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1 **Coach autonomy support predicts autonomous motivation and daily moderate-to-**
2 **vigorous physical activity and sedentary time in youth sport participants**

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1 **Abstract**

2 **Objective:** Guided by self-determination theory (Deci & Ryan, 1987), this study tested a
3 trans-contextual model linking perceptions of the social environment created by the youth
4 sport coach to levels of autonomous motivation and objectively measured daily moderate-to-
5 vigorous physical activity (MVPA) and sedentary time (ST) in young football players.

6 **Design:** The study employed a cross-sectional design, assessing physical activity using
7 accelerometers. **Method:** 105 male youth sport footballers (*M age* = 12.79 ± 1.85 years) wore
8 a GT3X accelerometer for 7 days. Measures of height and weight were recorded. Participants
9 completed a multi-section questionnaire assessing perceptions of autonomy support and
10 controlling coaching behaviours, and motivation toward their participation in sport and
11 physically active games. **Results:** Path analysis supported a model in which players'
12 perceptions of coach-provided autonomy support positively predicted autonomous motivation
13 for sport engagement. In turn, autonomous motivation was positively associated with MVPA,
14 and negatively related to ST (min/day). Controlling coach behaviours were positively linked
15 to controlled motivation. However, controlled motivation for sport and physically active
16 games was unrelated to daily MVPA and ST. Perceptions of coach-provided autonomy
17 support had a significant positive indirect effect on daily MVPA, and a significant negative
18 indirect effect on daily ST. **Conclusions:** Results suggest that autonomy supportive coach
19 behaviours are related to daily physical activity patterns in young male footballers. Theory-
20 based interventions that aim to encourage autonomy supportive coaching, and subsequently
21 foster autonomous reasons for sport engagement, may enhance the potential of youth sport
22 for increasing daily MVPA and reducing ST among children and adolescents active in this
23 setting.

24 **Key Words:** Self-determination Theory; MVPA; sedentary time; youth sport; accelerometer;
25 children; motivation

1 **Coach-provided autonomy support predicts autonomous motivation and daily**
2 **moderate-to-vigorous physical activity and sedentary time in youth sport participants**

3 A wide body of research indicates engagement in PA above a moderate intensity (i.e.,
4 moderate-to-vigorous physical activity, MVPA) is related to positive health outcomes in
5 children (Carson & Janssen, 2011; Ekelund et al., 2012; Janssen & Leblanc, 2010; Mark &
6 Janssen, 2011; Martinez-Gomez, Eisenmann, Tucker, Heelan, & Welk, 2011; Ness et al.,
7 2007; Prentice-Dunn & Prentice-Dunn, 2011). Specifically, higher levels of MVPA are
8 associated with reduced risk of obesity during childhood (Ness et al., 2007), improved cardio-
9 metabolic health (Ekelund et al., 2012) and a reduction in the presence of inflammatory
10 markers associated with cardiovascular disease and type II diabetes in youth (Carson &
11 Janssen, 2011). Such findings have led to the development of evidence-based guidelines
12 which state children should engage in at least 60 minutes and up to several hours of MVPA
13 per day (Janssen & Leblanc, 2011; Strong et al., 2005).

14 More recently, researchers have begun to investigate the negative effects of sedentary
15 behaviour on health outcomes related to obesity and non-communicable diseases (Carson &
16 Janssen, 2011; Chaput et al., 2012; Gaya et al., 2009; Henderson et al., 2012; Martinez-
17 Gomez et al., 2012; Mitchell, Pate, Beets & Nader, 2013; Prentice-Dunn & Prentice-Dunn,
18 2011). Sedentary behaviour refers to any waking behaviour characterised by low energy
19 expenditure (typically ≤ 1.5 metabolic equivalents) and little physical movement (e.g.,
20 behaviours undertaken in a sitting or reclining posture) (Sedentary Behaviour Research
21 Network, 2012). Existing research focused on sedentary behaviour and health has largely
22 examined associations between total sedentary time (ST) (i.e., the sum of the time spent in all
23 sedentary behaviours), and/or time spent engaged in a specific sedentary behaviour (e.g.,
24 television viewing) and health outcomes (Tremblay et al., 2011). Results from studies
25 investigating the relationships between total ST and health are somewhat equivocal. For

1 example, some studies have reported positive associations between ST and indicators of
2 adiposity, cardiovascular risk and type 2 diabetes (Gaya et al., 2009; Henderson et al., 2012;
3 Mitchell et al., 2013; Sardinha et al., 2008) where others have reported no associations
4 (Carson & Janssen, 2011; Chaput et al., 2012; Colley et al., 2013; Ekelund, Brage, Griffin &
5 Wareham, 2009). Conversely, engagement in specific sedentary behaviours are more
6 consistently linked to negative health outcomes, with positive relationships reported between
7 TV viewing and computer use with obesity associated health outcomes (Carson & Janssen,
8 2011; Martinez-Gomez et al., 2012; Tremblay et al., 2011). Nevertheless, a recent systematic
9 review concluded that decreasing any type of sedentary time is associated with lower health
10 risks in youth aged 5 to 17 years (Tremblay et al., 2011). As such, the most recent PA
11 guidelines have included a recommendation for children to minimise time spent engaged in
12 sedentary pursuits (Department of Health, 2011; US Department of Health and Human
13 Services, 2013).

14 Despite the endorsement of evidence-based recommendations for MVPA and ST
15 across the globe, youth are becoming increasingly sedentary (Nelson, Neumark-Stzainer,
16 Hannan, Sirard, & Story, 2006), and only a small percentage of children are engaging in
17 sufficient levels of MVPA to meet recommended guidelines (Craig & Mindell, 2008;
18 Riddoch et al., 2007). Thus, there is a need to understand what motivates children to engage
19 in MVPA, as well as the psycho-social factors that might contribute towards engagement in
20 ST in order to promote health-conducive PA patterns in youth. Concerning the
21 encouragement of MVPA in particular, past work has suggested that physically active
22 children are more likely to become physically active adults (Telama et al., 2005). Thus,
23 childhood seems to be a critical developmental period in which the formation of positive PA
24 habits (i.e., higher levels of MVPA participation) may be relevant to the promotion of

1 lifelong PA engagement and reduced risk of overweight and associated diseases during
2 adulthood.

3 **Youth sport as a setting for physical activity promotion**

4 Traditionally, efforts to increase MVPA and reduce ST among youth across the globe
5 have targeted the school setting. Certainly, the school is uniquely placed as the only
6 environment which almost all youth experience from early childhood to adolescence.
7 However, recent survey data indicates between 34% and 68% of school-aged youth engage in
8 youth sport in western countries (Australian Bureau of Statistics, 2009; National Council of
9 Youth Sports, 2008; UK Statistics Authority, 2013). As such, youth sport also represents an
10 important and globally relevant domain with regard to promoting engagement in MVPA and
11 reducing ST in children and adolescents. Studies have demonstrated youth sport participants
12 are more active than their non-sporting counterparts (Nelson et al., 2011). However, recent
13 research indicates that whilst youth sport can offer children and adolescents the opportunity
14 to engage in MVPA, MVPA accrued during youth sport time alone is not sufficient to meet
15 recommended guidelines (Leek et al., 2011, Wickel & Eisenmann, 2007). Studies have also
16 revealed youth sport participants to spend as much as 11 hours per day sedentary (Machado-
17 Rodrigues et al., 2012, Van-Hoye et al., 2013). Thus, participation in youth sport may not
18 necessarily mitigate the health risks of engaging in low levels of MVPA and high levels of
19 ST. Moreover, past studies have reported that around one in four youth sport participants are
20 overweight (Dowda, 2001), and 48% of obese youth report participation in sport (BeLue,
21 Francis, Rollins & Colaco, 2009). It seems, therefore, that a consideration of factors that
22 predict daily engagement in MVPA and ST among youth sport participants may have
23 important implications for encouraging healthier PA-related behaviours (i.e., higher daily
24 MVPA and less ST) during non-youth sport time, and subsequently, reducing the risk of poor
25 health among children and adolescents active in the youth sport setting. However, despite the

1 potential utility of youth sport as a context for PA promotion, studies to date have largely
2 neglected to examine the concomitants of MVPA engagement and ST among youth sport
3 participants.

4 **Self-determination Theory**

5 Self-determination theory (SDT; (Deci & Ryan, 1987; Deci & Ryan, 2000) is a
6 theoretical framework increasingly used to explain why some individuals are more likely to
7 engage in PA than others (Chatzisarantis & Hagger, 2009; Edmunds, Ntoumanis, & Duda,
8 2008; Hagger et al., 2009; Standage, Gillison, Ntoumanis, & Treasure, 2012; Teixeira,
9 Carraca, Markland, Silva, & Ryan, 2012; Vierling, Standage, & Treasure, 2007). A central
10 tenet of SDT is that behaviour is directed by motivation regulations that vary in levels of self-
11 determination. These motivation regulations are on a continuum ranging from those that are
12 more autonomous to more controlled, with the former linked to more adaptive outcomes
13 (Alvarez, Balaguer, Castillo, & Duda, 2009; Bartholomew, Ntoumanis, Ryan, & Thogersen-
14 Ntoumani, 2011; Cox, Smith, & Williams, 2008; Deci & Ryan, 1987; Deci & Ryan, 2008;
15 Owen, Astell-Burt, & Lonsdale, 2013; Pelletier, Fortier, Vallerand & Brière, 2001; Teixeira
16 et al., 2012).

17 Intrinsic motivation (IM) is the quintessential form of autonomous motivation and
18 represents the most self-determined (autonomous) regulation. When intrinsically motivated,
19 individuals engage in an activity primarily for the inherent rewards such as interest, fun and
20 satisfaction (Deci & Ryan, 2000). Four types of extrinsic motivation exist which vary in the
21 extent to which they are self-determined; i.e., integrated, identified, introjected and external
22 regulations. Integrated (i.e., the individual participates in sport because this behaviour is
23 integrated with his/her sense of self and reflects the individual's true goals and values) and
24 identified (i.e., the person identifies with the value of sport and chooses to take part as a
25 means to achieve personal goals and outcomes) regulations are autonomous forms of

1 extrinsic motivation, as the source of behaviour regulation emanates from the self. However,
2 it has been argued that the advanced nature of integrated regulation (i.e., established and fully
3 internalised values and goals) means this behavioural regulation is often not prevalent until
4 adulthood (Vallerand, 1997). As a result, studies among youth largely focus on examining
5 the consequences of intrinsic and identified regulations, often combining the two to represent
6 autonomous motivation. Introjected (i.e., participation in sport regulated by contingencies that
7 have been partially internalized, for example to avoid feelings of shame or guilt, or to attain
8 ego enhancement) and external (i.e., sport participation regulated by external demands,
9 rewards or pressures) regulation are considered controlled forms of extrinsic motivation
10 (Deci & Ryan, 2008). SDT also recognises amotivation, characterised by a lack of or
11 absence of motivation (Ryan, 1995). Previous research has indicated more autonomous forms
12 of motivation towards PA (e.g., daily, and/or within leisure time, exercise, physical education
13 settings) to be positively associated with levels of PA engagement among both adults and
14 children (Aelterman et al., 2012; Gillison, Standage, & Skevington, 2011; Owen et al., 2013;
15 Standage et al., 2012; Taylor, Ntoumanis, Standage, & Spray, 2010; Vierling et al., 2007;
16 Sebire, Jago, Fox, Edwards, & Thompson, 2013; Teixeira et al., 2012). Conversely,
17 controlled motivation towards PA has been negatively linked to levels of PA engagement
18 (Owen et al., 2013; Standage et al., 2012; Teixeira et al., 2012), although these associations
19 are reported less consistently than observed for autonomous motivation (in a positive
20 direction).

21 According to SDT, the social environment surrounding an individual is a central
22 determinant of autonomous motivation to be physically active (Deci & Ryan, 2008; Pelletier,
23 et al., 2001; Standage et al., 2012). In the PA contexts most frequently experienced by
24 children (e.g., PE classes, youth sport), the social environment is largely coloured by the
25 interpersonal styles of adults acting within these settings (i.e., the teacher/coach created social

1 environment). SDT advocates that more autonomous forms of motivation are promoted in
2 social environments that support an individual's sense of autonomy, (i.e., contexts that
3 promote choice, decision making, acknowledge the others' perspectives, provide a rationale
4 for what individuals are requested to do). Conversely, when controlling atmospheres are most
5 pronounced (i.e., contexts which limit choice, exert pressure, are coercive and in which
6 negative conditional regard is displayed), more controlled/less autonomous motivation will
7 result (Deci & Ryan, 1987; Deci & Ryan, 2000; Deci & Ryan, 2008). For example, within the
8 youth sport context, an autonomy supportive coach may provide players with meaningful
9 options in training, acknowledges athletes' preferences and explain the rationale behind the
10 decisions they make during training sessions and matches (Mageau & Vallerand, 2003). A
11 controlling coach may fail to listen to players' opinions and perspectives, display negative
12 conditional regard (i.e., withdraw attention if performance expectations are not met), and
13 employ the use of rewards to 'motivate' players to perform better (Bartholomew, Ntoumanis,
14 & Thogersen-Ntoumani, 2010).

15 **Self-determination theory and physical activity among youth**

16 To date, studies exploring the relationships between perceptions of the social
17 environment and PA engagement in youth have largely been conducted with a focus on the
18 social environment created by teachers in the PE setting. These studies have principally
19 investigated the associations between autonomy support, autonomous motivation and
20 subsequent engagement in PA. Overall, findings have revealed perceptions of teacher-
21 provided autonomy support in PE classes to be positively related to daily, leisure time and PE
22 class PA engagement as a result of fostering more autonomous forms of motivation
23 (Chatzisarantis & Hagger, 2009; Cox et al., 2008; Hagger et al., 2009; Standage et al., 2012;
24 Vierling et al., 2007). In addition, based on bivariate associations, studies have demonstrated
25 controlled motivation to be negatively linked to daily and leisure time PA.

1 Perhaps most importantly, results from studies conducted in this domain have
2 highlighted the presence of a trans-contextual effect, demonstrating autonomous motivation
3 fostered by the social environment in the PE setting, is related to PA engagement outside this
4 setting (i.e., daily and leisure time PA). Such findings are in line with Vallerand's
5 hierarchical model of motivation which suggests that motivation to engage in a behaviour
6 (e.g., PE) can generalise across contexts (Vallerand, 1997). That is, where individuals are
7 autonomously motivated towards PA participation in one setting, they may also be
8 autonomously motivated towards PA outside of this context. Subsequently, higher levels of
9 engagement both within and outside the setting in question may ensue.

10 With respect to existent studies examining the motivational processes through which
11 the social environment created within youth PA settings may impact upon young people's PA
12 engagement, a number of limitations should be acknowledged. First, an almost exclusive
13 focus on the PE setting limits our understanding of the potential value of promoting
14 autonomy support in other youth PA environments so that we might enhance children's levels
15 of daily PA engagement. Given that youth are physically active across a variety of settings
16 throughout the week and curricular time allocated to PE is declining in many Western
17 countries (Dollman, Norton & Norton, 2005), examining the motivational processes
18 operating within other youth PA environments and their implications for levels of PA
19 engagement, is an important area of research. Second, studies to date have largely neglected
20 to examine the impact a controlling interpersonal style may have upon levels of PA
21 engagement among youth. As controlling social environments are linked to more controlled
22 motivation, studies examining the implications of controlling behaviours among adults
23 central to shaping youth PA environments are warranted. Finally, previous research in this
24 area has tended to largely rely on self-report questionnaires and pedometers to assess PA
25 engagement among children and adolescents. The questionable validity of self-report

1 measures of PA (particularly among youth) and the inability of pedometers to determine
2 different dimensions of PA (e.g., intensity) limit our understanding of how social contextual
3 factors operating in youth PA settings are related to engagement in specific PA behaviours
4 (e.g., MVPA).

5 Accelerometers provide an accurate means of assessing frequency, intensity and
6 duration of PA (Troost, 2007). In SDT-grounded research on adults, accelerometers have been
7 utilised to investigate the relationships between motivation and MVPA (Sebire, Standage &
8 Vansteenkiste, 2011; Standage, Sebire & Loney, 2008; Teixeira et al., 2012). However,
9 among youth, very few studies exist that have employed accelerometers to investigate the
10 associations between the psychosocial correlates of PA and daily, leisure time, and/or domain
11 specific engagement in MVPA within the framework of SDT (Aelterman et al., 2012;
12 Lonsdale et al., 2013; Owen et al., 2013; Perlman, 2013; Roemmich, Lambiase Ms,
13 McCarthy, Feda, & Kozlowski, 2012; Sebire et al., 2013).

14 **Self-determination theory and prediction of MVPA**

15 Existing accelerometer-based studies which have examined the motivational
16 processes postulated by SDT have typically investigated the bivariate associations between a
17 single facet of the SDT model (i.e., the social context *or* motivation regulations) and MVPA
18 (Aelterman et al., 2012; Owen et al., 2013; Roemmich et al., 2012). In general, results have
19 been consonant with SDT tenets with respect to the prediction of engagement in MVPA.
20 Only one study has examined these associations at the multivariate level, testing a sequential
21 SDT based model which demonstrated a positive association between basic psychological
22 need satisfaction (See Ryan and Deci, 2000 for an overview of basic needs theory) and
23 intrinsic motivation towards PA, which in turn was positively linked to daily MVPA (Sebire
24 et al., 2013). However, the role of social contextual factors as determinants of the targeted
25 psychological antecedents and PA engagement was not examined. Owen et al., (2013)

1 conducted the only study to date which sought to examine the trans-contextual associations
2 between motivation and MVPA. Findings revealed more autonomous motivation (and
3 specifically intrinsic motivation) towards PE to be positively related to leisure time MVPA
4 (Owen et al., 2013). In contrast, external regulation was negatively associated with leisure
5 time MVPA, providing initial support for the contention that quality of motivation in one
6 context, may be related to engagement in MVPA in another.

7 **Self-determination theory and sedentary time**

8 The recent advancement towards using accelerometry has gone somewhat toward
9 testing the theoretical tenets of SDT with respect to the prediction of MVPA. However, only
10 one study to date has pulled from SDT in the investigation of the psychosocial correlates of
11 ST. In this intervention study, Lonsdale et al., (2013) sought to determine if the creation of
12 autonomy supportive PE environments would result in changes in students' motivation
13 towards PE and time spent sedentary during a 20 minute PE session. Results revealed where
14 the PE teacher provided opportunity for free choice of activities during PE, motivation
15 towards PE remained unchanged, but ST during the PE lesson was reduced (Lonsdale et al.,
16 2013). Whilst this study offers a novel contribution to the literature, further SDT-based
17 research is warranted which further explores the psychosocial correlates of ST and the
18 motivational processes underlying engagement in ST behaviours. In particular, given the high
19 levels of daily ST reported among youth (Pate, Mitchell, Byun & Dowda, 2011), studies
20 examining the motivational processes underlying engagement in daily ST are paramount
21 from a public health perspective.

22 As previously highlighted, initial support has been provided for the presence of a
23 trans-contextual association between motivation in one context and engagement in MVPA in
24 another (Owen et al., 2013). However, less is known concerning whether contextual
25 motivation to engage in PA in one setting, would be related to time spent engaged in

1 sedentary behaviours outside this context. Consonant with Vallerand's hierarchical model of
2 motivation (Vallerand, 1997), a lower quality of motivation towards PA, may mean that
3 children chose to spend their time engaged in activities of a more sedentary nature across
4 multiple contexts. Whilst there may be other important mediators in this relationship,
5 exploring the trans-contextual association between quality of motivation towards PA fostered
6 in one context and engagement in ST across other contexts, is an important first step in
7 determining the relevance of youth PA environments as trans-contextual settings for reducing
8 ST among children and adolescents.

9 When arguing the relevance of determining trans-contextual associations between
10 domain specific motivation for PA and daily ST, it is important to consider the PA and
11 sedentary behaviour paradigm as discussed across the literature (Biddle, Marshall, Gorely, &
12 Cameron, 2009; Katzmarzyk, 2010; Maher, Olds, Mire & Katzmarzyk, 2014). Indeed, in
13 contrast to evidence demonstrating MVPA and ST are two distinct behaviours (Biddle et al.,
14 2009), there is evidence to suggest that MVPA and ST are related behaviours with similar
15 correlates (Epstein, Roemmich, Paluch & Raynor, 2005; King et al., 2010). Based on the
16 latter assertion, it is likely that where motivation in one context is positively related to MVPA
17 in another, the opposite association may be observed for ST (i.e., an increase in MVPA may
18 be correspond to a decline in ST, Epstein, Roemmich, Paluch & Raynor, 2005; Loucaides,
19 Jago & Theophanous, 2011). Thus, determining associations between PA motivation and
20 both MVPA and ST may also contribute to an important body of research seeking to
21 determine the extent to which these two behaviours are related among youth.

22 **The present study**

23 The current study sought to build upon existing research by extending previous
24 findings from the PE context to an important setting for PA promotion in youth outside the
25 school (i.e., youth sport). We addressed this by testing a sequential SDT-based model

1 examining the trans-contextual associations between the social environment created by
2 coaches in the youth sport setting (i.e., its autonomy supportive and controlling features),
3 sport and PA related autonomous and controlled motivation and accelerometer-assessed daily
4 MVPA and ST. The inclusion of ST in our hypothesised model served a secondary and more
5 exploratory aim; i.e., we wanted to secure preliminary data regarding the potential value of
6 the youth sport context as an avenue through which levels of ST may be reduced among
7 youth sport participants. The indirect effects of perceptions of coach-provided autonomy
8 support and controlling coach behaviour on autonomous and controlled motivation were also
9 examined in order to explore the psychosocial mechanisms linking the social environment
10 created in youth sport football to daily engagement in MVPA and ST. Due to its popularity
11 across the world, our focus in the present study was on grassroots football participants (*note:*
12 football is also internationally referred to as soccer). Globally it is estimated over 22 million
13 youth participate in grassroots football (Kunz, 2007) and in some westernised countries,
14 footballers comprise between 40% and 68% of all youth sport participants (Australian Bureau
15 of Statistics, 2009; UK Statistics Authority, 2013; Womens Sports Foundation, 2008).

16 **Method**

17 **Participants and procedures**

18 Males aged 10-16 years ($N = 156$, $M\ age = 12.78 \pm 1.91$) were recruited from 24
19 football clubs. To be eligible for the study, participants were required to be playing grassroots
20 football regularly (i.e., \geq one training session and/ or match per week) for a community club
21 team outside school. Following initial contact with coaches at football clubs, trained
22 researchers visited clubs to distribute consent forms and information sheets to interested
23 participants and parents. Researchers returned one week later to administer a multi-section
24 questionnaire assessing perceptions of coach behaviour and players' motivation regulations.
25 Following this, measures of height and weight were recorded and accelerometers (GT3X

1 Actigraph, Pensacola, FL) were distributed. Study procedures and assessments were
2 approved by the local National Health Service Ethics Committee. Informed parental consent
3 and participant assent were obtained before participation in the study. All data were collected
4 six to seven months into the competitive football season (i.e., between February and March),
5 allowing time for the social environment within the youth sport setting to have been
6 established.

7 **Measures**

8 **Perceptions of the coach created social environment.** Perceptions of coach-
9 provided autonomy support and controlling coach behaviours were assessed via previously
10 validated scales (Adie, Duda, & Ntoumanis, 2012; Bartholomew et al., 2010; Williams,
11 Grow, Freedman, Ryan, & Deci, 1996). Following the stem “So far this season....,” five items
12 (e.g., my coach gives players choices and options) and six items (e.g., my coach threatens to
13 punish players to keep them in line during training) were used to measure players’
14 perceptions of coach-provided autonomy support and controlling coach behaviours,
15 respectively. Players were asked to rate their agreement with the items on a 5-point Likert-
16 scale ranging from 1 (strongly disagree) to 5 (strongly agree). Both scales had acceptable
17 internal consistency (autonomy support, $\alpha = .67$; controlling behaviours, $\alpha = .74$).

18 **Motivation regulations.** Behaviour regulations for participation in sport and active
19 games were assessed using an adapted version of the Behavioural Regulation in Sport
20 Questionnaire (BRSQ, Lonsdale, Hodge, & Rose, 2008). Following the stem “I participate in
21 sport and active games because....,” three items measured intrinsic motivation (e.g., because it
22 is fun)¹, and four items tapped identified (e.g., because I value the benefits), introjected (e.g.,
23 because I would feel guilty if I quit) and external (e.g., Because if I don’t other people will

¹ The original BRSQ measure uses four items to tap intrinsic motivation. In the present study, the item “because it feels pleasurable” was removed as this term was not thought to reflect

1 not be pleased with me) motivation. Items were responded to on a 7-point Likert scale
2 ranging from 1 (not true at all) to 7 (very true). The BRSQ subscales demonstrated
3 acceptable internal consistency in this study (intrinsic motivation, $\alpha = .75$, identified
4 regulation, $\alpha = .74$, introjected regulation, $\alpha = .80$ and external regulation , $\alpha = .84$), and have
5 been validated in research involving a large sample of youth sport football participants of
6 similar age to those targeted in this study (Viladrich et al., 2013). Consonant with SDT and
7 the approach used in other SDT-based studies in sport and other physical activity settings
8 (Aelterman et al., 2012; Chan & Hagger, 2012), autonomous motivation (intrinsic motivation
9 + identified regulation) and controlled motivation (introjected regulation + external
10 regulation) variables were computed and used as primary variables in subsequent analysis.

11 **Anthropometry.** Height was measured with a stadiometer (SECA, Leicester height
12 measure) to the nearest 0.1cm. Weight was measured with electronic scales (WW, precision
13 scale) to the nearest 0.1 kg. Body mass index (BMI) was calculated using the equation,
14 $\text{weight (kg)} \div \text{height (m}^2\text{)}$, and participants were classified as normal-weight, overweight or
15 obese according to UK BMI reference charts (Cole, Freeman, & Preece, 1995). BMI standard
16 deviation scores (BMI-SDS) adjusted for age-and-sex were computed (Cole, Freeman, &
17 Preece, 1998).

18 **Physical activity.** Daily MVPA and ST were measured using the Actigraph GT3X
19 accelerometer. The Actigraph accelerometer has been shown to be a valid and reliable
20 measure of PA among youth (Trost, 2007). The GT3X detects movements over pre-specified
21 time periods called epochs. Movements within each epoch are converted to ‘activity counts’
22 which are interpreted to determine time spent at different activity intensities. Accelerometers
23 were initialised in 15 second epochs in the present study (Riddoch et al., 2007). A trained
24 researcher distributed the accelerometers and provided participants and parents with verbal
25 and written instructions on how accelerometers should be worn. For assessment of PA among

1 youth, a seven-day measurement protocol is recommended to obtain a reliability coefficient
2 of 0.8 or above (Troost, Pate, Freedson, Sallis, & Taylor, 2000). As such, participants were
3 asked to wear the accelerometer for seven days following their training session (i.e., five
4 week days and two weekend days) during all waking hours, and instructed to remove the
5 accelerometer when bathing and/or engaged in water sports (e.g., swimming). Participants
6 were asked to record time periods when the accelerometer was removed (indicating reasons
7 why), and daily participation in sports and PA (e.g., cycling) in activity logs to aid with data
8 cleaning.

9 **Data processing**

10 Data from the GT3X were downloaded and analysed using Actilife software
11 (Actigraph, Pensacola, Florida). Questionnaire and PA data were cleaned and checked for
12 missing and spurious values respectively. Periods of accelerometer non-wear were
13 determined by strings of consecutive zeros lasting > 30 minutes, allowing for 1 minute of
14 counts < 100 (Cain, Sallis, Conway, Van Dyck, & Calhoun, 2013). Participants were
15 excluded from further analysis where they failed to record valid PA data [$N = 41$, ≥ 4 days,
16 with ≥ 8 valid hours of activity per day, including one weekend day), and/or provided
17 incomplete responses to questionnaire items ($N = 10$). The final sample consisted of 105
18 males (compliance = 66.88%), representing youth sport football players from all 24 of the
19 football clubs initially recruited. Of these, 45.7 %, 38.1%, 8.6% and 7.6% recorded 7, 6, 5
20 and 4 days of valid PA data respectively. Mean scores for questionnaire variables were
21 calculated from responses to the targeted scales, and average daily levels of MVPA and ST
22 were determined (minutes/day). MVPA and ST were defined as ≥ 2296 and <100 and cpm
23 respectively based on the cut points derived by Evenson and colleagues (Evenson, Catellier,
24 Gill, Ondrak, & McMurray, 2006). One-way analysis of variance indicated the final sample

1 did not differ from those excluded for physical characteristics (age, height, weight and BMI-
2 SDS), or because of missing questionnaire data (all $p = < .05$).

3 **Statistical analysis**

4 Descriptive statistics ($M \pm SD$) were calculated for all measured variables using
5 SPSS. Pearsons correlations were calculated to examine bivariate relationships between
6 variables in the hypothesised model (Figure 1), and to identify confounding factors that may
7 impact upon these relationships (i.e., BMI-SDS, age and valid-wear time). Where
8 confounding relationships were identified, the hypothesised model was adjusted accordingly
9 to control for these relationships (i.e., direct paths were stipulated between confounding
10 factors and PA variables where necessary; see Figure 2).

11 Path analysis with maximum likelihood estimation was employed in conjunction with
12 the bootstrapping procedure to test the hypothesised model (Figure 1) (Arbuckle & Wothke,
13 1999). Bootstrapping is a nonparametric resampling procedure that does not impose the
14 assumption of normality of the sampling distribution (Preacher & Hayes, 2008). Previous
15 research has shown this approach to be superior to alternative tests with respect to Type 1
16 error rates and power (Preacher & Hayes, 2008), Bootstrap-generated 95% bias corrected
17 confidence intervals were constructed for 2000 samples on the hypothesised model (Preacher
18 & Hayes, 2008; Shrout & Bolger, 2002). Model fit was evaluated using the chi-square
19 statistic (χ^2), comparative fit index (CFI), root square mean error of approximation
20 (RMSEA), and standardised root mean square residual (SRMR) (Hu & Bentler, 1999). Both
21 the CFI and RMSEA were appropriate to assess model fit in the present study as they are less
22 sensitive to sample size than other goodness-of-fit indices (Fan, Thompson, & Wang, 1999).
23 A non-significant χ^2 ($p = < .05$) and values of $> .90$ ($CFI \leq .06$ (RMSEA) and $\leq .08$ (SRMR)
24 were used as cut off criteria to indicate good fit of the data to the hypothesised model. In the
25 case of a CFI value $> .95$, the model is considered to have excellent fit (Hu & Bentler, 1999).

1 Table 2 reports the bivariate associations between all measured psychological
2 variables² and PA behaviours. Results indicate that perceived autonomy support was
3 significantly and positively correlated with autonomous motivation, and was unrelated to
4 controlled motivation. Perceived controlling coach behaviour was significantly and positively
5 correlated with controlled motivation, and significantly negatively correlated with
6 autonomous motivation. Autonomous motivation was also significantly positively associated
7 with daily MVPA and negatively related to daily ST. No relationships were observed
8 between controlled motivation and MVPA or ST.

9 BMI-SDS was not associated with MVPA ($p = .46$) or ST ($p = .88$) Further, age was
10 not related to MVPA ($p = .09$). However, both age and valid-wear time were significantly
11 positively correlated with ST ($r = .51, p = < .01$ and $r = .52, p = < .01$ respectively), and valid
12 wear time was also significantly positively associated with MVPA ($r = .23, p = < .05$). The
13 hypothesised model was therefore adjusted to control for these relationships in the subsequent
14 path analysis (i.e., direct paths were stipulated between valid wear time and MVPA and ST,
15 and between age and ST; see Figure 2).

16 Path analysis

17 The hypothesised model demonstrated an excellent fit to the data (Figure 2; $\chi^2 (14) =$
18 $18.64, p = .18, CFI = .98, RMSEA = .06, SRMR = .07$). Perceptions of coach-provided
19 autonomy support positively predicted autonomous motivation, which in turn, positively
20 predicted daily MVPA and negatively predicted ST. Perceptions of controlling coach
21 behaviour positively predicted controlled motivation. Controlled motivation was unrelated to
22 MVPA and ST. Perceptions of autonomy support and controlling coach behaviour were not
23 associated with controlled motivation and autonomous motivation, respectively. The 95%
24 bootstrap-generated bias-corrected confidence intervals revealed perceptions of coach-

² The factorial validity for each of the psychological scales was supported by confirmatory factor analysis. Please contact the first author for further details

1 provided autonomy support had a significant positive indirect effect on MVPA
2 (unstandardised $\beta = 4.90$ [95% CI = .11 to 9.75]), and a significant negative indirect effect on
3 ST (unstandardised $\beta = -9.90$ [95% CI = -20.35 to -.27]), via autonomous motivation.

4 Squared multiple correlations indicated perceptions of coach-provided autonomy
5 support accounted for 18.1% of the variance in autonomous motivation. Perceptions of
6 coach-provided autonomy support and autonomous motivation together explained 4.9% of
7 the variance in PA behaviours (MVPA = 3.3% ST = 1.6%). Significant path coefficients can
8 be interpreted to indicate that every standard deviation unit increase in autonomous
9 motivation (i.e., 0.65) is associated with an increase in daily MVPA by 4.82 minutes per day,
10 and a reduction in daily ST of 9.87 minutes per day. Over a week, this equates to an extra 34
11 minutes of MVPA, and over 1 hour (69 minutes) less ST.

12 Discussion

13 Grounded in self-determination theory (Deci & Ryan, 1987; Deci & Ryan, 2000), this
14 is the first study to test the relationships between perceptions of the autonomy supportive and
15 controlling features of the coaching environment, player motivation regulations to participate,
16 and accelerometer assessed daily MVPA as well as ST. Results are in line with the theoretical
17 tenets of SDT, and demonstrated perceptions of coach-provided autonomy support to
18 positively correspond to autonomous motivation towards sport and active games. In turn,
19 autonomous motivation was positively associated with daily MVPA and negatively predicted
20 daily ST in youth sport footballers. Perceptions of controlling coach behaviour were
21 significantly and positively associated with controlled motivation. However, controlled
22 motivation towards sport and active games was unrelated to both daily MVPA and ST.

23 The present study builds upon existing research by extending findings from the PE
24 context to an important setting for PA promotion outside the school environment, namely
25 youth sport. It is the first to demonstrate that the social environment created in the youth

1 sport setting is linked to daily levels of MVPA and ST. Given growing evidence for a
2 positive relationship between MVPA and markers of obesity and cardio-metabolic risk, and a
3 negative association between ST and these same health indicators (Gaya et al., 2009;
4 Henderson et al., 2012; Mitchell et al., 2013; Sardinha et al., 2008), findings have important
5 health implications for the millions of children active within youth sport settings.

6 Present results indicated that for every increase in autonomous motivation by one
7 standard deviation (i.e., 0.65), MVPA would increase by almost 5 minutes per day
8 (approximately 35 minutes per week). These findings are consonant with the work of Sebire
9 et al., (2013) who reported an increase in intrinsic motivation (the quintessential form of
10 autonomous motivation) by the same amount (i.e., $SD = 0.65$) would have equated to an
11 increase in MVPA of 4.45 minutes per day. Reflecting a new contribution to the literature,
12 findings also revealed autonomous motivation to be negatively related to daily ST. In
13 particular, for every SD increase in autonomous motivation, ST would decrease by
14 approximately 10 minutes per day (over an hour per week). The clinical significance of the
15 present findings can be illustrated when we consider past work investigating the associations
16 between MVPA, ST and health. Research has demonstrated an additional 10 minutes of
17 MVPA is reported to be associated with a 6-7% reduction in biomarkers of insulin sensitivity.
18 Conversely, an additional 10 minutes of ST per day is associated with up to a 2-4% increase
19 in these same biomarkers (Henderson et al., 2012). Moreover, data from the International
20 Children's Accelerometry Database (ICAD) demonstrated an additional 10 minutes of
21 MVPA per day is associated with a 0.5cm decrease in waist circumference (Ekelund et al.,
22 2012). A recent study reported that for every 1cm increase in waist circumference, the odds
23 of having levels of Alanine aminotransferase (a marker of the metabolic syndrome) above
24 those associated with increases in insulin sensitivity and central adiposity, increased by 1.06
25 (Trilk et al., 2013). Thus, present results suggest that fostering autonomous motivation

1 towards sport and active games may contribute towards increasing daily MVPA and reducing
2 ST towards levels which may lead to clinical health benefits. However, longitudinal studies
3 and, in particular, intervention studies are necessary to determine whether increasing
4 autonomy supportive coaching behaviours corresponds to increased levels of MVPA and
5 reduced ST among youth sport participants.

6 Akin with previous studies (Cox et al., 2008; Hagger et al., 2009; Owen et al., 2013;
7 Standage et al., 2012), present results demonstrated domain specific autonomous motivation
8 fostered within a specific youth PA context (i.e., youth sport) was related to engagement in
9 PA outside this setting (i.e., daily MVPA). Thus, findings suggest the presence of a trans-
10 contextual effect, indicating that motivation towards sport and active games cultivated in the
11 youth sport setting, was related to engagement in MVPA and the time spent in sedentary
12 pursuits across multiple contexts. Past work has indicated MVPA accrued during youth sport
13 is not sufficient to meet recommended guidelines (Leek et al., 2011). As such, children and
14 adolescents need to engage in additional MVPA outside the youth sport environment to
15 achieve recommended levels. The presently observed trans-contextual associations may
16 therefore have implications for increasing daily MVPA towards levels identified as being
17 beneficial for health among sport participants. Our findings suggest that if the coach-created
18 climate is more autonomy supportive, and young football players are more autonomously
19 motivated, then they are more likely to exhibit higher levels of daily MVPA. These results
20 are in line with Vallerand's hierarchical model of motivation which suggests motivation
21 regulation for engagement in a particular behaviour (e.g., PA) can generalise across life
22 domains (e.g., sport, the home, school) (Vallerand, 1997). Whilst we did not measure
23 participants' motivation towards PA across other contexts in this study, other research has
24 demonstrated motivation towards PA (and subsequent PA engagement) to transfer across
25 contexts. For example, Standage et al., (2012) reported autonomous motivation towards PE to

1 be positively related to autonomous motivation towards exercise related PA, which in turn,
2 was positively associated with 4 day pedometer step count (i.e., total PA). Current and past
3 findings therefore indicate that autonomous motivation fostered by the social environment
4 created within different youth PA settings (e.g., PE and youth sport) is likely an important
5 determinant of PA engagement outside the immediate PA context. Future studies should seek
6 to determine whether motivation towards sport and physically active games predicts
7 autonomous motivation towards PA across other contexts.

8 We also observed autonomous motivation towards sport and physically active games
9 to exhibit a negative trans-contextual association with ST. The present findings serve an
10 important first step in determining how quality of motivation in one setting, may relate to
11 engagement in ST outside of this setting. As such, results highlight the potential of youth
12 sport as a domain through which levels of ST may be reduced among youth. That is, results
13 suggest that enhancing autonomous motivation towards sport and active games may offer an
14 avenue through which ST can be attenuated among youth sport participants. However,
15 important to note is that autonomous motivation accounted for 1.6% of the variance in ST.
16 Thus, it is likely that other psychosocial variables are influencing young footballers' time
17 spent in sedentary activities.

18 The finding that autonomous motivation was related to both MVPA and ST
19 (positively and negatively, respectively) also warrants further discussion. Specifically, results
20 may indicate that these two behaviours are somewhat related among the current sample of
21 youth sport footballers, and that higher levels of MVPA may correspond to lower levels of
22 ST in this group of children and adolescents. Indeed, research among youth has indicated
23 that where engagement in MVPA is increased, time spent sedentary is reduced (Epstein et al.,
24 2005; Loucaides et al., 2011). Whilst this opposes studies suggesting that these two
25 behaviours are independent (Biddle et al., 2009), the correlation between MVPA and ST

1 observed in the present research is higher than that reported in population based studies of
2 youth (Biddle et al., 2004; Ekelund et al., 2012). In addition, our findings indicated youth
3 sport participants spent approximately 72% of their day engaged in MVPA or ST. Thus, it
4 may be that when not engaged in sport and active games, youth sport participants are likely to
5 be engaged in ST. However, important to note is that the present correlation between MVPA
6 and ST ($r = -0.46$) indicates there is a substantial portion of the variance in ST that cannot be
7 explained by engagement in MVPA.

8 This study makes a further novel contribution to the literature, demonstrating the
9 presence of a significant indirect effect of perceptions of coach-provided autonomy support
10 on daily MVPA and ST via autonomous motivation. Results therefore support the basic tenets
11 of SDT, underlining the central role of autonomous motivation for encouraging adaptive
12 behavioural outcomes (i.e., PA engagement). Previous studies conducted in the PE setting
13 report contradictory findings to present results, revealing no significant indirect effect of
14 teacher-provided autonomy support on PA engagement via motivation regulations for PE or
15 leisure time (Standage et al., 2012; Vierling et al., 2007). Contrasting findings may result
16 from inconsistencies in terms of the variable used to represent differences in motivation
17 regulations. The present study focused specifically on autonomous motivation representing
18 intrinsic and identified regulations, whereas past research which examined indirect effects
19 have employed a relative autonomy/self-determination index (Hagger et al., 2009; Standage
20 et al., 2012). Thus, differing findings might indicate perceptions of autonomy support are
21 related to PA engagement via a positive association with autonomous motivation, rather than
22 a negative association with controlled motivation. Such detailed information is lost when a
23 self-determination index is employed.

24 The current study is also the first to investigate the motivational processes through
25 which perceptions of a controlling interpersonal style may be related to objectively assessed

1 MVPA and ST among youth. Past research conducted in youth sport and PE settings has
2 largely focused on investigating the role of perceptions of autonomy support as an antecedent
3 of motivation and related outcomes, neglecting to examine the possible deleterious
4 consequences of controlling behaviours (Bartholomew et al., 2011). Our findings revealed
5 perceptions of controlling coach behaviour to be positively related to controlled motivation,
6 but unrelated to autonomous motivation. Controlled motivation, in turn, was unrelated to
7 daily MVPA and ST. Results are in line with previous studies demonstrating perceptions of
8 controlling behaviours to be more strongly related to motivation regulations which fall lower
9 on the self-determination continuum (i.e., introjected or external motivation) (Deci & Ryan,
10 1987; Deci, Eghrari, Patrick, & Leone, 1994; Pelletier et al., 2001). Indeed, SDT posits that
11 perceptions of a controlling interpersonal style are related to less overall internalisation and
12 more controlled motivation (Ryan & Deci, 2000). However, in contrast to present findings, a
13 recent study demonstrated controlled motivation towards leisure time PA to be negatively
14 related to leisure time MVPA (Owen et al., 2013). Differing findings may be due to the fact
15 analysis was only conducted at the bivariate level in the previous study. Future studies should
16 aim to further investigate the potentially maladaptive consequences of controlling
17 interpersonal styles and controlled motivation in the context of PA engagement among youth
18 within and across PA-related settings. Further, in explicating the lack of significant
19 relationships between controlled motivation and daily MVPA and ST in the present study, the
20 cross-sectional design employed should be kept in mind. Longitudinal studies have
21 demonstrated controlled motivation to be related to dropout among sport participants (García
22 Calvo, Cervelló, Jiménez, Iglesias, & Moreno Murcia, 2010). Thus, in the long term,
23 controlled motivation may result in lower levels of MVPA (and perhaps increased ST) as a
24 result of discontinued sport engagement (Kjonnixsen, Anderssen, & Wold, 2009; Nelson et
25 al., 2011).

1 Whilst present results highlight the value of the youth sport setting as a context for PA
2 promotion, youth sport is only one setting in which children and adolescents have the
3 opportunity to be physically active during a typical week. Consequently, the psychosocial
4 factors operating in this environment are likely one of many influences on daily/weekly
5 levels of PA engagement and ST pursuits. In line with this, the theoretical model tested in the
6 present study accounted for only 3.3 % of the variance in daily MVPA, variance similar to
7 that reported by Sebire et al., 2013, who demonstrated intrinsic motivation to account for 4%
8 of the variance in daily MVPA among youth (Sebire et al., 2013). Such findings point
9 towards the importance of considering the broader context of youth PA, i.e., the many social,
10 psychological and physical-environmental factors (e.g., teachers, parents, peers, the built
11 environment) operating within various settings in which children have the opportunity to be
12 physically active (e.g., sport, PE, the school yard, the home, recreational environments).
13 Research exploring the salience of such factors across a variety of youth PA settings will help
14 to identify malleable targets for interventions aimed at increasing PA engagement in youth.
15 As such, a more comprehensive approach to PA promotion among youth is likely to be most
16 effective towards increasing daily MVPA and reducing ST towards levels identified as being
17 beneficial for health.

18 A notable strength of the current study is the use of accelerometers to measure PA.
19 Accelerometers provide a more accurate, objective assessment of PA over and above that of
20 self-report measures (Troost, 2007), and allow researchers to quantify intensity and frequency
21 of PA. Moreover, the analytical approach adopted enabled a model to be tested that adjusted
22 for significant associations between accelerometer wear time, age and MVPA and ST.
23 Previous studies that have not controlled for these relationships may have overestimated the
24 variance accounted for in PA behaviours by motivation (e.g., Standage et al., 2012). Thus,

1 present results may reflect a more accurate representation of the potential influence of quality
2 of motivation on engagement in PA relative to existing research.

3 Certain considerations should be made when interpreting current findings. Youth
4 sport football was the sport examined due to the potential for widespread application of
5 findings to large numbers of youth sport participants across the globe. However, caution
6 should be taken before generalising current findings to other sports. In addition, a lack of
7 access to and interest from female football teams regarding participation in the study resulted
8 in an exclusively male sample. Nevertheless, the basic tenets of SDT are not assumed to
9 differ as a function of gender, and previous research investigating the relationships between
10 perceptions of autonomy support, motivation regulations and PA measured by pedometers,
11 reported model fit was invariant across samples of male and female youth (Standage et al.,
12 2012). Future research should seek to replicate the present research via the inclusion of both
13 males and females from a variety of different sports. Further, the cross-sectional design of
14 this study limits inferences concerning the direction of causality. For example, it is possible
15 that a coach's interpersonal behaviour may be influenced by a player's motivation. Therefore,
16 it is important to replicate the present study employing a longitudinal design to explore the
17 targeted relationships over time. Finally, whilst this study makes an important contribution to
18 the literature regarding the role of motivation towards sport for reducing ST in leisure time,
19 findings do not allow speculations to be generated regarding how perceptions of the social
20 environment created in youth sport might be linked to time spent engaged in specific
21 sedentary pursuits (e.g., TV viewing, video games, and computer use). Future studies would
22 do well to employ a mixed methodology, combining self-report measured of sedentary
23 behaviour and accelerometer assessed ST in order to further understand the implications of
24 youth sport participation for children's engagement in sedentary behaviours (Sebire, Jago,
25 Gorely, Hoyos Cillero, & Biddle, 2011).

1 In conclusion, extending findings focused largely within the PE context, our results
2 suggest that more autonomy supportive environments within youth sport appear conducive to
3 higher levels of autonomous motivation towards sport and active games, and are associated
4 with more positive PA-related behaviours (i.e., higher engagement in MVPA and less ST per
5 day) in this sample of young male footballers. Thus, encouraging autonomy supportive
6 behaviours among youth sport coaches may hold implications for increasing daily MVPA
7 towards recommended guidelines and reducing daily ST in youth. Overall, this study points
8 to the promise of the youth sport setting as a context for PA promotion (and sedentary time
9 reduction) among children and adolescents.

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1 Table 1. Descriptive statistics

	Mean \pm SD (<i>N</i> = 105)	Range (min – max)
<i>Psychological Variables</i>		
Autonomy support	3.98 \pm 0.55	2.40 – 5.00
Controlling coach behaviour	2.19 \pm 0.64	1.00 – 4.18
Autonomous motivation	6.24 \pm 0.69	4.00 – 7.00
Controlled motivation	2.93 \pm 1.55	1.00 – 6.83
Intrinsic motivation	6.55 \pm 0.56	4.75 – 7.00
Identified regulation	5.75 \pm 0.97	2.75 – 7.00
Introjected regulation	2.85 \pm 1.50	1.00 – 6.65
External regulation	2.33 \pm 1.45	1.00 – 6.75
<i>Physical Characteristics</i>		
Age (years)	12.77 \pm 1.85	10 – 16
Height (m)	1.60 \pm 0.13	1.31 – 1.90
Weight (kg)	51.81 \pm 14.13	26.0 – 92.30
BMI (kg/m ²)	20.01 \pm 3.26	13.16 – 30.17
BMI-SDS	.55 \pm 1.05	-2.93 – 2.79
<i>Physical Activity</i>		
MVPA (min/day)	70.29 \pm 24.58	20.54 – 143.11
ST (min/day)	486.66 \pm 66.21	320.45 – 616.13
Valid-wear days	6.22 \pm 0.90	4.00 – 7.00
Valid-wear time (hours/day)	12.83 \pm 0.88	10.75 – 14.91

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1 Table 2. Pearson correlations between psychological and PA variables

	1	2	3	4	5
1. Autonomy support					
2. Controlling coach behaviour	-.32**				
3. Autonomous motivation	.58**	-.23*			
4. Controlled motivation	-.12	.42**	-.07		
5. MVPA	.14	-.11	.22*	.13	
6. ST	-.01	.04	-.09	-.07	-.46**

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3 Note: * = $p < .05$, ** = $p < .01$

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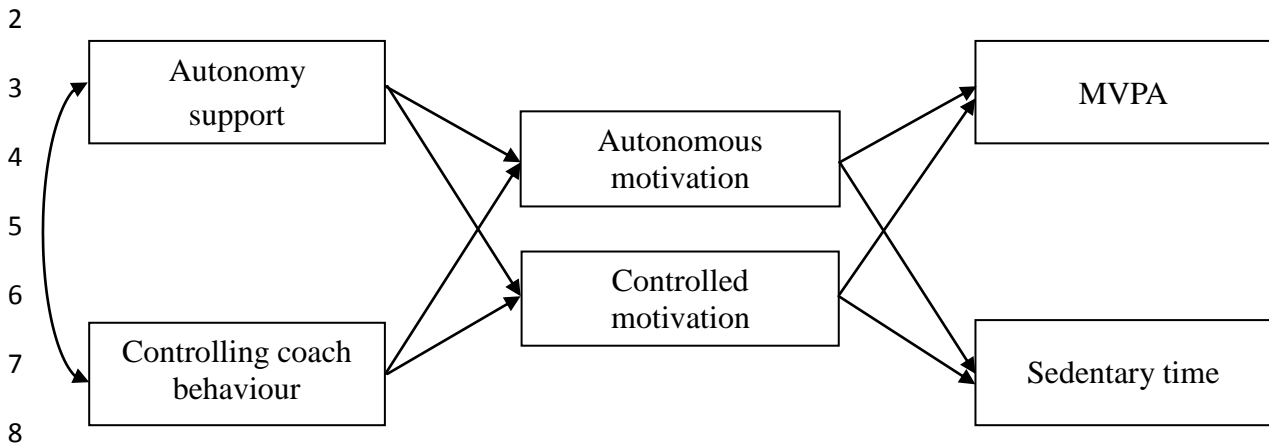
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1 Figure 1. The self-determination theory process model

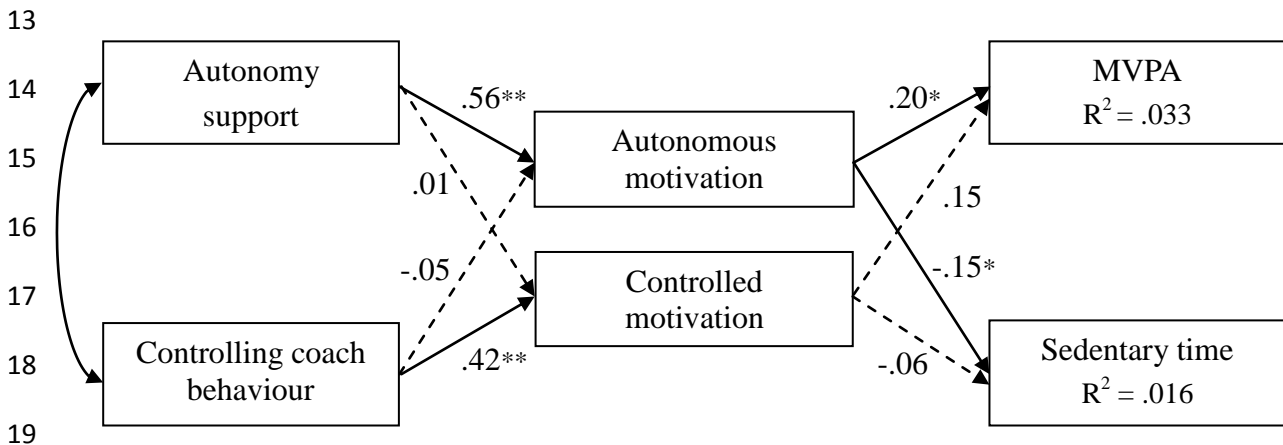


9 Note: Arrows indicate all paths tested

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12 Figure 2. Data fit to the hypothesised model



20 Note: ** $p < .01$, * $p < .05$. Dashed lines indicate a non-significant relationship ($p > .05$).

21 Age and valid wear time were also included as endogenous variables in the model. Previously
22 identified confounding relationships were controlled for by stipulating direct paths between
23 a) valid wear time and MVPA, b) valid wear time and ST c) age and ST, d) age and valid
24 wear time. These relationships are excluded from the figure to allow ease of interpretation

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