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ScienceDirect

Journal of Sport and Health Science 6 (2017) 423–433

www.jshs.org.cn

Original article

Empowering youth sport environments: Implications for daily moderate-to-vigorous physical activity and adiposity

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Received 18 June 2015; revised 24 October 2015; accepted 2 December 2015

Available online 31 March 2016

Abstract

Background: Evidence suggests involvement in youth sport does not guarantee daily guidelines for moderate-to-vigorous physical activity (MVPA) are met, and participation may not mitigate the risks associated with physical inactivity. The need to promote higher habitual MVPA engagement amongst children active in the youth sport context has therefore been underlined. Framed by self-determination theory, the aim of the present study was to examine the implications of the motivational climate created in youth sport, for children's daily engagement in MVPA and associated adiposity. Specifically, we sought to test a motivational sequence in which children's perceptions of an empowering coach-created motivational climate were related to autonomous and controlled motivation, which in turn predicted sport-related enjoyment. Finally, enjoyment was assumed to predict accelerometer assessed daily MVPA and, following this, adiposity.

Methods: Male and female youth sport participants aged 9–16 years ($n = 112$) completed multi-section questionnaires assessing their perceptions of the motivational climate created in youth sport (i.e., autonomy supportive, task involving, socially supportive), autonomous and controlled motivation, and sport-related enjoyment. Daily MVPA engagement was determined via 7 days of accelerometry. Percent body fat (BF%) was estimated using bio-electrical impedance analysis.

Results: Path analysis revealed perceptions of an empowering motivational climate positively predicted players' autonomous motivation, and in turn, sport-related enjoyment. Enjoyment was also significantly negatively related to players' BF%, via a positive association with daily MVPA.

Conclusion: Fostering more empowering youth sport environments may hold implications for the prevention of excess adiposity, through encouraging higher habitual MVPA engagement. Findings may inform the optimal design of youth sport settings for MVPA promotion, and contribute towards associated healthy weight maintenance amongst youth active in this context. Longitudinal and intervention studies are required to confirm these results.

Keywords: Accelerometry; Exercise psychology; Moderate-to-vigorous physical activity; Motivation; Obesity; Self-determination theory; Youth sport

1. Introduction

Evidence based guidelines indicate school-aged youth should engage in ≥60 min of moderate-to-vigorous physical activity (MVPA) per day.[1–4] Several government reports have underlined youth sport as a context through which children and adolescents may achieve these recommendations, advocating involvement in sport to encourage youth to lead more physically active lifestyles.[5,6] Accordingly, the role of youth sport for preventing overweight and obesity amongst children and adolescents has also been argued.[5] However, recent studies have revealed that, whilst sport involvement may indeed offer a number of children and adolescents the opportunity to engage in substantial amounts of MVPA, participation in youth sport does not necessarily guarantee daily MVPA recommendations are met.[7–9] Moreover, research has demonstrated that 1 in 4 youth sport participants are overweight or obese, with 48% of obese youth report participation in sport.[10–12] Such findings point to the need to promote MVPA engagement even in this group of children and adolescents (i.e., youth sport participants) whom are traditionally thought to be amongst the most healthy and active in the population.

In order to advance engagement in MVPA amongst children and adolescents active in the youth sport setting, we must first

Peer review under responsibility of Shanghai University of Sport.

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https://doi.org/10.1016/j.jshs.2016.03.006

2095-2546/

identify factors within this context that are related to habitual MVPA participation (i.e., daily MVPA). Self-determination theory (SDT)[13] and achievement goal theory (AGT)[14] are 2 contemporary theories of motivation successfully used to understand the correlates and determinants of behavioral outcomes (e.g., PA engagement) across diverse settings, including youth sport. Specifically, these theoretical frameworks have guided researchers in their attempts to understand the interaction between the PA environment and the motivational processes pertinent to PA engagement.

1.1. SDT

SDT considers the importance of variability in the reasons "why" individuals are motivated to engage in a particular behavior (e.g., sport, PA), and asserts that motivation can vary in the degree to which it is autonomous (i.e., more self-determined) or controlled (i.e., less self-determined),[13,15] each holding different implications for cognitive, affective, and behavioral outcomes. Autonomous motivation refers to participation in a behavior for feelings of enjoyment and personal satisfaction that arise from participation in that activity (e.g., "I engage in sport because it is fun") and/or engagement to accomplish personally valued goals and outcomes (e.g., "I engage in sport because it is important to me"). Controlled motivation is thought to operate when a person's behavior is governed by external rewards, threats or punishment (e.g., "I play sport because I feel pressure from other people to play"), internal pressures and/or to enhance feelings of pride, and self-esteem (e.g., "I participate in sport because I would feel guilty if I did not").[16] SDT posits that where behavior is guided by autonomous motivation, more adaptive outcomes will likely ensue. In contrast, where controlled motivation is thought to be operating, deleterious consequences are frequently observed.[13,17,18]

A central assumption of SDT is the notion that the social environment operating within a particular context is a prominent factor influencing motivational processes and related behavioral outcomes.[13] The social environment is also referred to as the "motivational climate", and is largely created by the interpersonal behaviors of significant others acting within contexts (e.g., teachers, coaches, parents, peers).[13,15] Within the context of youth sport, the interpersonal behaviors of the coach are a prominent factor influencing the social environment[19] (i.e., the coach-created motivational climate).

Studies conducted across youth PA settings have largely focused on the implications of an autonomy supportive climate for young people's motivation and associated emotional, cognitive and behavioral outcomes.[13,19–24] Autonomy support can be broadly conceptualised as providing a sense of choice and decision making, supporting self-initiative, considering individual perspectives, and providing a rationale to foster the consideration of personal relevance.[13] For example, an autonomy supportive youth sport coach would acknowledge athletes' feelings and preferences, explain the rationale behind decisions made during training sessions and matches, and welcome players' input into decision making.[19] More recently, SDT-informed studies have also begun to examine alternative features of the social environment in PA settings, including socially supportive interpersonal behaviors.[25] A socially supportive youth sport coach would ensure every athlete is cared for and feels valued both as a player and as a person.[19,25] SDT posits that where the motivational climate created by significant others supports an individual's sense of autonomy and provides social support, more autonomous and less controlled motivation will be resulted.[13] In turn, more positive outcomes will likely follow (e.g., reduced stress and enhanced well-being).[13,25] With regard to PA participation, research has reported perceptions of autonomy support and social support to hold positive implications for levels of PA engagement amongst youth.[20,26,27]

1.2. AGT

Whilst SDT considers a number of climate dimensions relevant to one's optimal functioning, alternative theories of motivation place emphasis on other aspects of the motivational climate not specifically considered within SDT. AGT[14] asserts 2 dimensions of the motivational climate to exist, centred on the degree to which motivational climates are task-involving (i.e., mastery focused) and ego-involving (i.e., centred on the demonstration of normative ability).[14,28] Task-involving climates are considered to be more adaptive in nature, and refer to environments in which hard work, learning, skill development, and co-operation are valued.[25] Whilst relatively fewer studies have adopted an AGT lens to examine the relevance of the motivational climate for PA participation, the available data indicate perceptions of a task-involving motivational climate within physical education (PE) to be positively related to PA intentions amongst youth.[24,25,29]

1.3. Integrating SDT and AGT

Studies examining the relevance of the motivational climate created within a particular context (e.g., sport), for cognitive, affective and behavioral outcomes, have more recently begun to consider the empirical links between the fundamental concepts described by SDT and AGT.[25,29–31] Specifically, this work has examined the value of simultaneously considering the climate dimensions offered by SDT and AGT, in order to understand the motivational processes underpinning optimal functioning within achievement related domains. The initiation of this theoretically integrated approach was primarily driven by research aiming to investigate the implications of both the SDT- and AGT-referenced features of the motivational climate for satisfaction of the "basic psychological needs",[15] and in turn, self-determined motivation.[30]

Basic needs theory is a sub-theory of SDT which postulates conditions that support and individual's experience of competence (i.e., feeling efficacious), autonomy (i.e., a sense that behavior is guided by personal choice and volition) and relatedness (i.e., feeling connected to others) foster more self-determined motivation. Indeed, empirical studies have consistently demonstrated the satisfaction of these 3 "basic needs" is positively associated with autonomous motivation, and subsequently, more adaptive outcomes (e.g., enhanced, enjoyment, well-being, and performance).[18,30,32] Importantly, investigations seeking to integrate SDT and AGT have revealed that when considered in parallel, perceptions of autonomy supportive, socially supportive, and task involving climate dimensions vary in their relationships with the satisfaction of the basic psychological needs.[25,31] Moreover, research demonstrates the climate dimensions proposed by SDT and AGT predict a unique amount of the variance in the basic psychological needs.[31] For example, Quested and Duda[31] reported that whilst dancers' perceptions of a task-involving climate positively predicted satisfaction of all 3 psychological needs, the strongest association was observed for competence need satisfaction. Similarly, the strength of the relationship between dancer's perceptions of an autonomy supportive climate and autonomy and relatedness need satisfaction, was stronger than observed for a task-involving climate and autonomy and relatedness needs. As such, findings suggest each climate dimension is likely to hold distinct implications for self-determined motivation within any given context. Consequently, a fuller understanding of the potential impact of the motivational climate for self-determined motivation should emerge when the environmental factors emphasised in AGT and SDT are considered together (rather than taken into account in isolation from one another).[30,31,33]

Recently, Duda[30] underlined the importance of jointly considering the dimensions of the motivational climate outlined by SDT and AGT, suggesting the motivational climate should be conceived as hierarchical and multidimensional in nature. Pulling from both theories of motivation, Duda[30] proposed the motivational climate could be more or less "empowering". Specifically, the lower order climate dimensions of autonomy support, social support, and task involvement are joined to represent a higher order "empowering" dimension. An empowering motivational climate would ensure that individuals feel cared for respected and connected to others, supports their sense of choice and personal volition, and encourages individuals to strive for, and achieve task-involved competence (e.g., emphasising goals such as increased effort and task mastery). Adopting this integrated conceptualisation of the motivational climate provides a useful framework through which the implications of the dimensions of the motivational climate proposed by SDT and AGT concurrently, with respect to the implications held for autonomous motivation, PA engagement, and other important outcomes could be examined.

1.4. SDT, AGT, and autonomous motivation for PA

Studies to date have neglected to examine the consequences of empowering motivational climates for autonomous motivation and in turn, PA participation amongst youth. However, a cogent body of work has demonstrated empirical support for the hypothesised sequential associations with regard to the lower order dimension of autonomy support. Specifically, autonomy support (provided by the teacher) is reported to be positively related to more autonomous motivation towards PA, and in turn, higher levels of self-reported and pedometer assessed daily and leisure time PA engagement amongst youth.[22] Such associations have been coined as "trans-contextual" or described as "cross domain", and highlight the adaptive motivational processes through which autonomous motivation fostered by the motivational climate in one context (e.g., PE) may influence levels of PA engagement outside of that setting (e.g., leisure time or daily/habitual PA).

SDT would postulate that the positive, trans-contextual association between autonomous motivation and PA engagement is likely to occur via enhanced enjoyment.[16,34] Past research consistently reports a positive association to exist between autonomous motivation within the PE setting and enjoyment of PA.[21,35,36] Moreover, enjoyment of PA (in general and during PE) is demonstrated to be a key determinant of levels of daily and leisure time PA engagement amongst youth,[21,37–39] with studies demonstrating autonomous motivation to be positively associated with PA engagement via the experience of enhanced enjoyment.[21] For example, Cox et al.[21] reported autonomous motivation in PE to be positively related to students' enjoyment of PE, which in turn was related to self-reported MVPA engagement during leisure time. Certainly, where an individual enjoys participating in PA within a particular setting, this is likely to encourage the transfer of this behavior beyond this environment. However, the role of enjoyment in the trans-contextual association between autonomous motivation and PA engagement has not been explored beyond the PE context. Studies are also yet to investigate these sequential associations to include a consideration of the motivational climate as an antecedent to autonomous motivation, enjoyment and ensuing PA participation. Indeed, extant studies have only investigated the implications of the motivational climate for autonomous motivation and subsequent enjoyment amongst youth, neglecting to examine successive associations with levels of PA participation.[18,21] Still, results from these studies have revealed the lower order climate dimensions of autonomy support and task involvement to be positively associated with PA related enjoyment, via promotion of more autonomous motivation.[18,40,41] Such findings further demonstrate the conceptual links between AGT and SDT with regard to the implications of the motivational climate for optimal functioning, and point to the value of integrating AGT and SDT when studying the motivational processes underpinning PA engagement amongst youth.

A further overarching drawback of research seeking to examine the motivational processes underlying levels PA engagement amongst youth is a reliance on pedometers and self-report methods to assess PA participation.[22] The bias introduced by self-report and the inability of pedometers to determine intensity and duration of PA engagement, mean the implications of the motivational climate and associated motivational processes for participation in health enhancing PA (i.e., MVPA) are not well identified. Moreover, studies to date have been unable to determine the degree to which variability in MVPA, attributable to the motivational climate created within a particular setting, may hold meaningful implications for important health outcomes (e.g., well-being, adiposity). Indeed, if youth PA settings are considered to be effective avenues for obesity prevention,[5] research is required which seeks to elucidate factors within targeted PA contexts that may encourage MVPA engagement towards levels that may hold benefit for adiposity. Thus, studies which investigate whether motivational climate dimensions and associated psychological processes posited to underlie optimal functioning, are linked to variability in MVPA, and in turn, adiposity are warranted (i.e., the motivational climate → autonomous/controlled motivation → enjoyment → MVPA → adiposity). Results from such studies will inform the optimal design of youth PA contexts for promoting MVPA to the extent it may contribute to the prevention of overweight and obesity amongst youth.

1.5. The present study

The primary aim of the present study was therefore to examine the implications of an empowering coach-created climate and ensuing motivational processes (i.e., autonomous and controlled motivation, enjoyment), for MVPA engagement and obesity related health, amongst males and females active in the youth sport context. Specifically, we sought to test the motivational sequence presented in Fig. 1, in which children's perceptions of an empowering coach-created motivational climate were related to autonomous and controlled motivation, which in turn predicts sport-related enjoyment. Finally, enjoyment is assumed to predict accelerometer assessed daily MVPA and adiposity. We hypothesised that a more empowering social environment would be related to higher levels of MVPA, which in turn, would be associated with lower levels of adiposity, via positive associations with autonomous motivation and enjoyment, and a negative association with controlled motivation (Fig. 1).

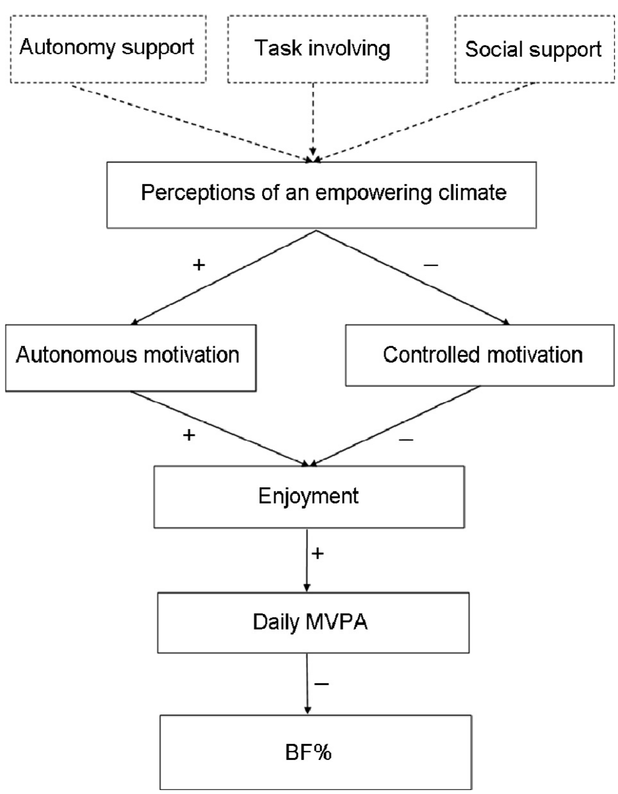

Fig. 1. The hierarchical and multidimensional conceptualisation of an empowering social environment: hypothesised associations with SDT referenced motivational processes, daily MVPA engagement, and adiposity status. Signs (+/−) indicate the direction of hypothesised associations. Lower order dimensions are modelled here for illustrative purposes. Only the higher order variable of perceptions of an empowering motivational climate was included in the hypothesised model. BF% = percent body fat; MVPA = moderate-to-vigorous physical activity; SDT = self-determination theory.

2. Methods

2.1. Recruitment

Male and female youth sport participants were recruited from football, netball, and hockey teams. Lead coaches ($n = 149$) at youth sport clubs were contacted by a member of the research team via phone call and/or email. Coaches interested in participating in the project ($n = 47/149$, 32%) were provided with study information which was passed on to parents and players. Following this, researchers visited training sessions in order to introduce the study, and willing participants and parents completed assent and consent forms, respectively.

2.2. Participants and protocol

Youth sport footballers were a subsample of English participants recruited to the Promoting Adolescent Physical Activity (PAPA) project (teams, $n = 38$; players, $n = 149$).[30] In addition to participating in the core PAPA protocol, these players also wore an accelerometer for 7 days and undertook measurements of body composition. Following completion of the PAPA project, additional female participants were recruited from netball and hockey teams in England (teams, $n = 9$; players, $n = 57$), in order to enable exploration of our primary research question as related to a more heterogeneous population of youth sport participants. All participants were aged between 9 and 16 years (age: 12.07 ± 2.58 years, mean ± SD) and were regularly participating (i.e., ≥1 session/week) in their respective sport at the grassroots level (i.e., players were not playing for/training with national, international, or professional teams).

Data collection was carried out at least 6 weeks into the season in order to allow time for the coach-created motivational climate to be established. Study procedures were conducted by trained researchers during 2 youth sport sessions, 1 week apart. During the first visit, accelerometers and wear time log sheets were distributed to participants, and measurements of height, weight, and body composition were recorded. The second visit involved participants completing multi-section questionnaires examining the targeted psychological variables, and collection of accelerometers and wear time logs. The study was approved by West Midlands National Health Service Research Ethics Committee (No. 10/H1207/39).

2.3. Objective measures

2.3.1. Anthropometrics

Height, weight, and body composition were measured at the start of training sessions where possible to reduce potential errors in measurement resulting from prior strenuous exercise, dehydration and over-drinking (i.e., to compensate for water lost during training sessions). Participants were barefoot and wearing light clothing (e.g., shorts and a T-shirt). Height was measured using a portable stadiometer (Leicester height measure; TANITA Europe, Amsterdam, The Netherlands) to the nearest 0.1 cm. Weight was assessed using bioelectrical impedance scales (Tanita SC330P; TANITA Europe) to the nearest 0.1 kg. Measurements were recorded in duplicate and average values calculated. Where the first 2 measures differed by more than 0.4 cm or 0.5 kg, a third measure was recorded and the average of the 2 closest values determined. Body composition was assessed using foot-to-foot bioelectrical impedance analysis (BIA) following entry of the participant's height and weight into the bioelectrical impedance scales. Percent body fat (BF%) was the outcome variable of interest in the present study. Body mass index (BMI, kg/m^2) was also calculated for descriptive purposes.

2.3.2. MVPA

MVPA was assessed using the ActiGraph GT3X accelerometer (ActiGraph, Pensacola, FL, USA). Accelerometers were initialised to measure PA in 15 s epochs. Verbal and written instructions were given by the researcher regarding how the accelerometer should be worn and a demonstration given. Participants were asked to wear accelerometer on the right hip for 7 days during all waking hours. Directions were given to remove the accelerometer only for showering/bathing or participation in water-based activities (e.g., swimming).

2.4. Social psychological measures

2.4.1. Perceptions of the coach-created motivational climate

Participants' perceptions of coach-created empowering youth sport environments were assessed using the Empowering and Disempowering Motivational Climate Questionnaire-Coach (EDMCQ-C).[33] The EDMCQ-C has been validated in the case of 2273 children and adolescents from sports teams in England and Wales.[33] Following the stem "So far this season. . .", players responded to 17 items assessing their perception of the coach-created motivational climate as autonomy supportive (5 items, e.g., "The coach encourages players to ask questions"), task involving (9 items, e.g., "My coach encourages players to try new skills"), and socially supportive (3 items, e.g., "My coach could really be counted on to care, no matter what happened"). Players responded to items on a 5-point scale (i.e., 1 = *strongly disagree*, 5 = *strongly agree*).

2.4.2. Motivation regulations

Autonomous and controlled motivation towards sport participation were measured using the Behavioural Regulation in Sport Questionnaire (BRSQ) adapted for use with each specific sport.[42] Eight items each were used to assess autonomous motivation (e.g., "Because it teaches me self-discipline") and controlled motivation (e.g., "Because I would feel guilty if I did not, because people push me to play"). Following the stem "I participate in football/netball/hockey. . ." players were asked to rate their agreement with items on a 5-point scale (i.e., 1 = *not true at all*, 5 = *very true*).

2.4.3. Enjoyment

The 4-item interest/enjoyment subscale of the Intrinsic Motivation Inventory (IMI)[43] was used to assess participants' sport related enjoyment. Players rated the degree to which they had enjoyed their sport participation in the last 3–4 weeks via their responses to 4 items (e.g., "I found this sport interesting") on a 5-point scale (i.e., 1 = *strongly disagree*, 5 = *strongly agree*). Both the BRSQ and the enjoyment/interest subscale of the IMI have been validated for use with samples of youth sport participants.[44]

2.5. Data processing

Data were downloaded from the GT3X to a computer and analysed using the ActiLife software (Version 6.2; ActiGraph). Accelerometer data were checked for spurious values and periods of non-wear (>30 min of consecutive zeros, allowing for 1 min of counts <100[45]). Participants were excluded from analysis where they failed to meet minimum wear criteria for valid PA data (i.e., wear time, ≥8 h on ≥4 days, including a weekend day, $n = 37$),[45] or were missing ≥2 item responses per questionnaire subscale ($n = 43$). Where participants were missing = 1 item score per subscale (i.e., missing data ≤ 3%), missing data were computed using the expectation maximisation method in SPSS (Version 21.0; IBM Corp., Armonk, NY, USA). Time restrictions placed upon researchers at training sessions resulted in exclusion of a further participants ($n = 14$) due to missing body composition assessments.

One-way analysis of variance (ANOVA) revealed excluded participants did not differ from those included in terms of age, height, weight, BMI, and BF% (all $p \geq 0.19$). χ^2 analysis demonstrated the males were more likely to be excluded from analysis on the basis of missing data than females ($\chi^2(1) = 11.85$, $p \geq 0.01$). Following data reduction procedures, the final sample consisted of 112 youth sport participants (male, $n = 70$; female, $n = 42$; protocol compliance = 54.37%; teams, $n = 47$). For these participants, mean scores for targeted social psychological measures were computed from questionnaire responses, and average daily MVPA (min/day at ≥2296 counts/min) calculated (total MVPA/number of valid days).[46]

2.6. Statistical analysis

Preliminary statistical analyses were conducted using SPSS (Version 21.0). Descriptive statistics were calculated and Pearson's correlations were computed to examine bivariate relationships between all measured variables. One-way ANOVA was conducted to determine significant differences between males and females for all variables included in the hypothesised model.

Path analysis with maximum likelihood estimation was employed in conjunction with the bootstrapping procedure to test the hypothesised model using AMOS (SPSS AMOS Version 21.0; IBM Corp.) (Fig. 1). Bootstrapping is a nonparametric resampling procedure that does not impose the assumption of normality of the sampling distribution and is appropriate for use with small sample sizes.[47] Bootstrap-generated 95% bias corrected confidence intervals (CIs) were constructed for 5000 samples on the hypothesised model.[47]

Model fit was evaluated using the χ^2 statistic, comparative fit index (*CFI*), incremental fit indices (*IFI*), standardised root mean square residual (*SRMR*), and root square mean error of approximation (*RMSEA*) in the present study.[48] The *CFI* was used to assess model fit in this study due to the sample size available for analyses. Specifically, the *CFI* displays restricted random variation under various sample size conditions, relative to other incremental fit indices.[49] A non-significant χ^2 ($p \le 0.05$), a *CFI* and *IFI*, >0.95 and >0.90 indicate good and adequate fit of the model to the data, respectively.[50–52] For the *RMSEA*, values below 0.05 would suggest a very good fit, and those below 0.10 would indicate a reasonable fit between model and data.[51,53] Examination of the *p* of close fit (PCLOSE) statistic in conjunction with the *RMSEA* and the 90%CI allows comparison of the null hypothesis with the alternative hypothesis. Where the PCLOSE statistics is >0.05, the null hypothesis cannot be rejected. Thus, the specified model is considered to have a close fit to the data.[51] In a well-fitting model, the lower value of the 90%CI for the *RMSEA* includes or is very near to 0, where the upper value is less than 0.08.[51] Where the value for *RMSEA* exceeds the lower bound of the 90%CI, the model is considered to have poor fit. A cutoff of <0.10 and <0.08 for the *SRMR* specify good and acceptable fit, respectively.[51,54] This combination of fit indices and cut-off criteria were used in the present study to provide a balanced approach to testing model fit. It is emphasised that the cut-off criteria selected should be considered as guidelines, rather than golden rules.[55] Accordingly, the strength and direction of path coefficients were also considered in assessing the validity of the models.[55] Path coefficients corresponding to (β) 0.1, 0.3, and 0.5 were interpreted as small, medium, and large effect sizes, respectively.

Squared multiple correlations (R^2) were interpreted to determine the variance in MVPA (min/day) and adiposity which could be explained by the hypothesised model.[56] The phantom model approach was used to examine the presence of specific indirect effects.[57] Specifically, the size of the effect of each variable included in the model, on daily MVPA and adiposity, via the downstream-hypothesised motivational processes (i.e., the indirect effects) were examined. The significance of indirect effects was determined via examination of the bootstrap bias-corrected 95%CI.

3. Results

Table 1 reports descriptive statistics for all participants stratified by sex. The final sample was 78% Caucasian (Asian = 8%, Black = 8%, multi-ethnicity = 3%, missing = 3%). Mean scale scores for psychosocial variables indicated that in general, participants perceived high levels of coach-created empowering climates. In addition, participants reported high levels of autonomous motivation and enjoyment, and moderate levels of controlled motivation. One-way ANOVAs revealed significant differences between males and females for perceptions of an empowering coach-created motivational climate, controlled motivation, and also for daily MVPA and BF% ($p < 0.05$). Specifically, males perceived the motivational climate to be less empowering ($F(1, 110) = 5.91$, $p < 0.05$), reported higher levels of controlled motivation ($F(1, 110) = 12.37$, $p < 0.01$), engaged in higher levels of MVPA ($F(1, 106) = 76.87$, $p < 0.01$), and had lower BF% ($F(1, 106) = 62.45$, $p < 0.01$), relative to females.

Table 1
Descriptive statistics for all participants stratified by sex (mean ± SD).

	Total ($n = 112$)	Male ($n = 70$)	Female ($n = 42$)
Physical characteristics			
Age (year)	12.07 ± 1.58	11.67 ± 1.52	12.74 ± 1.45
Height (m)	1.56 ± 0.12	1.54 ± 0.13	1.60 ± 0.08
Weight (kg)	47.53 ± 12.26	45.15 ± 13.00	51.49 ± 9.85
BMI (kg/m^2)	19.17 ± 2.93	18.73 ± 3.08	19.90 ± 2.54
BF%	17.72 ± 6.23	14.83 ± 4.71**	22.53 ± 5.43
Psychosocial variables			
Empowering climate	4.18 ± 0.46	4.10 ± 0.46*	4.31 ± 0.43
Autonomous motivation	4.39 ± 0.45	4.42 ± 0.45	4.33 ± 0.45
Controlled motivation	2.26 ± 0.89	2.53 ± 0.80**	1.80 ± 0.78
Enjoyment	4.55 ± 0.48	4.61 ± 0.46	4.44 ± 0.51
Physical activity			
Daily MVPA (min/day)	64.48 ± 22.19	75.45 ± 19.48**	46.19 ± 12.06
Valid day	6.19 ± 1.03	6.19 ± 1.07	6.19 ± 0.97
Valid hour (h/day)	12.95 ± 0.93	12.83 ± 0.76	13.13 ± 1.14

*$p < 0.05$, **$p < 0.01$, compared with female.
Abbreviations: BF% = percent body fat; BMI = body mass index; MVPA = moderate-to-vigorous physical activity.

3.1. Pearson correlations

Bivariate correlations are described in Table 2. Analyses demonstrated participants' perceptions of an empowering motivational climate to be significantly and positively associated with players' autonomous motivation and sport-related enjoyment. Conversely, athletes' perceptions of empowering climates were negatively related to their degree of controlled motivation. Autonomous motivation was also significantly and positively associated with sport-related enjoyment and daily MVPA. Controlled motivation was significantly positively correlated with daily MVPA, and significantly negatively related to BF%. Enjoyment demonstrated a significant and positive relationship with daily MVPA engagement. Finally, daily MVPA was significantly negatively associated with BF% and age, and age was significantly positively correlated with accelerometer wear time.

3.2. Path analyses

With specific reference to Fig. 2, the hypothesised model was first tested (i.e., model only adjusted for age, paths 1^a–1^g). Results revealed the hypothesised model demonstrated an adequate fit to the data ($\chi^2(14) = 26.16$, $p = 0.03$, $CFI = 0.92$, $IFI = 0.93$, $SRMR = 0.10$, $RMSEA \le 0.09$ (90%CI: 0.03–0.14, PCLOSE = 0.11) (Fig. 2). Perceptions of an empowering motivational climate were positively associated with players' autonomous motivation towards their sport participation, and negatively related to controlled motivation. In turn, autonomous motivation positively predicted sport-related enjoyment, which was positively associated with daily MVPA (min/day). Variability in participants' daily MVPA was also negatively associated with BF%. Controlled motivation towards sport was not associated with players' reported enjoyment of their sport involvement. Squared multiple correlations revealed the model (including adjustment for age) account for 26% of the variance in daily MVPA (motivational processes = 19.3%, age = 6.7%) and 27.6% of the variance in adiposity (motivational processes and daily MVPA = 24.7%, age = 2.9%).

A second exploratory model was tested in order to examine whether the sequential associations reported may vary as a result of gender differences revealed in the present sample. This

Table 2
Reliability analysis and bivariate correlations amongst variables included in the hypothesised model.

	Cronbach's α	1	2	3	4	5	6	7
1. Empowering climate	0.87	—						
2. Autonomous motivation	0.74	0.51**	—					
3. Controlled motivation	0.87	−0.32**	−0.18	—				
4. Enjoyment	0.80	0.36**	0.62**	−0.16	—			
5. MVPA		−0.09	0.19*	0.29**	0.30**	—		
6. BF%		0.09	−0.08	−0.23*	−0.15	−0.53**	—	
7. Age		−0.09	−0.07	−0.12	−0.16	−0.24**	0.17	—
8. Accelerometer wear time		0.10	0.03	−0.15	0.02	−0.15	−0.02	0.25**

*$p < 0.05$; **$p < 0.01$.
Abbreviations: BF% = percent body fat; MVPA = moderate-to-vigorous-physical activity.

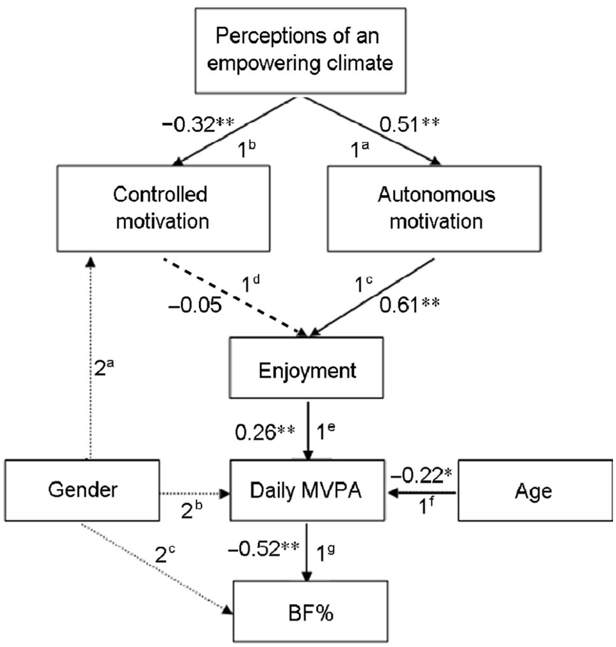

Fig. 2. Data fit to the hypothesised model. Results are reported for the hypothesised model adjusted for the significant associations between age and daily MVPA (1[a]–1[g]) as reported in previous youth sport research.[23] Values reported represent path coefficients (β). Yhe Dashed line indicates a non-significant relationship 1[d]). Dotted lines represent additional paths tested after adjustment for gender (2[a]–2[c]). *$p < 0.05$, **$p < 0.01$. BF% = percent body fat; MVPA = moderate-to-vigorous physical activity.

involved modelling gender as an observed variable, adding direct paths to all endogenous variables included in the model for which between-gender differences were revealed (i.e., controlled motivation, daily MVPA, and BF%, paths 2[a]–2[c], Fig. 2). As with logistical regression analysis, males and females were considered nominal data (i.e., 1 male, 2 females). Individual path coefficients were then re-examined to determine whether the inclusion of gender would significantly impact upon the relationships reported.

Results revealed that following adjustment for gender, all associations within the model remained significant and in the same direction. Significant negative associations were observed between gender and controlled motivation ($\beta = -0.37$, $p \leq 0.01$) and gender and daily MVPA ($\beta = -0.58$, $p \leq 0.01$). A significant positive association was demonstrated for gender and BF% ($\beta = 0.46$, $p \leq 0.01$). Examination of squared multiple correlations indicated that the fully adjusted model (adjusted for age and gender) accounted for 45.5% of the variance in daily MVPA, and 39.6% of the variance in adiposity. Age and gender together accounted for 41.3% of the variance in daily MVPA (age = 6.7%, gender = 34.6%), with the unique variance explained by the hypothesised motivational processes observed as 4.1%. For adiposity, age and gender accounted for 36.3% of the variance (age = 2.9%, gender = 33.4%), with psychosocial predictors and MVPA together explaining 3.4% of the variance in this outcome.

3.3. *Indirect effects*

The indirect effects and bootstrap bias-corrected 95%CI are reported in Table 3. Results are presented as per the model adjusted for both age and gender. This is to ensure that variability in daily MVPA and adiposity which may be attributable to these demographic factors is accounted for in the analyses. That is, this approach ensured the size of the associations with regard to the indirect effect(s) of the motivational climate, autonomous motivation, and enjoyment, on daily MVPA and adiposity, are not overestimated.

Table 3
Factor estimates of specific indirect effects following adjustment for gender.

Factor	β	Bootstrap bias-corrected 95%CI (lower, upper)
Empowering→enjoyment[b]	0.32[a]	0.19, 0.47
Empowering→MVPA[b]	3.11[a]	0.79, 6.30
Empowering→BF%[b]	−0.19[a]	−0.47, −0.05
Empowering→enjoyment[c]	0.01	−0.02, 0.05
Empowering→MVPA[c]	0.12	−0.15, 0.66
Empowering→BF%[c]	−0.01	−0.06, 0.01
Autonomous motivation→MVPA	6.23[a]	1.49, 11.69
Autonomous motivation→BF%	−0.49[a]	−0.91, −0.08
Controlled motivation→MVPA	−0.28	−1.31, 0.42
Controlled motivation→BF%	0.02	−0.02, 0.10
Enjoyment→BF%	−0.59[a]	−1.35, −0.12

Notes: The phantom model approach does not allow for estimation of standardised effects. Results are therefore presented in their unstandardised form.
[a] Significance indicated via 95%CI.
[b] Tested via autonomous motivation.
[c] Tested via controlled motivation.
Abbreviations: BF% = percent body fat; CI = confidence interval; MVPA = moderate-to-vigorous physical activity.

Results demonstrated perceptions of an empowering motivational climate to have a significant positive indirect effect on enjoyment, via autonomous motivation. A significant positive effect for perceptions of an empowering climate on daily MVPA, via autonomous motivation and enjoyment, was also observed. Perceptions of an empowering climate were also significantly and negatively related to BF%, via autonomous motivation, enjoyment, and daily MVPA. Analyses also revealed a significant positive indirect effect for autonomous motivation on daily MVPA via enjoyment, which then corresponded to a significant negative indirect effect on BF%. Finally, results revealed enjoyment to have a significant and negative indirect effect on BF% via daily MVPA. No significant indirect effects were observed for controlled motivation (Table 3).

4. Discussion

Framed by Duda's[30] integrated approach to examining the motivational climate, the present study examined the motivational processes undergirding the association between perceptions of an empowering coach-created motivational climate and daily MVPA amongst male and female youth sport participants. Moreover, the current research aimed to examine the extent to which motivation (i.e., their level of autonomous and controlled motivation) and related enjoyment, were associated with adiposity status amongst this cohort. Results supported the theoretical propositions,[13,14,30] and revealed perceptions of an empowering motivational climate to be positively related to autonomous motivation, and in turn, participants' sport related enjoyment. Findings also revealed enjoyment to have a negative indirect effect on players' adiposity via the successive positive association with daily MVPA, which was also apparent after adjusting for gender related variability in MVPA and adiposity.

Current public health recommendations suggest participation in youth sport represents an avenue through which the escalating obesity epidemic may be addressed.[5] However, with recent studies indicating that participation in youth sport is unlikely to guarantee MVPA guidelines are met,[7,8] efforts to promote PA amongst children and adolescents active in this context are warranted. That is, if youth sport is considered to be a prominent setting for obesity prevention, it is not enough to assume participation alone will provide youth with sufficient MVPA to accrue benefits to health. Rather, there is a necessity to identify avenues through which this context can be further optimised for PA promotion towards levels likely to hold benefit for health. The present findings point to the relevance of the coach-created motivational climate in this regard, suggesting the creation of more empowering youth sport environments may hold implications for advancing habitual levels of MVPA engagement, and in turn, may be associated with the prevention of excess adiposity amongst children and adolescents active in this context. Namely, the extent to which the motivational climate is perceived as empowering may result in varied levels of engagement in MVPA and associated health consequences (e.g., adiposity) for those youth who participate.

Results of the current study are in line with those of past research documenting the trans-context associations between autonomous motivation fostered in the PE setting and engagement in leisure time MVPA.[23,58] Moreover, results support those of recent work demonstrating facets of an empowering motivational climate in the youth sport setting to be related to daily engagement in MVPA via autonomous motivation in sport.[23] Fenton et al.[23] revealed perceptions of an autonomy supportive coach-created motivational climate (which is one key facet of an empowering climate) to be positively related to autonomous motivation, and in turn, daily MVPA amongst youth sport footballers aged 9–16 years. The adoption of Duda's[30] hierarchical and multidimensional approach in the current study builds upon the findings of Fenton et al.[23] Specifically, demonstrating that perceptions of an empowering motivational climate (encompassing autonomy support, social support, and task involving dimensions) is relevant for levels of daily MVPA engagement amongst youth sport participants. Present results inform us that where youth sport coaches create an environment which champions effort and personal improvement, provides players with choices and options, and makes all players feel valued as individuals, more autonomous motivation may likely ensue. In turn, when one's sport participation is guided by the experience of fun, pleasure, and personal importance, athletes are more likely to enjoy their sport involvement and subsequently, demonstrate higher habitual MVPA engagement.

Adding a further novel contribution to the literature, our results demonstrate autonomous motivation is positively related to accelerometer assessed daily MVPA amongst youth, via a positive association with sport-related enjoyment. Importantly, this relationship was observed independent of players' experience of controlled motivation. Findings therefore suggest that emphasising autonomous motives for participation in sport are likely central to facilitating adaptive motivational processes (i.e., the experience of enjoyment) and related engagement in health enhancing PA. Moreover, the sequential associations observed between autonomous motivation, enjoyment, daily MVPA, and adiposity, were still present following adjustment for gender related differences in the targeted variables. As such, results further highlight the adaptive features of the motivational climate and associated motivational processes to be particularly salient when considering factors pertinent to PA engagement and associated health amongst both males and females active in the youth sport setting. Indeed, present results are consistent with past SDT and AGT grounded work, whereby perceptions of autonomy supportive and task involving motivational climates are linked to the experience of enjoyment in PA and sport contexts, via the promotion of more autonomous motivation.[18,40,41]

The lack of an association between controlled motivation and daily MVPA at the multivariate level (i.e., via enjoyment) is in line with findings from previous studies that have examined this relationship amongst children and adolescents.[23,58] Coupled with present findings, results suggest that there may be no immediate consequences of sport-related controlled motivation for a child's daily MVPA engagement. However, the longer term implications of this motivation regulation for MVPA behavior and associated health, are yet to be explored. Indeed, longitudinal studies have reported controlled motivation to be positively related to drop out amongst sport participants.[59] Given that maintained participation in youth sport during childhood is associated with higher levels of PA engagement and reduced risk of poor health during adulthood,[60,61] minimising controlled motives for participation in youth sport may therefore still be of paramount importance when considering PA and health trajectories throughout the life course. Importantly, the higher levels of controlled motivation amongst boys in the present study suggest this may be particularly relevant to male youth.

To our knowledge, the present study is the first to examine the extent to which variability in accelerometer assessed daily MVPA predicted by the SDT-referenced motivational processes operating within the youth sport setting, is associated with objectively assessed body composition (i.e., adiposity) amongst youth. Results demonstrated perceptions of an empowering social environment, autonomous motivation and enjoyment accounted for 4.1% of the variance in daily MVPA. In turn, these factors negatively predicted BF%. Translating this into quantifiable health benefit, results demonstrated that an increase in self-reported enjoyment of sport by one on the intrinsic motivation inventory (e.g., a participant changing their response to statements ("I had fun whilst playing football. . ."), from "*agree*" to "*strongly agree*", or from "*disagree*" to "*neutral*") would equate to approximately 12 min more MVPA per day. Analysis of indirect effects indicated that in turn, this degree of variability would correspond to 1.2% lower body fat amongst males and females in the present sample. This negative association is promising when we consider that youth PA interventions to date have largely reported limited success with regard to reducing overweight and obesity amongst youth.[62] Indeed, current findings demonstrate that a child's sport related enjoyment (fostered by perceptions of an empowering motivational climate), may be an important psychosocial factor influencing variability in engagement in MVPA to the extent that it may contribute towards the prevention of excess adiposity and maintenance of a healthy weight amongst youth. Still, it is important to note that the hypothesised model examined currently only accounted for 3.4% of the variance in adiposity (after adjustment for age and gender). Thus, adopting a more comprehensive approach towards identifying and targeting other modifiable contributors towards engagement in PA, both at the individual and policy level, is paramount. That is, whilst this is the first study to underscore the significance of the motivational climate for MVPA and associated adiposity amongst youth, it is important to acknowledge that the social environment created by the coach is only 1 factor to consider when developing strategies to promote healthful levels of MVPA engagement in children and adolescents.

The present research addressed a number of limitations to previous work, namely, the application of accelerometers and bioelectrical impedance to assess MVPA and body composition within the context of SDT. This multidisciplinary study therefore enabled investigation of the relevance of empowering motivational climates for MVPA and obesity related health amongst youth sport participants. Moreover, past work examining the bivariate associations between daily MVPA and adiposity in youth sport participants has relied on using BMI as a proxy for weight status.[10,23,63] Research has questioned the value of using BMI to assess adiposity amongst this cohort, due to its inability to distinguish between muscle and fat.[10] Thus, the use of bioelectrical impendence to estimate adiposity in the present research may constitute a more valid exploration of the direction and strength of the association between MVPA and weight status in youth sport participants.

Whilst this study has number of noteworthy strengths, it is not without its limitations. First, the cross-sectional nature of the research means that we cannot infer the causal direction of the reported associations. Still, there is a cogent body of SDT driven work which supports the direction of the relationships as explored presently. For example, experimental studies have shown that the creation of more autonomy supportive social environments and enhanced autonomous motivation are related to higher levels of MVPA during PE.[64] A further limitation to the current work is homogeneity of the sample with regard to the sport examined, particularly for males. Findings can therefore not be generalised across the broad spectrum of children who participate in grassroots sport. The study methodology also precludes examination of other pertinent factors which may have impacted upon the targeted motivational processes examined, and in turn, levels of MVPA engagement. For example, the peer-created motivational climate created within youth sport has been reported to hold implications for levels of autonomous motivation amongst sport participants.[65] Similarly, biological and environmental variables likely to impact directly upon MVPA engagement and adiposity (e.g., fitness, dietary behaviors) could not be adjusted for in analyses. The ability to adequately control for all factors likely to affect primary outcomes is an inherent difficulty associated with field-based research. Still, the results of the present study serve to act as a useful starting point towards which to focus subsequent work seeking to determine the salience of the motivational climate for levels of MVPA engagement and associated health amongst youth.

Finally, whilst it would have also been of interest to conduct invariance testing to examine the tenability of the motivational processes across genders, the final sample size prohibited such analyses. In addition, we were unable to conduct a full measurement model to account for measurement error with regard to the psychosocial variables examined. However, the measures utilised presently have been validated for use amongst youth sport participants.[33,44] We also acknowledge that sample size restrictions did not enable investigation of role of the basic psychological needs with respect to the motivational processes examined. Still, evidence of the relationships between the climate dimensions proposed by SDT and AGT, basic psychological need satisfaction, and subsequently, autonomous motivation is reported consistently within the literature.

A reduced sample size may also hold implications for model fit as reported herein. Specifically, data fit to the hypothesised model may have been improved slightly with a larger sample size. For example, it is well regarded that a smaller sample size may result in an inflated *RMSEA* value due to increased probability of sampling error.[66] As a result, the *RMSEA* is reported to over-reject true-population models at small sample sizes.[48,66] We also point out that the whilst the model fit criteria applied in this study is consistent with that used across the literature, emphasis has been placed on the need for researchers to employ their own subjective interpretations in conjunction with statistical measures when reaching decisions regarding model fit. That is, whilst recommended cut-offs offer a useful guideline, they do not necessarily reflect the plausibility of a model and should be interpreted with caution, rather than being considered as "golden rules".[50,55,66]

5. Conclusion

The conceptualisation of the motivational climate as hierarchical and multidimensional, with the inclusion of both SDT and AGT proffered autonomy supportive, socially supportive and task involving aspects of coach behavior (in this case, empowering[30]), may offer a useful approach towards examining the implications of motivational climate for PA engagement amongst youth. Current findings are the first to elucidate the implications of an empowering coach-created motivational climate for daily MVPA engagement and associated adiposity amongst males and females active in the youth sport context. Results indicate that the creation of more empowering youth sport environments and associated adaptive motivational processes, may hold value for advancing habitual levels of engagement in MVPA, and may also be relevant towards preventing excess adiposity amongst children and adolescents active in this setting. Findings may contribute towards informing the optimal design of youth sport settings for MVPA promotion and associated healthy weight maintenance amongst children and adolescents active in this context.

Acknowledgments

The authors would like to thank all of the coaches and players who gave their time to participate in this study. In addition, the authors would like to thank the members of the PAPA team who contributed to the conception and design of the PAPA protocol. This work was supported by the European Commission under the Seventh Framework Programme—Health (No. 223600) as part of the PAPA project (www.projectpapa.org). The work of Sally Fenton was supported by the Centre for Obesity Research (COR) at the University of Birmingham.

Authors' contributions

JLD is the principle investigator on the RCT referred to in the manuscript (the PAPA study) and revised the manuscript; SAMF led the structuring and writing of the manuscript and organised the data collection; PRA and TGB were involved in the design of the study and manuscript revision throughout the writing process. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

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