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Psychological Need Satisfaction, Motivational regulation, and Leisure-time Physical Activity of Chinese College Athletes: Comparison Across Gender and Competition Level

Yan Liang [1, 2], Tongtong Guo [3] and Jian Yang [4]

[1] Sino-French Joint Research Center of Sport Science, College of Physical Education and Health, East China Normal University, Shanghai 200241, China; njnu219@163.com

[2] University Rennes 2, Rennes, Bretagne, France; yan.liang@etudiant.univ-rennes2.fr

[3] College of Physical Education and Health, East China Normal University, Shanghai, China; guotongtong2023@163.com;

[4] College of Physical Education and Health, East China Normal University, Shanghai, China; yangjianxz@sina.com

Abstract

Based on the self-determination theory process model, we explored the cor-relations between the latent constructs of psychological need satisfaction, motivational regulation, and leisure-time physical activity. College athletes (n=300) between 18 and 25 years of age completed a test battery on motivational aspects based on self-determination theory. Basic Psychological Need in Exercise Scale and Behavior Regulation in Exercise Questionnaire 2 were used to measure psychological need satisfaction and motivational regulation in exercise context. International Physical Activity Questionnaire was used to measured leisure-time physical activity in different intensity. Results show that autonomous motivation and identified regulation are mediators in the association between psychological need satisfaction

and leisure-time physical activity. Gender and competition levels moderated several of the paths in the model linking psychological need satisfaction with motivational regulation and lei-sure-time physical activity. Research results support the theoretical hypothesis of SDT in physical activity context, as well as demonstrating gender and competition level differences in the proposed sequential mechanisms. This study highlighted the potential value of considering moderating factors and the need to further examine the underlying mechanisms between psychological need, motivational regulation, and lei-sure-time physical activity.

Keywords: Psychological need; motivational regulation; leisure-time physical activity; college athlete; gender; competition level

1 Introduction

Regular physical activity (PA) promotes both mental and physical health (Physical Activity Guidelines Advisory Committee, 2008; WHO, 2022) and is beneficial for people of all ages and abilities (WHO, 2022). Theories of behavior change in physical activity help to explain and understand physical activity and provide an organizational framework for effective intervention. The paucity of studies explaining the underlying processes of theoretically derived hypotheses may account for intervention failures (Baranowski et al., 1998; Taylor et al., 2012).

Thus, a large number of behavioral theories have been used to comprehend the complex theoretical constructs and obtain the expected theory-based intervention effect (Rhodes & Nigg, 2011; Rhodes, McEwan & Rebar, 2019). Self-determined theory (SDT) was widely applied to the study of motivation, through a comprehensive and systematic program of inductive research focused on specific motivational phenomena. It also provided a framework to design and implement intervention programs using motivation in the context of exercise (Standage & Ryan, 2020; Bhavsar et al., 2020).

One of the central notions in SDT is organismic integration theory (OIT), which is concerned with the internalization process of motivational regulations. The theory posits that individuals have the propensity to assimilate external motives into their self-concept through the process of internalization (Ryan & Deci, 2000). From a low to a high degree of self-motivation, motivations, extrinsic motivation, and intrinsic motivation represent the full motivational

spectrum. At one end of the continuum, amotivation represents a complete lack of intention to engage in an activity. At the other end of the continuum lies intrinsic motivation, the most self-determined form of motivation.

A total of four external motivations are situated between amotivation and intrinsic regulation. The least autonomous type is external regulation and includes motives that are controlled by external contingencies, including attaining competition rewards or avoiding punishment. Introjected regulation lies next on the continuum and reflects motives driven by self-administered contingencies such as contingent self-esteem and guilt or shame avoidance. Next on the continuum is identified regulation, which reflects behaviors resulting from consciously valuing the activity and its benefits, including the motivation to remain healthy and keep maintain a slim body. Lastly, the most self-determined form of extrinsic motivation is integrated regulation, in which a behavior is well internalized and assimilated into one's core values and structure of the self (Bhavsar et al., 2020).

The internalization process is described as the process of taking values or beliefs from external sources (controlled motivation) and converting them into one's own values or beliefs (autonomous motivation) (Bhavsar et al., 2020). For example, through the process of internalization, the behavior may be performed later for external reward and become part of integrated regulation.

A primary distinction is made between autonomous (identified regulation, integrated regulation, and intrinsic regulation) versus controlled motivation (introjected regulation and external regulation). A central proposition within SDT, both in individual regulations and composite regulation, autonomous types of motivations lead to beneficial results (Standage & Ryan, 2020). In exercise contexts, numerous researchers have examined the associations between motivational regulations and a variety of outcomes (Rhodes, McEwan & Rebar, 2018; Rhodes & Nigg, 2011; Teixeira, Carraça & Markland, 2012). In general, more autonomous regulation styles are associated with more positive outcomes, including self-reported and objective exercise behavior (Gillison, Standage & Skevington, 2006; Standage, Sebire & Loney, 2008; Standage & Ryan, 2012). Contrastingly, controlled regulation styles have been associated with maladaptive outcomes, such as burnout (Jowett et al., 2013), mental health problems (Thøgersen-Ntoumani & Ntoumanis, 2006), and well-being (Standage et al., 2012).

The basic need theory, another sub-theory of SDT, proposes that people have three universal necessities for wellness, growth, and healthy functioning, namely the psychological need for autonomy, competence, and relatedness (Vallerand, 2000). Autonomy activities are those that

are self-endorsed and reflect authentic values and interests. Competence is the need to feel effective and capable of task mastery and refers to the need to interact effectively with the environment. Relatedness is to be accepted by others, care for others, and to feel close, connected and cared for by important others (Ryan & Deci, 2017). According to the SDT, when these psychological need are satisfied, people experience more integrated and autonomous forms of motivation, greater effective functioning, and increased well-being (Deci & Vansteenkiste, 2004). Moreover, the satisfaction of three need promotes self-determined motivation and indirectly influences behavioral outcomes through the mediation effect of motivational regulation (Edmunds, Ntoumanis & Duda, 2006; Russell & Bray, 2009; Vlachopoulos, Ntoumanis & Smith, 2010; White et al., 2018). To be specific, psychological need satisfaction indirect promote physical activity through the mediating effect of autonomous motivation and autonomous types of regulation. Conversely, psychological need satisfaction might impair physical activity through controlled motivation and controlled types of regulation.

Although the relationship is supported by a considerable amount of research, the association between need satisfaction and mediation correlation concerning behavioral outcomes such as PA is still inconsistent to some degree. Some research studies reported autonomous regulation styles (relative to controlled motivation styles) that are positively associated with self-reported and objective exercise behavior (Gillison, Standage & Skevington, 2006; Standage, Sebire & Loney, 2008; Standage & Ryan, 2012), whereas controlled regulation styles are associated with maladaptive outcomes, such as physical inactivity (Jowett et al., 2013; Thøgersen-Ntoumani & Ntoumanis, 2006; Standage, Gillison & Ntoumanis, 2012).

Other studies have found that self-determined motivation seems to be unrelated to these behaviors (Mouratidis et al., 2020; Weman Josefsson, Lindwall & Andreas, 2015). One reason for the inconsistent results could be the influence of moderating factors such as gender (Weman Josefsson, Johnson & Lindwall, 2018), age (Frederick-Recascino & Schuster-Smith, 2003), school level (Wang & Chen, 2021), as well as other demonstrate variables on the associations between psychological need, motivation and behavior.

Due to the inconsistent results and insufficient evidence for moderating variables in the SDT process, researchers continue to call for sophisticated analyses to clarify the role of need satisfaction in the development of self-determined motivation (Frederick-Recascino & Schuster-Smith, 2003). For instance, comparative studies have found obvious gender differences (Chen et al, 2020; Guérin et al, 2012), where males reported higher satisfaction

need and autonomous regulation, as well as a stronger association between related pathways. However, research on the differences in specific pathways for gender-specific athletes is scarce and further research is needed. Moreover, to date, few studies have explored the moderating effect of competition-level sports concerning SDT and leisure-time PA. Especially, as sports motivation is a dynamic system in athletes' professional lifespan, athletes can endorse various degrees of need and motivation during their careers. The completion-level could influence the underlying mechanisms on SDT process and the physical activity participation. Distinguish the differences in the pathways between psychological need, motivation, and physical activity can help create targeted intervention programs for college athletes.

As a special group, Chinese university athletes need to balance their academic studies with sports training, as well as adhere to sports training in order to improve sports performance in sports competition. Researchers have explored psychological need that are negatively associated with burnout symptoms, disaffection, and negative affect in athletes (Keshtidar & Behzadnia, 2017; Calvo et al., 2010; Lonsdale, Hodge

& Rose, 2009). However, fewer studies have focused on the association between psychological need satisfaction, motivational regulation and leisure-time PA in college athletes. Exploring the association between the SDT process and leisure-time PA can help to understand the underlying psychological process in leisure-time PA participation, and creates targeted intervention programs for college athletes in the self-determined context.

In this study, we focused on the key pathways of SDT in the leisure-time physical activity in college athletes. We tested the mediating effects of motivational regulation on the correlation between psychological need satisfaction and college athletes' physical activity in leisure time, as well as gender and competition level differences in the aforementioned associations. We hypothesis that psychological need satisfaction positively and indirectly predicts leisure-time PA through the mediation on autonomous motivation and separate autonomous types of regulation (identified regulation, integrated regulation, intrinsic regulation). Reversely, psychological need satisfaction negatively and indirectly predicts leisure-time PA through the mediation on controlled motivation and separate controlled types of regulation (external regulation and introjected regulation).

The hypotheses to be tested in this study are as follows:

H1: Psychological need satisfaction positively influences autonomous motivation and further

promotes leisure-time physical activity.

H2: Psychological need satisfaction negatively influences controlled motivation and further impacts leisure time and physical activity.

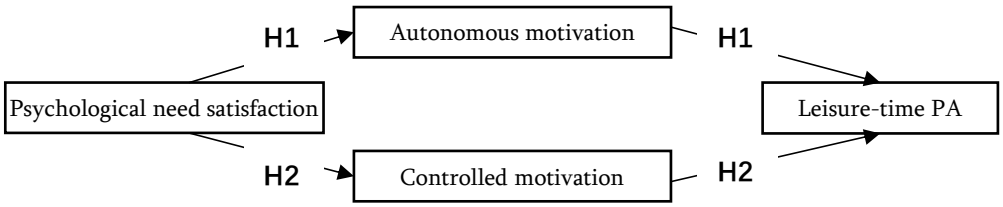

Figure 1. Mediation model of autonomous and controlled motivation between total need satisfaction and leisure-time physical activity (Hypothesis model 1)

H3: Psychological need satisfaction negatively influences amotivation and further impacts leisure-time physical activity.

H4: Psychological need satisfaction negatively influences external regulation and further impacts leisure-time physical activity.

H5: Psychological need satisfaction negatively influences introjected regulation and further impacts leisure-time physical activity.

H6: Psychological need satisfaction positively influences identified regulation and further promotes leisure-time physical activity.

H7: Psychological need satisfaction positively influences intrinsic regulation and further promotes leisure-time physical activity.

H8: Psychological need satisfaction positively influences integrated regulation and further promotes leisure-time physical activity.

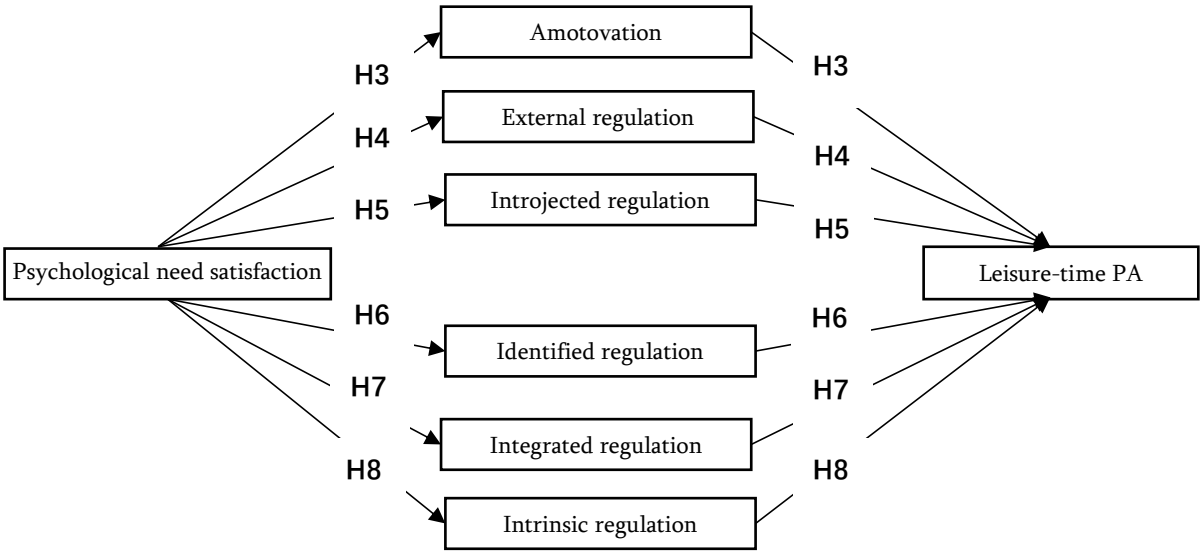

Figure 2. Mediation model of separate behavioral regulation between total need satisfaction and leisure-time physical activity (Hypothesis model 2)

2 Methodology

2.1 Participants

Participants were college athletes voluntarily recruited from two universities located in south-eastern China. The sample consisted of a total of 321 participants of which 21 participants were excluded as per the following exclusion criteria: (1) more than 50% consistent answers in the psychological variables; (2) the questionnaire was not completed totally. The final sample consisted of 300 participants—88 female participants and 202 male participants. Of these, 92 participants had a professional athlete status (69.3%), and 208 participants did not have a professional athlete status (30.7%). Participants' ages ranged from 18 to 25 (Mage=20.45, SDage=1.097), and the body mass index (BMI) ranged from 17.21 to 35.62 (MBMI=20.45, SDBMI=1.097).

2.2 Study design and procedure

The cross-sectional study was conducted from April to May 2022. The Committee on Human Research Project of East China Normal University approved the study. All the participants were recruited by coaches during recess at the two universities (sport science college) in China. Consent was required before the formal questionnaires were administered. The formal questionnaire comprised three independent parts—psychological need satisfaction, motivational regulation, and leisure-time PA, as well as demographic factors—gender, age, grade, BMI, and competition level. Before participants answered the questionnaire, the

purpose and the approximate completion time for the questionnaire were explained to participants. Participants completed the questionnaire in groups of 20 in a quiet classroom.

2.3 Methods

2.3.1 International Physical Activity Questionnaire-Long Version (IPAQ-L)

The International Physical Activity Questionnaire-long version (IPAQ-L) was used to investigate physical activity (Craig et al., 2003). The original IPAQ-L comprises five different domains of physical activity, including job-related physical activity, transportation physical activity, housework and caring for family and recreation, and leisure-time physical activity. In this study, we used the leisure-time domain to measure leisure-time physical activity.

A total of seven questions in the leisure-time domain measured three different intensities of PA—light PA, moderate PA, and vigorous PA. For example, the question "Think only of physical activities that you did for at least 10 minutes to follow. In the past seven days, how many days did you do vigorous physical activities in your free time?" was used to measure vigorous PA. For each intensity of physical activity, the frequency and time of leisure-time PA were recorded to calculate the exact energy expenditure. Each intensity of PA was attached according to metabolic equivalent (MET) as follows: walk (3.3 MET); moderate PA (4.0 MET); vigorous physical activity (8.0 MET). The formulation of physical activity level in each domain = MET * frequency * time (IPAQ group, 2005). The total leisure-time physical activity was the summary of three different intensities of PA.

2.3.2 Basic Psychological Need in Sports (BPNES)

The Basic Psychological Need in Sports Scale (BPNES) was used to assess autonomy, competence, and relatedness (Liu, Chung & Duan, 2013). The scale consists of 12 items which were rated on a 5-point Likert scale ranging from "totally disagree (1)" to "very strongly agree" (5). In the present study, the internal consistency of the given subscale was as follows: autonomy (α=0.885), competence (α=0.861), and relatedness (α=0.848). The construct validity was as follows: $\chi 2/df$ =2.885, CFI=0.951, RMSEA=0.079. The results indicated that the internal consistency and structural validity of BPNES were acceptable in the present study.

2.3.3 Behavioral Regulation in Exercise Questionnaire 2 (BREQ-2)

The Behavioral Regulation Exercise Questionnaire 2 (BREQ-2) was used to assess motivation in exercise (Liu et al., 2015). The BREQ-2 consists of 19 items that measured six types of

motivation ranging from lower to higher levels of autonomy (i.e., amotivation, external, introjected, identity, integrated, and intrinsic regulation of exercise). The 4-point scale rating ranged from “not true for me” (0) to “very true for me” (4). In the present study, the internal consistency of a given subscale was as follows: amotivation (α=0.883), external regulation (α=0.847), introjected regulation (α=0.863), identified regulation (α=0.598), integrated regulation (α=0.813), intrinsic regulation (α=0.740). The construct validity was as follows: χ2/df =2.953, CFI=0.883, RMSEA=0.081. The results indicated that the internal consistency and structural validity of BREQ-2 were acceptable in the present study. Based on the organismic integration theory, controlled motivation was composited by external and introjected regulation and autonomous motivation was composited by identified, integrated, intrinsic regulation. Autonomous motivation, controlled motivation and each motivational regulation were examined as a mediator between psychological need satisfaction and leisure-time PA.

2.4 Data analysis

Descriptive statistics were used to calculate the mean and standard deviations for all study variables. An independent sample t-test was conducted to examine differences in psychological variables and physical activity across gender and competition level. The Spearman coefficient correlation analysis was used to investigate the associations among the study’s variables as a preliminary analysis to demonstrate the adequacy of subsequent path analysis.

Following preliminary psychometrics and descriptive analyses, the study’s hypotheses were tested using robust maximum likelihood estimators by structural equation modeling (SEM).

Firstly, structural equation modeling was employed to test the model fit in the hypothesized theoretical model. Missing data were handled using a full maximum likelihood estimator. SEM criterions based on recommendations by Hu and Bentler (Hu & Bentler, 1999), the root mean square error of approximation (RMSEA; cutoff values close to .06), and comparative fit index (CFI; cutoff values close to 0.95) were used to judge the overall model fit since chi-square (χ2) values are sensitive to sample size and often inflate Type 1 error.

Secondly, multi-group path analysis using SEM was adopted to examine the difference of the model parameters varied across different gender and competition levels. The fit of an unconstrained model was tested, followed by a series of constrained models. The difference between each of the constrained and unconstrained models was tested by calculating the

difference between the statistics for the two models under comparison. The criteria concerning the difference in CFI (△CFI) between nested models were used to evaluate the invariance hypothesis, |△CFI|≤0.05 indicates invariance (Cheung & Rensvold, 2002).

Thirdly, pairwise parameter comparison was used to test whether parameters varied in each pathway in the model. The criteria regarding the pathway differences were evaluated by critical ratios, |Z| >1.96 indicating the significant differences between each pathway across groups (Kline, 2015).

Lastly, the bootstrap-generated bias-corrected confidence approach was used to explore the mediation effect of the motivation effect on the relationship between need satisfaction and physical activity. An asymmetric 95% confidence interval based on 1000 resamples was used to test indirect effects.

3 Results

3.1 Descriptive analysis among studying variables

Table 1 presents a descriptive analysis across study variables divided into gender and competition level groups. The independent sample *t-test* analysis revealed that males reported higher amotivation (t=2.168, p<0.05) and leisure-time physical activity (t=1.524, p<0.05) compared to females. Low-competition athletes reported a higher autonomy need (t=1.183, p<0.01), amotivation (t=3.155, p<0.01), external regulation (t=3.409, p<0.05), integrated regulation (t=2.131, p<0.01), and autonomous motivation (t=2.128, p<0.05), but less leisure-time physical activity (t=-4.497, p<0.01), compared to high-level athletes (t=-7.842, p<0.01).

Table 1 Descriptive of psychological need satisfaction, motivational regulation, and leisure-time physical activity across gender and competition level

Variables	**Groups**		**Group comparison**	
	Male	**Female (M ± SD)**	***T***	***P***
Autonomy	6.209±0.898	5.892±1.102	2.661	0.13
Competence	5.430±1.094	5.001±1.043	3.234	0.672
Relatedness	4.940±1.220	4.441±1.326	3.226	0.367
Need	5.526±0.804	5.111±0.901	4.026	0.214

Amotivation	1.910±1.079	1.635±0.913	2.168	0.012
External	2.222±1.113	1.855±0.962	2.796	0.052
Introjected	3.308±1.071	2.890±1.192	3.053	0.199
Identity	4.083±0.665	3.949±0.602	1.686	0.44
Integrated	3.959±0.788	3.814±0.835	1.47	0.414
Intrinsic	4.178±0.608	4.120±0.642	0.765	0.459
Autonomous	4.073±0.593	3.961±0.591	1.542	0.964
Controlled	2.765±0.893	2.372±0.938	3.512	0.38
Leisure PA	2321.382±2921.301	1809.505±2278.184	1.524	0.045
Autonomy	6.150±0.851	6.005±1.218	1.183	0.002
Competence	5.222±1.085	5.442±1.105	-1.613	0.803
Relatedness	4.821±1.210	4.679±1.414	0.889	0.13
Global Need	5.397±0.822	5.375±0.939	0.206	0.205
Amotivation	1.944±1.118	1.541±0.748	3.155	0
External	2.240±1.113	1.788±0.927	3.409	0.023
Introjected	3.363±1.071	2.739±1.136	4.565	0.467
Identity	4.093±0.623	3.919±0.687	2.161	0.262
Integrated	3.977±0.748	3.764±0.909	2.131	0.009
Intrinsic	4.185±0.574	4.101±0.711	1.091	0.065
Autonomous	4.085±0.553	3.928±0.669	2.128	0.025
Controlled	2.802±0.919	2.264±0.827	4.817	0.266
Leisure PA	1696.400±2358.362	3189.123±3218.469	-4.497	0

(Autonomy=autonomy need satisfaction; Competence=competence need satisfaction; Relatedness= relatedness need satisfaction; Need=total psychological need satisfaction; Autonomous=autonomous motivation; Controlled=controlled motivation; External=external regulation; Introjected=introjected regulation; Identified=identified regulation; Integrated=integrated regulation; Intrinsic=intrinsic regulation Leisure PA=leisure-time physical activity)

3.2 Estimation of measurement models and the moderating effect

Because the latent factors of competence, autonomy, and relatedness correlated with each other moderately to strongly, the three psychological need satisfactions were composited into

one total psychological need factor and tested in the mediation model (Weman Josefsson, Lindwall & Andreas, 2015).

The results of bivariate correlation analysis among study variables show that several pathways have significant correlations in statistics as follows: (1) total psychological need satisfaction related to autonomous motivation (r= 0.551, p<0.01) and separate autonomous regulation, including identified regulation (r=0.415, p<0.01), integrated regulation (r=0.469, p<0.01), and intrinsic regulation (r=0.541, p<0.01); (2) leisure-time physical activity positively related to autonomous motivation (r=0.126, p<0.05) and identified regulation (r=0.179, p<0.01), and negatively related to amotivation (r= -0.160, p<0.01) and external regulation (r= -0.168, p<0.01).

Based on the significant statistical pathways, further analysis was conducted to test the fitness of hypothetical model 1 and model 2. Both separate regulations and composite motivation were tested separately in the mediation model to explore the exact mediating effect of motivation on psychological need satisfaction.

The first model tested the indirect relationship between the total psychological need satisfaction factor predicated on physical activity via autonomous motivation and controlled motivation. This test resulted in an acceptable fit ($\chi 2/df$=0.0183, GFI=1.00, CFI=1.00, RMSEA=0.00). Figure 3 presents the correlation and pathway coefficient in model 1.

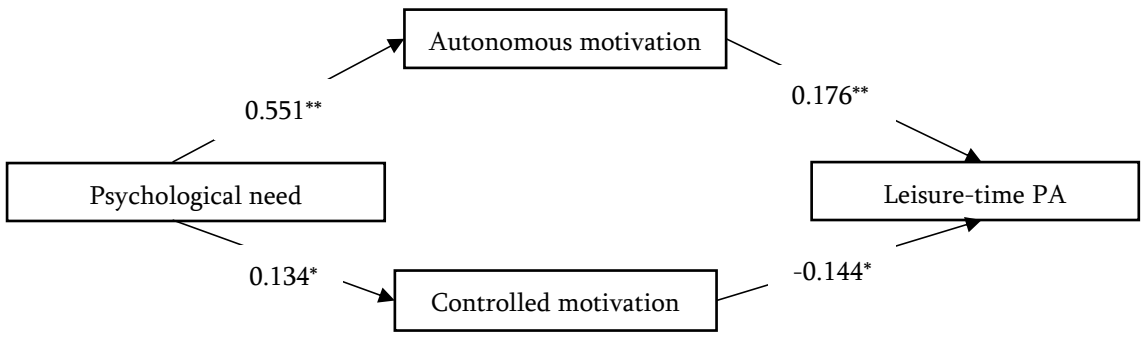

Figure 3. Mediations on autonomous motivation and controlled motivation between the relationship between psychological need and leisure-time PA

Table 2 presents the results of the path coefficient from model 1. In the full sample, the path from total psychological need satisfaction to autonomous motivation was moderately positive and significant (b=0.551, p<0.01), whereas the path from need satisfaction to controlled motivation was also positive and significant (b=0.134, p=0.019). Moreover, autonomous motivation predicted leisure-time physical activity (b=0.176, p<0.01), while controlled

motivation negatively predicted leisure-time (b=0.144, p<0.05). A multi-group analysis result of model 1 indicated non-significant differences across gender groups ($\triangle\chi^2$ =4.765, p=0.312) and competition-level groups ($\triangle\chi^2$ =2.205, p=0.138) in model structure. However, results of the critical ratios in pathways indicated that the pathway of autonomous motivation to leisure-time PA is stronger in male athletes, compared to female athletes (|Z|=2.118).

The second model focused on the separate regulations model. The controlled motivation was replaced by external regulation and introjected regulation, autonomous regulation was replaced by identified regulation, integrated regulation, and intrinsic regulation. Figure 4 presents correlation and pathway coefficients in model 2. The results indicate that the separate regulations model was acceptable to the model to fit the full sample ($\chi 2/df$=5.037, GFI=0.984, CFI=0.984, RMSEA=0.116). Table 3 presents the results of the path coefficient from model 2. In the full samples, total need satisfaction significantly predicted introjected regulation (b=0.160, p<0.01), identified regulation (b=0.402, p<0.01), integrated regulation (b=0.457, p<0.01), and intrinsic regulation (b=0.536, p<0.01). In terms of paths from separate regulation to physical activity, only external regulation (b=-0.188, p<0.05) and identified regulation (b=0.244, p<0.01) predicted leisure-time physical activity.

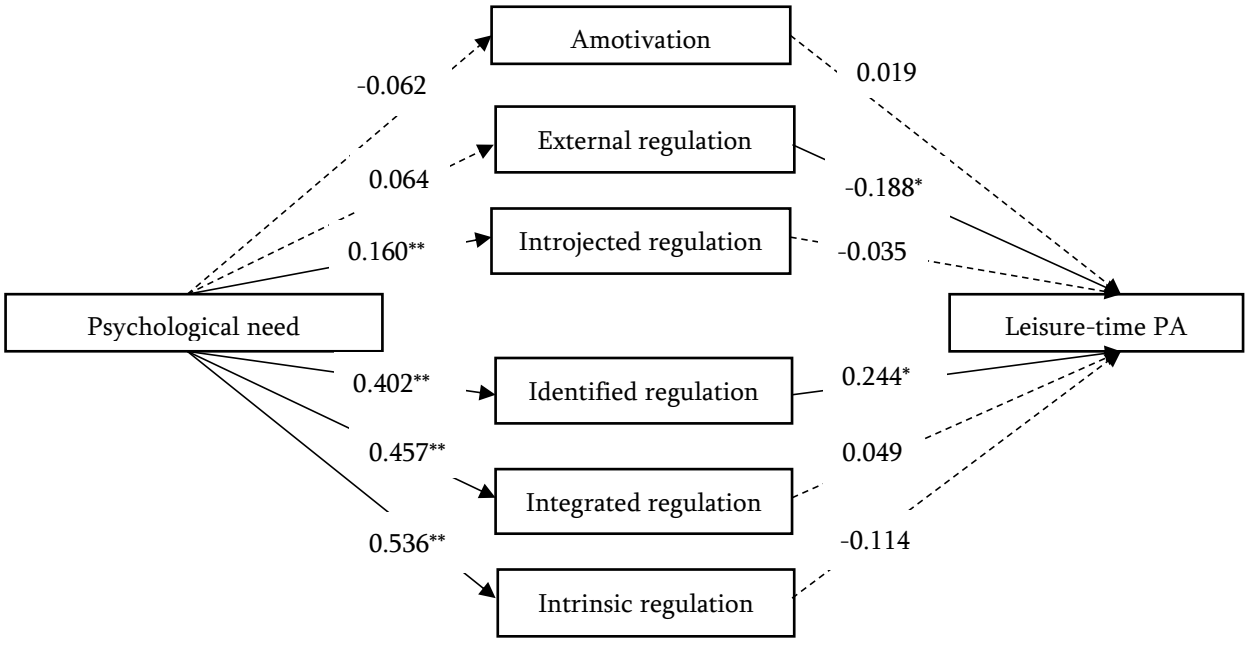

Figure 4. Mediations on separate motivational regulations between the relationship of psychological need and leisure-time physical activity (Solid lines represent significant path coefficients, dashed lines represent insignificant path coefficients)

Multi-group analysis in model 2 indicated non-significant difference across gender ($\triangle\chi^2$ =1.660, p=0.198) and competition level ($\triangle\chi^2$ =2.205, p=0.138); parameter comparison indicated that the negative pathway estimate of need satisfaction to amotivation is stronger in high-level competition athletes (|Z|= 2.602). Moreover, critical ratios for differences in the pathway from identified regulation to leisure-time activity are significantly stronger in females (|Z|=2.139) compared to male athletes. Similarly, the pathway from identified regulation to leisure-time activity is also significantly stronger in high competition-level athletes (|Z|=2.279) compared to low competition-level athletes.

Table 2 Pathway estimation between psychological need satisfaction, motivational regulation and leisure-time physical activity (standardized estimates)

Variable	Full Sample	Gender Group			Competition Group		
		Men	Women	Z	Low	High	Z
Model 1: Mediation on autonomous and controlled motivation							
Need → Autonomous	0.551**	0.545**	0.552**	-0.569	0.524**	0.603**	1.088
Need → Controlled	0.134*	0.09	0.099	0.028	0.177*	0.046	-1.317
Autonomous → Leisure PA	0.176**	0.238**	0.006	-2.118	0.206**	0.163	-0.16
Controlled → Leisure PA	-0.144*	-0.1*	-0.135	0.515	-0.073	-0.098	-0.432
Model 2: Mediation on individual regulation							
Need → Amotivation	-0.062	-0.089	-0.105	0.066	0.028	-0.354**	-2.602
Need → External	0.064	0.053	-0.03	-0.719	0.12	-0.072	-1.668
Need → Introjected	0.16**	0.095	0.182	0.669	0.184**	0.123	-0.575
Need → Identify	0.402**	0.408**	0.368**	-1.142	0.408**	0.405**	-0.234
Need → Integrated	0.457**	0.446**	0.465**	-0.092	0.402**	0.561**	1.638
Need → Intrinsic	0.536**	0.537**	0.547**	-0.181	0.509**	0.59**	1.107
Amotivation → Leisure PA	0.019	-0.076	0.174	1.242	0.047	0.004	-0.121
External → Leisure PA	-0.188*	-0.195	-0.099	0.545	-0.211	-0.162	-0.183
Introjected → Leisure PA	-0.035	0.04	-0.292*	-1.871	0.101	-0.081	-1.096
Identify → Leisure PA	0.244**	0.07	0.478**	2.139	0.101	0.487**	2.279
Integrated → Leisure PA	0.049	0.198	-0.165	-2.029	0.12	-0.142	-1.277

Intrinsic → Leisure PA	-0.114	-0.114	-0.092	0.368	-0.059	-0.154	-0.641

(Need=total psychological need satisfaction; Autonomous=autonomous motivation; Controlled=controlled motivation; Leisure PA=leisure-time physical activity; External=external regulation; Introjected=introjected regulation; Identified=identified regulation; Integrated=integrated regulation; Intrinsic=intrinsic regulation; Z= value of pathway differences in critical ratios)

3.3 Mediating and moderating effect of motivational regulation between psychological need satisfaction and leisure-time PA

Based on the acceptable fitness of model 1 and model 2, we further distinguished the mediating (indirect) effects of autonomous motivation, control motivation and separate motivational regulations. Table 3 presents the mediation analysis results of motivational regulations on the relationship between psychological need satisfaction and leisure-time PA. In the full sample, psychological need satisfaction indirectly and positively predicted leisure-time physical activity through the mediation of identity regulation (*ab*=0,098, 95% CI: 0.045-0.17) and autonomous motivation (*ab*=0.097, 95% CI 0.032, 0.154). On the other hand, psychological need satisfaction negatively and indirectly predicted leisure-time physical activity (*ab*=-0.019, 95% CI -0.044, -0.006)) through controlled motivation.

As a consequence of the differences in the paths between psychological need satisfaction, motivational regulation, and leisure-time PA across gender and competition levels, the mediating effects of motivational regulation also differed. Table 3 shows the mediation results for different gender and different competition level, psychological need satisfaction positively predicted leisure-time physical activity through integrated regulation (*ab*=0.088, 95%CI 0.019, 0.165) and autonomous motivation (*ab*=0.13, 95%CI 0.065, 0.19) in male athletes (but not in female athletes). Whereas psychological need satisfaction positively predicted leisure-time physical activity via identified regulation (*ab*=0.176, 95%CI 0.079, 0.363) in females (but not for males).

Concerning differences in competition level, psychological need satisfaction positively predicts leisure-time PA via the mediating effect of integrated regulation (*ab*=0.048, 95%CI 0.007, 0.106) and autonomous motivation (*ab*=0.108, 95%CI 0.038, 0.196) for low competition level athletes (but not for high competition level athletes). Whereas psychological need satisfaction predicted leisure-time through identified regulation (*ab*=0.197, 95% CI 0.043, 0.357) for high competition level athletes (but not for low competition level athletes).

Table 3 The mediating effects of motivational regulation in the relationship between psychological need satisfaction and leisure-time physical activity across gender and competition level (standardized estimates)

Variable	Full sample *b* (95% CI)	Men *b* (95% CI)	Women *b* (95% CI)	Low level *b* (95% CI)	High level *b* (95% CI)
H1: Need → AM → leisure	0.097* (0.032, 0.154)	0.13** (0.065, 0.19)	0.004 (-0.131, 0.175)	0.108* (0.038, 0.169)	0.098 (-0.021, 0.201)
H2: Need → CM → leisure	-0.019* (-0.044, -0.006)	-0.016 (-0.042, 0.006)	-0.013 (-0.06, 0.05)	-0.013 (-0.043, 0.002)	-0.005 (-0.041, 0.009)
H3:Need →amotivation →leisure	-0.001 (-0.019, 0.004)	0.007 (-0.009, 0.027)	-0.018 (-0.103. 0.006)	0.001 (-0.005, 0.035)	-0.001 (-0.086, 0.104)
H4: Need → external →leisure	-0.012 (-0.04, 0.004)	-0.01 (-0.038, 0.015)	0.003 (-0.016, 0.049)	-0.025 (-0.08, -0.002)	0.012 (-0.023, 0.05)
H5: Need → introjected → leisure	-0.006 (-0.032, 0.017)	0.004 (-0.016, 0.031)	-0.053 (-0.129. -0.006)	0.019 (-0.006, 0.064)	-0.01 (-0.048, 0.024)
H6: Need → identified →leisure	0.098** (0.045, 0.17)	0.028 (-0.034, 0.096)	0.176** (0.079, 0.363)	0.041 (-0.023, 0.106)	0.197* (0.043, 0.357)
H7: Need → integrated → leisure	0.023 (-0.055, 0.094)	0.088* (0.019, 0.165)	-0.077 (-0.254, 0.05)	0.048* (0.007, 0.106)	-0.079 (-0.266. 0.133)
H8: Need → intrinsic → leisure	-0.061 (-0.128, 0.003)	-0.061 (-0.14, 0.008)	-0.05 (-0.188, 0.052)	-0.03 (-0.101, 0.029)	-0.091 (-0.224, 0.05)

(Need=total psychological need satisfaction; Autonomous=autonomous motivation; Controlled=controlled motivation; Leisure=leisure-time physical activity; External=external regulation; Introjected=introjected regulation; Identified=identified regulation; Integrated=integrated regulation; Intrinsic=intrinsic regulation)

4 Discussion

The purpose of the study was to examine key pathways of self-determination theory in the physical activity context, linking satisfaction of psychological need with motivational regulation and exploring how gender and competition level may moderate these linking pathways. Our main analyses revealed that the SDT process can be used to demonstrate leisure-time physical activity in Chinese college athletes. The present study results support the general SDT stipulations and the results of previous studies on autonomous motivations promotes leisure-time physical activity, as well as mediated correlation between psychological need satisfaction and leisure-time physical activity (White et al., 2018; Mouratidis et al., 2020; Weman Josefsson, Lindwall & Andreas, 2015; Weman Josefsson, Johnson & Lindwall, 2017;

Wang & Chen, 2021).

Furthermore, the differences across gender and competition level in the mediating effect of motivation were statistically significantly different in direction and strength. Stronger correlations from autonomous motivation and integrated regulation to leisure-time physical activity were found in male athletes than in female athletes. Stronger correlations between identified regulation and leisure-time physical activity were found in high-level competition athletes than in low-level competition athletes. Overall, these findings contribute interesting information on how the theoretically hypothesized associations between need satisfaction, motivation, and exercise may be moderated.

4.1 Association between psychological need satisafction and motivational regulation

Consistent with previous studies (Edmunds et al., 2006; Russell et al., 2009), the present study results indicate psychological need satisfaction positively correlated to autonomous motivation, as well as positively related to autonomous types of regulation (identified regulation, integrated regulation, and intrinsic regulation) in the full sample of college athletes. Nevertheless, the present results also indicated that psychological need satisfaction was positively related to controlled motivation, a finding that is opposite to the original hypothesis and previous studies (Guérin et al, 2012; Bartholomew, Ntoumanis & Thøgersen-Ntoumani, 2012), which indicated that psychological need satisfaction negatively predicted controlled types of regulation (external regulation and introjected regulation).

In a further analysis of controlled type of separate regulations, we found that psychological need satisfaction only significantly and positively correlated to introjected regulation, but has shown non-significant correlation to external regulation. Introjected regulation is a self-esteem-related contingency and is practiced because people feel that they “should” or “must” act (Standage & Ryan, 2020). One possible reason for psychological need satisfaction is strongly correlated to introjected regulation might the influence of the special identity to college athletes’ psychological need. For instance, the need for competence in athletes might be satisfied when they dedicate themselves to completing training tasks or placing top ranking in the competition. The need for relatedness might be satisfied by obey and follow the coach's training schedule and requirements. Moreover, the multi-group analysis indicated that the correlation between need satisfaction and introjected regulation is stronger in high-competition level athletes. This could be because high-level athletes have a higher self-requirement and self-discipline and get more pressure from the external environment.

4.2 Mediation effect of motivational regulation between psychological need satisfaction and leisure-time PA

Concerning hypothetical model 1, the results of mediation analysis supported the motivation effect of autonomous motivation (H1). Similar to the findings of previous studies, the present study results indicated that psychological need satisfaction indirectly promote leisure-time PA through the mediation on autonomous motivation (Thøgersen-Ntoumani & Ntoumanis,2006; Standage et al., 2012; Vallerand et al., 2000).

On the other hand, consistent with previous studies, the present results indicated that controlled regulation styles have been associated with lower physical activity levels in leisure time (Edmunds, Ntoumanis & Duda, 2006; Russell & Bray, 2009). However, the mediation analysis shown that controlled motivation played a role between psychological need satisfaction and PA but with a reverse direction compared to hypothesis two (H2). Specifically, psychological need satisfaction negatively predicted leisure-time PA through controlled motivation in college athletes.

In view of our explanation of positive association between psychological need satisfaction and controlled motivation in the last paragraph. This results revealed that although psychological need satisfaction positively related to controlled motivation (e.g., top place in competition ranking satisfies competence need, or praise from coaches and teammates might satisfied relatedness need). Those kinds of controlled regulations still impair leisure-time physical activity in college athletes. In conclusion, mediation analysis results revealed that autonomous motivation promote college athletes' physical activity participation in leisure time, while control motivation impairs leisure-time PA participation. Thus, cultivating autonomous motivation contributes to college athletes' physical activity participation in self-determination contexts.

Concerning hypothesis model 2, the results of mediation analysis supported H6 and rejected the other hypotheses (H3, H4, H5, H7 and H8). Our study was one of the first studies to explore the mediating effect of separate regulation on psychological need satisfaction and leisure-time PA in college athletes. The results of our study advanced the underlying mechanisms of the SDT construct in exploring leisure-time PA and showed that identity regulation is the strongest predictor of leisure-time physical activity. Identified regulation is relatively autonomous and refers to behaviors that stem from the conscious valuing of an activity as an important and instrumental goal (Standage & Ryan, 2020). College athletes as semi-professional athletes tend to participate in more physical activity due to instrumental

goals such as sports performance enhancement or motor skill learning (Teixeira et al., 2012).

Our results support the theoretical proposal of SDT that autonomous motivation promote PA and played a role of mediation between psychological needs satisfaction and PA in self-determined contexts. While, controlled motivation impairs physical activity participation in leisure-time, although with the positive association to psychological need in some degree. In the analysis of separate motivation regulation, identity regulation is the only predictor of leisure-time physical activity, while other autonomous regulations are not significant concerning leisure-time PA, additional moderating variables may be significant and should be further explored.

4.3 Moderating effect of gender and competition level in meidation of motivational regulation between psychological need satifatcion and leisure-time PA

Although most of the pathways were invariant in the testing model, several points were different across gender and competition level on the mediation effects of motivational regulation and their effects were statistically significant.

Concerning gender, the present results indicated two significant difference across the different gender groups. Firstly, male college athletes tend to adopt more autonomous types of regulation and generate higher levels of PA. The results support the results of studies by Lauderdale (2015) and Athanasios (2007) but are inconsistent with the results of the study by Weman-Josefsson (Weman Josefsson, Lindwall & Andreas, 2015; Weman Josefsson, Johnson & Lindwall, 2017). The inconsistent results may be due to cultural variations concerning the basic psychological need of nutrition for growth, which vary widely across cultures (Deci et al., 2001). Cultural differences significantly impact social identity and social expectations for males and females. Secondly, results of this study show a stronger prediction by identified regulation for leisure-time physical activity in female college athletes, indicating that females tend to endorse a more instrumental goal in physical activity, even during the leisure time.

As a consequence of the moderating effect of gender, we found different mediation effects on the connection between psychological need, motivational regulation and leisure-time PA across gender. In particular, integrated regulation and autonomous motivation mediated the correlation between psychological need satisfaction and leisure-time PA in male college athletes, while identified regulation mediated the correlation between need and leisure PA in female athletes.

Concerning the competition level, two significant differences across different groups. First, a

stronger negative prediction from psychological need satisfaction to amotivation in high competition level athletes compared to low competition level athletes. Secondly, the correlation between identified regulation and leisure-time physical activity, which is stronger in high competition-level athletes compared to low competition-level athletes.

Amotivation is a state in which an individual is entirely lacking in intention to engage in an activity, which could arise from feeling incompetent at an activity, not expecting the behavior to lead to an anticipated outcome, or finding no value in it (Standage & Ryan, 2020). Reversely, identified regulation stems from the conscious valuing of an activity as an important and instrumental goal (Standage & Ryan, 2020). The possible reason of those different pathways in competition level is that high-level competition athletes who value leisure-time physical activity and its benefits for its instrumental goal (e.g., improve sports performance and motor skill even in the leisure-time context). Conversely, low competition-level athletes spend their leisure-time activity in their autonomous or intrinsic mode (e.g., enjoyment or amusement).

Under the moderating effect of competition level, identified regulation played a mediator role in the relationship between psychological need satisfaction and leisure-time PA in high competition level athletes, while autonomous motivation played the mediator role between psychological need satisfaction and leisure-time PA in low competition-level athletes.

5 Conclusions

The results of the study supported the hypothesized association between basic psychological need, motivational regulation, and leisure-time physical activity in Chinese college athletes. Autonomous motivation promotes leisure-time physical activity and plays a role of mediation between psychological need satisfaction and leisure-time physical activity. Controlled motivation impairs the leisure-time physical activity, although with the positive association to psychological need in some degree. We also found that some of the paths differed across gender and competition levels, which indicates that mechanisms in the SDT process model could vary depending on the subgroup. We suggest that cultivate autonomous motivation in college athlete and focus on the moderating effect variables in physical activity promotion intervention in college athletes.

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