In the present work, autonomy and competence, but not relatedness, were positive predictors of autonomous motivation towards PE. Further, autonomy and competence had positive indirect effects on autonomous motivation towards exercise, PSC, and HRQoL. Indirect effects from autonomy and competence also approached significance with regard to total step-count (4-days). Such findings support the premise within SDT that autonomy and competence are necessary nutriments to motivation and healthy functioning within, and across, domains. With regard to across domains, it would seem logical that any transference effects of autonomous motivation and well-being across related contexts would depend on the satisfaction of basic psychological needs within and across domains (i.e., to underpin and support volitional and endorsed engagement). Before testing cross-domain models couched within SDT however, the development of context-specific measures of need satisfaction developed in a manner that is informed by user-group engagement at all steps of the process (e.g., item development, item meaning) would markedly aid such investigations (Standage et al., 2007).

At the within-context level, the present finding as it pertains to relatedness departs from our hypothesis and the tenets of SDT which would hold that the three needs are essential and the neglect of one or more will lead to negative functional effects (cf. Ryan & Deci, 2008). For the main part, past work has supported a link between relatedness and autonomous motivation (cf. Standage et al., 2007), however relatedness has been shown in some prior SDT-based models not to predict autonomous motivation in school PE (Standage & Gillison, 2007). Similar to the findings reported by Standage and Gillison, the direction of the “relatedness to autonomous motivation towards PE” path was positive, but failed to reach significance (i.e., $p = .25$). While relatedness may be considered as more distal predictor of intrinsic motivation compared to the other two needs, it is fundamental to the internalization of PE activities that are deemed important but not rich in inherent interest for students (cf.

Standage et al., 2007). As such, it is important to disentangle this null finding. A number of factors may contribute including (i) a lack of a PE-specific measure assessing context relevant supports for relatedness; (ii) cross-sectional assessments which fail to assess the dynamic nature of interactions among students and their peers as well as their teachers; (iii) the use of index of relative autonomous motivation encompassing different motivational regulations which may mask important information, especially given the aforementioned proximal and distal relationships between relatedness and different types of motivation; and/or (iv) against a backdrop of secure relationships a student may not be as reliant on proximal supports given their general sense of connectedness, close relationships, and feeling of being cared for by important others (e.g., Ryan & Deci, 2000). With the latter point in mind, the nature of differing social agents across different contexts, reflect interpersonal interactions, social networks, and supports that are more complex than proposed and assessed within our model (e.g., see Cox & Ullrich-French, 2010). For example, it is likely that many students will be exposed to different cohorts of peers in their out-of-school activities as well has having multiple sources of relatedness across these related-domains (e.g., parents, different peer groups, numerous teachers, various coaches, etc). Future work would do well to examine this complex network of relationships from numerous important others simultaneously and across multiple time-points. Such work would provide greater insight and a broader understanding of the dynamic interplay and functioning role of relatedness in, and across, domains.

In addition to being integral to internalization, within SDT relatedness is hypothesized to be vital for continued active involvement in activities, social integration, and well-being. Some support for this theoretical postulation is evidenced by a positive direct path to HRQoL in the model (Figure 1), suggesting relatedness in PE to have a direct effect on the participants' well-being as indexed by their social, physical, school, and emotional functioning. Such a finding is consistent with past work (e.g., Standage & Gillison, 2007), and is indicative of the role that students' perceptions of secure and quality interactions with others within a school PE context has for their overall health-related functioning.

A second modification to the hypothesized model was the addition of a direct path from competence to PSC. This addition makes conceptual sense in the context of hierarchical models of self-concept (see Marsh, 1990b and Fox, 1997 for reviews). In the present work, PSC was indexed by evaluative perceptions of the self with regard to physical abilities and physical appearance. Accordingly, the moderate path from competence to PSC suggests that evaluative perceptions of the physical self are enhanced when competence is supported within school PE. This finding, coupled with the indirect effects of autonomy and competence on exercise motivation and the health-related outcomes, align with the key concepts underpinning PE in the UK. That is, the overarching aims of PE are to promote competence, performance, creativity, and healthy, active lifestyles via a number of key processes (viz., developing skills in physical activity, making and applying decisions, developing physical and mental capacity, evaluating, improving and making informed choices about healthy, active lifestyles) (see The National Curriculum, 2007). Such content and the intended processes of provision offer insight into why appropriately delivered PE programs should yield supports for the satisfaction of autonomy and competence that are pertinent and can facilitate indices of health-related well-being and physical activity. The role of relatedness is also evident and future work with appropriately developed PE-specific measures would do well to test the effect of school-level perceptions of relatedness on indices of social integration, assimilation, and responsibility. PE is considered an important context for students to learn to connect with others in a manner in which they develop personally and socially, and in which they develop concepts of fairness and personal and social responsibility (The National Curriculum).

Akin with past research (e.g., Hagger et al., 2005) and supporting our hypothesis (H_3), autonomous motivation towards PE positively predicted autonomous motivation in a distinct, yet related context (viz., towards exercise). Further, indirect effects showed a mediating effect of autonomous motivation towards PE on PSC and HRQoL. The indirect effect for total step-count (4-days) approached significance ($p = .06$). Collectively, such findings corroborate past research pertaining to the adaptive role of autonomous motivation (or high quality regulation) in facilitating adaptive engagement in and across physical activity domains (Hagger & Chatzisarantis, 2007; Standage et al., 2007). The data also align with an overarching aim of PE, namely that of supporting students to make an informed choice about adopting a healthy, active lifestyle beyond the confines of school PE (cf. The National Curriculum, 2007).

In accordance with the final hypothesis (H_4) and consistent with the tenets of SDT, autonomous motivation towards exercise positively predicted PSC, HRQoL, and total number of steps taken over a 4-day period. Such findings add to a cogent body of work that documents the many positive exercise and health-related outcomes that are associated with one's engagement in activities being driven by more autonomous forms of motivation (see Standage & Ryan, in press, for an overview). The positive paths between autonomous motivation towards exercise and (i) HRQoL and (ii) PSC provide support for the notion that volitional, self-regulated reasons for partaking in exercise not only drive adaptive exercise engagement (e.g., Standage, Sebire, & Loney, 2008) and the exercise experience (cf. Standage & Ryan) but also support the development of positive markers of physical health (i.e., indexed in this work by subjective perceptions of health, wellness, and positive evaluations of the self within the physical domain). The positive, albeit weak, path between autonomous motivation towards exercise and total step-count across a 4-day period mirrors past data (e.g., Vierling et al., 2007). Although pedometers provide a useful and economical means to objectively estimate activity via step counts (i.e., they are inexpensive, easy to use, reliable, etc.), they are not without limitations (e.g., they cannot assess intensity, duration, frequency of physical activity) (see Bassett & Strath, 2002). Thus, the weak association between autonomous motivation towards exercise and this marker of physical activity could be due to an incongruence between motivation towards exercise (i.e., a structured, purposeful, repetitive and planned type of physical activity) and step-counts accrued via a wide-array of activities within free-living situations (e.g., lower intensity incidental behaviours, distance of home to school). Similar to past work with adult populations (e.g., Standage et al. 2008), SDT research examining motivational processes within child and adolescent samples would do well to use more advanced technology capable of assessing bouts of activity that are deemed to be health-enhancing, by the nature of their intensity and duration.

Although there were a number of strengths to the present work (e.g., the prospective design, use of an objective marker of physical activity, assessment of health-related wellness), there were also a number of limitations. Each variable was only assessed at one time-point, thus causal inferences cannot be drawn. Moreover, as motivation is a dynamic process, future work would do well use within- and between-person designs to examine SDT-related constructs in the physical domain at various levels (i.e., person-level and day-level) alongside ongoing assessments of wellness and behavior (Taylor, Ntoumanis, Standage, & Spray, 2010; Standage & Ryan, in press). Further, relations among motivational processes and indices of health and well-being should also be examined over a longer duration and across different development stages of the school cycle.

The study was also limited by other measurement issues (i.e., above and beyond the need for the development of context specific measures alluded to previously). For example, and while most relevant to the domains studied in this work, a potential difficulty of using HRQoL measures in place of overall QoL measures, is that many are focused towards measuring disability and the limitations imposed by poor health, rather than obtaining a positive view of a person's life. The PedsQL that was used in this work phrases all items in a negative manner; "It is hard for me to run" and "I cannot do things other kids my age can do" (Varni et al., 1999). Such items may be perceived to have little relevance to healthy adolescents.

Conclusion

Overall, the results from the present work provided support for the paths specified within the proposed model of motivational processes that spanned the contexts of school PE, exercise, and indices of health-related well-being. Akin with SDT, the results of this study reinforce the motivational and well-being benefits that students experience from interactions with autonomy-supportive teachers who provide social conditions that are conducive to students experiencing support for their basic needs. The results also support a cogent body of past SDT research by documenting the motivational, behavioral, and well-being advantages of being autonomously motivated in one's physical activity-related endeavors. Lastly, as predicted by SDT, model fit was shown to be invariant across responses from boys and girls.

This study adds a number of unique contributions to knowledge within the extant literature. However, the aforementioned limitations also reinforce the need for future research to encompass key issues such as the development of PE context specific measures of SDT-related variables, the use of better assessments of health-enhancing physical activity that capture the intensity, duration, and frequency (e.g., actiheart units; cf. Standage et al., 2008), consideration of multiple sources of need-support from different and pertinent social agents, and a need to study motivation as a dynamic, as opposed to static, process.

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Footnotes

[1]Within SDT, a number of behavioral regulations reside on a continuum that varies in the degree to which the regulations are autonomous. From the most to the least autonomous, these are *intrinsic motivation*, *integrated regulation*, *identified regulation*, *introjected regulation*, *external regulation*, and *amotivation*. In the present work, we were interested in assessing autonomous motivation towards PE and exercise. For a discussion on the characteristics of each regulation see Ryan and Deci (2008).

[2]Although the scoring of the BREQ-2 specifies the inclusion of amotivation, other work has adopted the premise that amotivation reflects a lack of motivation and should not be included in a relative index of autonomous motivation (i.e., RAI; e.g., Standage & Gillison, 2007). To this end, we conducted the analyses again with amotivation not included in the RAI. Results provided an identical pattern of associations.

[3]The introjected regulation subscale of the BREQ-2 consists of only 3 items, as opposed to the 4 items tapping each for the other motivational regulations. Thus, the fourth RAI indicator was calculated without a score for introjected regulation.

[4]The factor loadings, uniquenesses, standard errors, z values, and squared multiple correlations are available on request from the first author.

[5]We did not test the invariance of error variances and covariances as this is an overly restrictive test of invariance (e.g., Bryne, 2010).

Table 1

Descriptive Statistics and Cronbach Internal Consistency Estimate for Each Measure

Subscale	*M*	SD	Kurtosis	Skewness	α
Autonomy support (PE)	4.26	1.20	-.52	-.14	.87
Autonomy (PE)	3.54	1.41	-.64	.16	.86
Competence (PE)	5.09	1.33	.19	-.81	.89
Relatedness (PE)	4.78	1.27	.08	-.51	.89
Intrinsic motivation (PE)	5.12	1.61	-.43	-.63	.91
Identified regulation (PE)	5.32	1.50	.41	-.97	.90
Introjected regulation (PE)	4.04	1.34	-.26	-.09	.70
External regulation (PE)	3.84	1.62	-.75	.13	.82
Amotivation (PE)	2.52	1.38	.10	.86	.79
Intrinsic motivation (EX)	2.75	1.02	-.32	-.62	.89
Identified regulation (EX)	2.55	.83	-.01	-.55	.70
Introjected regulation (EX)	1.55	1.02	-.56	.26	.72
External regulation (EX)	.85	.79	-.06	.79	.77
Amotivation (EX)	.43	.73	4.91	2.17	.84
Health-related quality of life	78.26	13.23	1.73	-.96	.90
Physical functioning	88.27	12.06	5.81	-1.80	.79
Social functioning	80.29	17.50	2.08	-1.19	.81
School functioning	69.56	18.16	.15	-.61	.75
Emotional functioning	74.92	18.67	.39	-.67	.79
Physical abilities scale	3.59	.90	-.50	-.45	.88
Physical appearance scale	3.16	.93	-.42	-.14	.88
Total step-count (4 days)	44822	14622	.98	.52	-

Note. PE=Physical Education, EX= exercise

Table 2

Standardized Parameter Estimates of Indirect Effects

Parameter			β	Bootstrap Bias-Corrected 95% CI's (lower, upper)
Indirect effects				
Autonomy support	→	Autonomous motivation (PE)	.54*	.48, .61
Autonomy support	→	Autonomous motivation (EX)	.38*	.32, .44
Autonomy support	→	Physical self-concept	.37*	.31, .44
Autonomy support	→	Health-related quality of life	.28*	.22, .35
Autonomy support	→	Total step-count (4 days)	.04 [b]	-.00, .07
Competence	→	Autonomous motivation (EX)	.38*	.31, .45
Competence	→	Physical self-concept	.11*	.07, .15
Competence	→	Health-related quality of life	.08*	.04, .12
Competence	→	Total step-count (4 days)	.04 [b]	-.00, .08
Autonomy	→	Autonomous motivation (EX)	.28*	.22, .34
Autonomy	→	Physical self-concept	.08*	.06, .12
Autonomy	→	Health-related quality of life	.06*	.03, .09
Autonomy	→	Total step-count (4 days)	.03 [a]	-.00, .06
Autonomous motivation (PE)	→	Physical self-concept	.20*	.14, .26
Autonomous motivation (PE)	→	Health-related quality of life	.14*	.07, .22
Autonomous motivation (PE)	→	Total step-count (4 days)	.07 [c]	-.01, .14

Note. * ($p < .05$), [a] ($p = .05$), [b] ($p < .06$), [c] ($p = .06$),

PE=Physical Education, EX= exercise

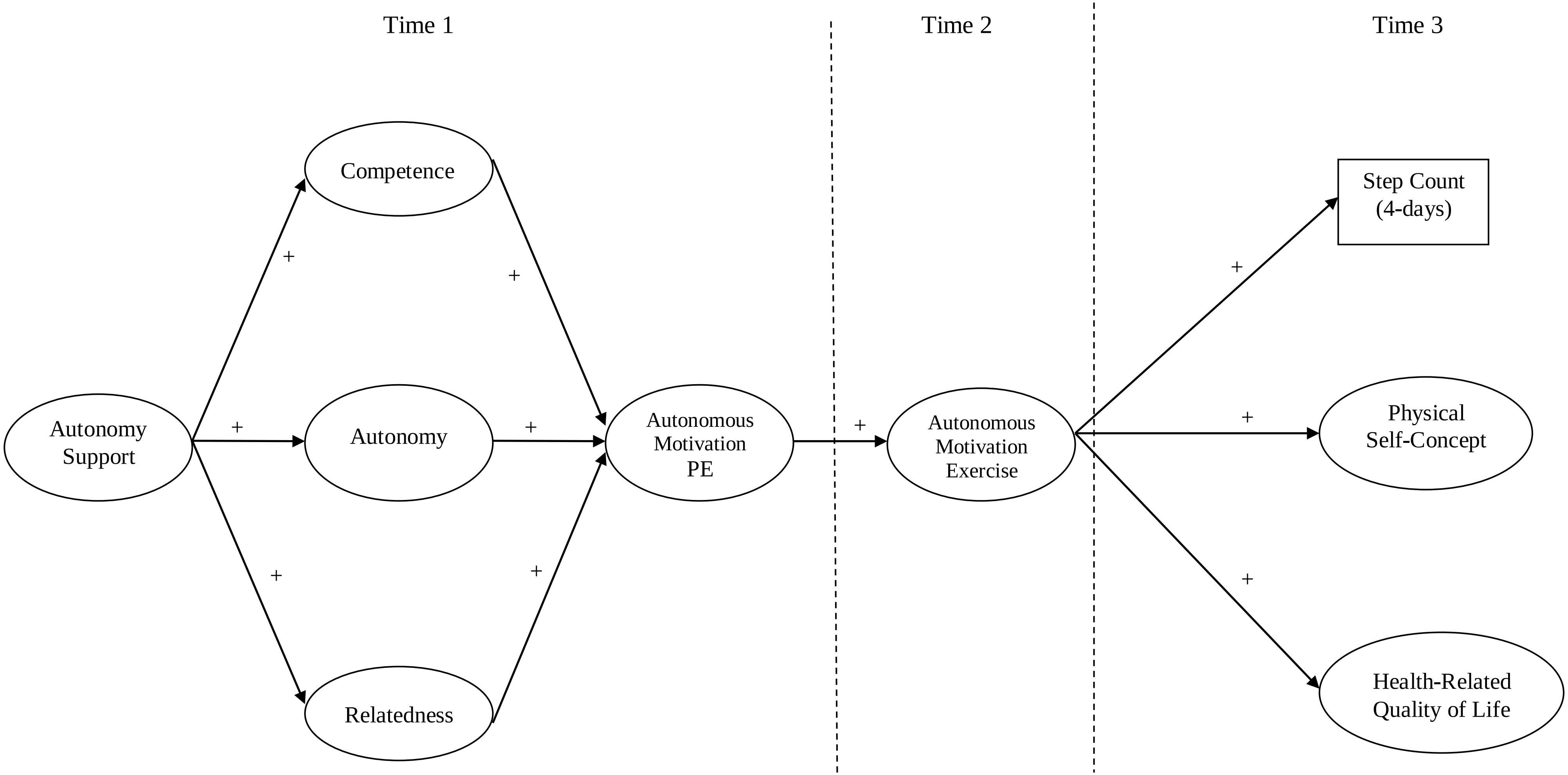

Figure 1. Hypothesized model of motivational processes.

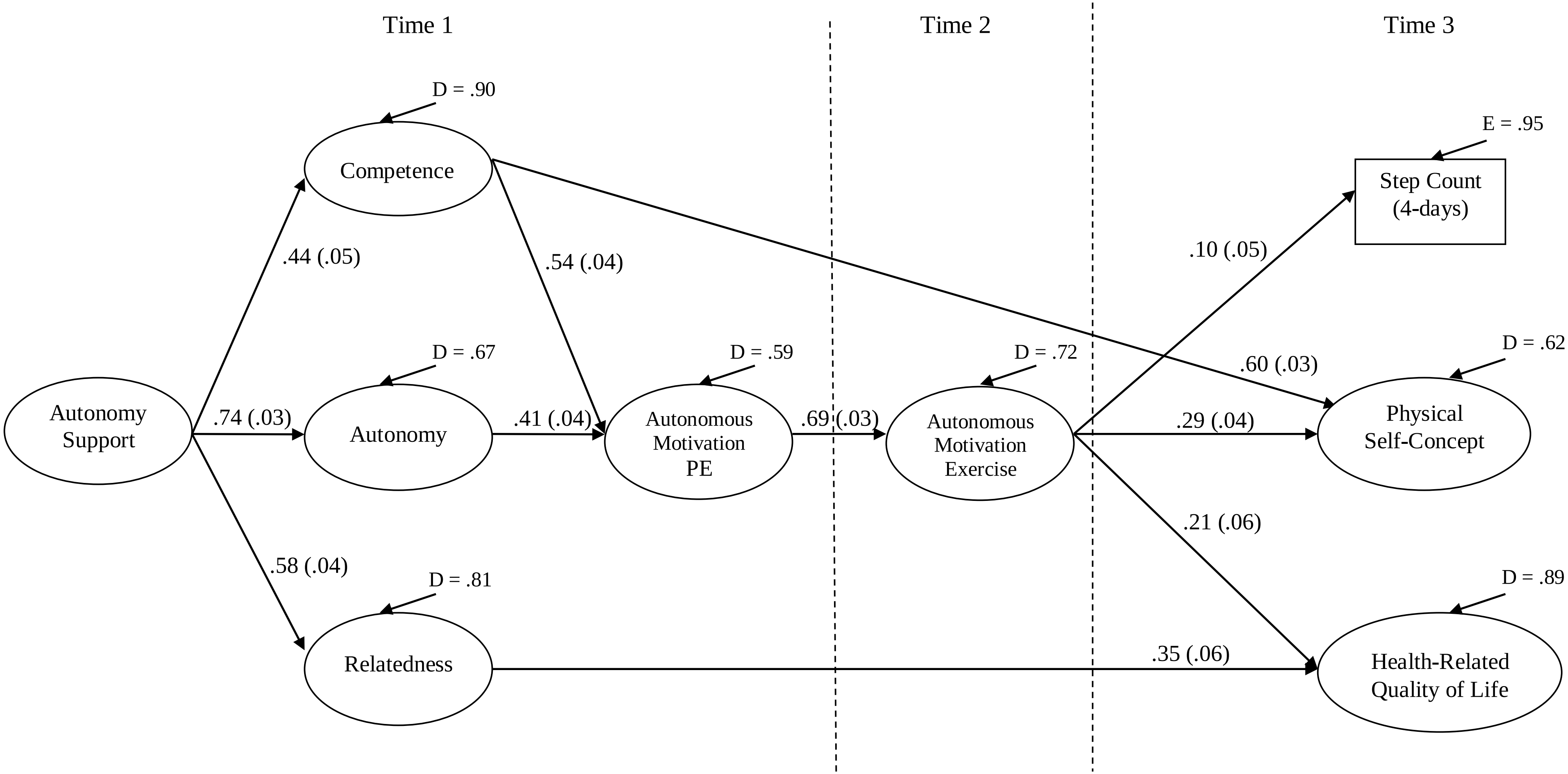

Figure 2. Final model of motivational processes. All standardized estimates are significant ($p < .05$). The bootstrap 95% CI estimate of the standard error for each parameter is shown in parenthesis. Aligned with findings which have shown the psychological needs to be associated (e.g., Standage et al., 2003), the disturbance terms of the three needs were allowed to correlate. In the present work the correlations of the disturbances were as follows: $r_{\text{autonomy-competence}} = .17$; $r_{\text{competence-relatedness}} = .36$; $r_{\text{autonomy-relatedness}} = .09$.