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ORIGINAL RESEARCH

Self-Determination Theory Mechanisms in Men's Long-Term, Objectively Measured Physical Activity and Sedentary Behavior in the European Fans in Training Program

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Background: Evidence supporting Self-Determination Theory (SDT) utility in facilitating and explaining physical activity (PA) behavior change and maintenance is robust and rapidly increasing. This paper aims to describe how SDT was used to develop the European Fans in Training program, and its adequacy, concerning the critical mechanisms theoretically provided, to predict objectively measured PA and sedentary behaviors. ***Methods:*** European Fans in Training was a gender-sensitized, healthy lifestyle program that successfully attracted men and supported them in making changes in their PA and diet. This study analyzes self-reported psychometric and objectively measured PA data from the European Fans in Training intervention group of 560 overweight men aged 30–65 from 4 countries (The Netherlands, Norway, Portugal, and the United Kingdom). ***Results:*** The motivational mediation sequence predicted by SDT showed an acceptable to excellent fit for the data: $\chi^2 = 200.204$; df = 87; $P = .000$; comparative fit index = .956; Tucker–Lewis Index = .933; root mean square error approximation = .050 (90% CI, .041 to .059); standardized root mean square residual = .056. Perceived need support by coaches was positively related to greater need satisfaction, which led to higher levels of self-determination and an increase in steps, lifestyle PA, and sit-to-stand transitions. Perceived need-thwarting behaviors were negatively associated with need satisfaction and indirectly with self-determination. ***Conclusions:*** Results confirm that interventions can create conditions for individuals to experience psychological need satisfaction, self-determined motivation, and PA-related health behavior change. These findings provide further support to the utility and acceptability of SDT among policymakers and practitioners wishing to promote PA in previously sedentary adults.

Keywords: motivation, intervention, sitting/standing, overweight, health promotion

Insufficient physical activity (PA) levels are a substantial concern for public health globally.[1,2] Low levels of PA and high sedentary behaviors can increase the risk of several chronic diseases, including obesity, type 2 diabetes, cardiovascular disease,[3] and cancer.[4] It is further associated with a higher risk of premature death, as well as decreased cognitive function and mental health.[5,6]

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Evidence indicates that interventions grounded in behavior change theory could be more effective in promoting PA compared with those lacking a theoretical foundation.[7] However, contrasting findings suggest that this distinction may not be unequivocally defined as some studies point to no additional contributions to PA promotion from theory-based interventions.[8] This discrepancy highlights the necessity for additional research to clarify the specific conditions under which theoretical frameworks augment intervention outcomes. Theories allow for the organization of predictors in causal paths that lead to behavior, explaining why and how interventions work (or do not), and identifying which variables interventions should target (or discard).[8] Theory also guarantees that a methodical and exhaustive array of evidence-based determinants are duly addressed[9] and thus endorsed as part of best practices in intervention design.[10]

Self-Determination Theory (SDT) is a theoretical framework that can explain the motivational dynamics behind the regulation of health behaviors. It focuses on the psychological antecedents, mechanisms, and basis for interventions in health contexts.[11,12] Evidence supporting its rationale and utility in facilitating and explaining health behavior change and maintenance is rapidly

increasing and has been summarized in recent meta-analytical reviews.[13–16]

In short, the SDT framework revolves around volitional or self-determined behavior and the social and cultural conditions contributing to its promotion, postulating a set of fundamental and universal psychological needs that underlie human motivation and well-being.[12] The premise underlying this approach posits that sustainable motivation is an internal construct originating from within the individual rather than an external imposition. It is argued that, to promote initiation and maintenance of behavior change effectively, it is essential to support participants' basic needs for autonomy (ie, the need to feel a sense of choice, volition, and self-endorsement), competence (ie, the need to feel a sense of mastery and capacity to accomplish the behavior), and relatedness (ie, the need to feel meaningfully connected to others, valued, and understood). By fostering autonomous motivation and well-being through the fulfillment of these basic needs, individuals are more likely to engage in and sustain behavior change. On the contrary, when these 3 fundamental needs are impeded, individuals are prone to cultivate controlled motivations and regulate their behavior based on external contingencies and internalized self-judgments. Consequently, behavior change is less likely to be maintained.[17] Thus, the most important social and environmental factor within an SDT-based motivational climate concerns the degree of need-supportiveness—the extent to which others and the environment more broadly support or, on the other hand, thwart these needs.

One of the strengths of SDT is that it proposes processes of behavior change that can be targeted in different health behavior interventions. In these interventions, techniques are developed and implemented to satisfy the 3 basic psychological needs, thus fostering the process of internalization (ie, the active transformation of controlled regulation into more autonomous forms of [self-] regulation), in turn leading to increased integration of this regulation into a person's personality and positive behavior change.[18]

Interventions based on SDT principles have been found to encourage long-term changes in health (including PA) behaviors.[15,19] SDT has also been highlighted as relevant to understanding the change and maintenance of overall health behavior change.[15,20,21] By leveraging the insights offered by SDT, researchers and practitioners can design more effective, evidence-based interventions tailored to the unique needs of diverse populations.[15,22]

SDT is also associated with the construct of self-regulation,[23,24] which describes a person's ability to plan, monitor, and evaluate their behavior.[23] Interventions pointing at changes in behavior using a variety of self-regulation skills are thought to influence behavior change and maintenance.[25,26] Research has identified that skills such as self-monitoring, individualized goal setting, and action planning are critical mediators of long-term PA[27] and core features of effective behavior change/maintenance interventions.[24,28]

The establishment of innovative and gender-responsive sporting club environments has the potential to substantially enhance motivational constructs among men by fostering equitable gender relationships, promoting autonomy, and cultivating intrinsic motivation. Empirical research suggests that sporting clubs that actively challenge traditional gender norms and stereotypes foster supportive atmospheres that facilitate increased involvement of men in a broader spectrum of sports. Moreover, environments that prioritize the satisfaction of psychological needs are instrumental in augmenting commitment and engagement in sport. Ultimately, these tailored environments not only serve to dismantle detrimental ideologies but also contribute to the development of a more inclusive and motivating experience for men, which subsequently promotes sustained participation and heightened satisfaction in sports activities.[29–31]

European Fans in Training (EuroFIT) was a healthy lifestyle program grounded in evidence and sociological and motivational theories (including SDT) while being gender sensitive. It was tested via a randomized controlled trial in The Netherlands, Norway, Portugal, and the United Kingdom (for study protocol and main results details, see[31,32]). Specifically, it utilized SDT to internalize men's motivational regulation through coach-induced, needs-supportive environments (fulfillment of the need for relatedness, competence, and autonomy) in football club settings. EuroFIT was delivered as planned by trained local club coaches working flexibly in all countries. It attracted men and supported initiating and maintaining PA and diet changes.[31] EuroFIT participants also showed improved diet, body weight, cardiometabolic health indicators, well-being, and other secondary outcomes.[31]

Given its theoretical underpinnings and the potential contribution to different types of movement-related outcome changes in the program (steps, sedentary behaviors, daily active lifestyle choices) and the importance of testing SDT mechanisms in a real-world setting over time, this paper aims to describe how SDT was used to develop the EuroFIT program and its adequacy concerning the critical mechanisms theoretically provided (measured both at postprogram and after 12 mo) to predict PA (number of daily steps) and sedentary behavior, including sit-to-stand transitions (objectively measured) and lifestyle PA (subjectively reported; after 12 mo from baseline).

Materials and Methods

Study Design

Data were collected at different times: (1) baseline: before starting the intervention (time 1), (2) postprogram: after the intervention (time 2), and (3) after 12 months from baseline (time 3). Because the study analyzes the utilization of SDT constructs in shaping the EuroFIT intervention, evaluates the degree to which the program influenced key motivational constructs and health outcomes linked to PA and sedentary behavior, the current analysis only included individuals from the intervention group. Moreover, this analysis only includes postprogram (4 mo) and 12-month data because, at baseline, participants would not have captured the coaches need-supportive/-thwarting.

Participants

Power analysis for a single-group structural equation modeling was conducted using an expected medium effect size ($d = .40$, Cohen d), power = 0.95, and $P = .05$, with 15 observed variables. The choice of effect size was based on previous SDT-based interventions in PA and health promotion contexts, which reported small to moderate effects for similar variables (eg, need satisfaction, motivation, and behavioral outcomes). For instance, studies have reported effect sizes ranging from $d = 0.30$ to $d = 0.50$, supporting the appropriateness of using $d = 0.40$ as a conservative and literature-based estimate.[33,34] The analysis determined that approximately 384 participants are needed.[35] A total of 560 men with self-reported body mass index ≥27 kg/m^2 at initial screening aged between 30 and 65 years old ($M = 45.88$ [8.98]) and from 4 countries were allocated to the intervention group. Men were recruited from the following countries and

professional football clubs: The Netherlands (n = 141): ADO Den Haag, FC Groningen, PSV, and Vitesse; Norway (n = 131): Rosenborg BK, Strømsgodset IF, and Vålerenga Fotball; Portugal (n = 116): Futebol Clube do Porto, Sporting Clube de Portugal, and Sport Lisboa e Benfica; and United Kingdom (England; n = 172): Arsenal FC, Everton FC, Manchester City FC, Newcastle United FC, and Stoke City FC.

Intervention

The EuroFIT program was specifically focused on exploring the connection between gendered identities and health behaviors. Coaches equipped participants with extensive behavior change techniques to use as tools of behavior change, which were then reinforced and practiced through group discussions and face-to-face sessions. The program encouraged participants to adopt new behaviors and maintain these changes over time. To achieve this, participants were urged to choose from various skills and strategies available in the EuroFIT toolbox to modify their PA, sedentary behavior, and dietary habits. The program materials were designed to deliver clear, concise, and relevant messages to help participants understand how they could enhance their PA, sedentary behavior, and diet.[32]

The Supplementary Material (available online) provides detailed examples of how SDT-based principles were embedded in the program to promote psychological need satisfaction, the key processes targeted, and the behavior change techniques used to impact those constructs following the classification of motivation and behavior change techniques used in SDT-based interventions in health contexts.[18] These are described briefly with examples of how the intervention was implemented to nurture each need:

(1) Autonomy support was developed by encouraging the selection of self-relevant goals. This was achieved by prompting participants to link behavior changes to other important values, such as spending time playing with their children. Participants were also encouraged to set goals and modifications based on individual preferences for PA and diet, consistent with their current lifestyles.

(2) The enhancement of perceived competence was achieved by adjusting the level of challenge to match one's fitness and skill, providing feedback, and utilizing a toolkit of established self-regulatory techniques.

(3) To promote relatedness among football club participants, a group of fans was created within the club, where participants were visibly similar and shared similar interests. Opportunities for peer interaction and shared learning were provided. As men deepened their commitment and enjoyed interactions, they could forge collective identities that permitted new ways of being and behaving. These increased the feelings of relatedness and enabled increased autonomy and practice of new skills, leading to effervescent experiences.

The EuroFIT coach's role was to promote camaraderie and provide a positive, relaxed, interactive environment where men felt confident. The coach acted as a facilitator of discussions rather than as an expert on lifestyle change. The goal was to support everyone in choosing and using the lifestyle change strategies and techniques that worked best for them and to set meaningful goals.

Football club coaches received 2 days of training in the delivery of EuroFIT, including creating a motivational, autonomy- and mastery-supportive climate and understanding and respecting participants' perspectives and preferences for lifestyle change. The coaches learned to provide a rationale for behavior change, collaboratively develop behavior change options for the men to choose from, and facilitate the development of participants' personally relevant goals. Engagement was promoted by ensuring enjoyable, fun, nondogmatic, experiential, and interactive sessions. Cheerful banter was encouraged to create a mutually supportive "team" environment that helps men learn from each other by sharing tips and advice.

A pocket-worn activity and sedentary/nonsedentary behavior monitor, the SitFIT, was developed and validated to offer users real-time feedback on step counts and upright (nonsedentary) time.[34] The SitFIT enabled participants to track their progress against an individualized program designed to increase their daily step count and duration of time spent upright. Participants could also view their step and upright time data for the past 7 days, and a more detailed historical record of the SitFIT data could be accessed by uploading the data to the MatchFIT app. The primary objective of MatchFIT was to facilitate intersession social support and enhance group participation in PA by organizing a team-based collective step challenge as a complement to self-monitoring.

Instruments

Data were collected at the baseline, immediately following the program, and again 12 months postbaseline. Comprehensive details regarding the specific questionnaires administered at each time point can be found in the study protocol.[32] The assessments encompassed an extensive array of validated psychosocial measures related to SDT.[32] In accordance with established best practices, validated versions of the questionnaire specific to each country were utilized when such versions were accessible. In instances where sections of the questionnaires do not possess official validation, translations were undertaken by members of the EuroFIT research teams, subsequently followed by a back-translation into English performed by the principal investigators in each respective country.

Need Support From the Coach

To assess the extent to which participants report that coaches were able to support their autonomy, competence, and relatedness, a multidimensional instrument that analyzes supportive style: autonomy support (3 items, eg, "encourage me to take my initiative"), competence support (4 items, eg, "give me exercises that are suited to my level"), and relatedness supportive (3 items, eg, "look after me well") was used.[36] This scale uses a 5-point scale ranging from "not true for me" to "very true for me."

Need Thwarting by the Coach

To analyze the autonomy thwarting (3 items, eg, "I feel forced to follow training decisions my coach has made for me"), competence thwarting (3 items, eg, "Situations occur with my coach in which I am made to feel incapable"), and relatedness thwarting by the coach (3 items, eg, "I feel my coach can be dismissive of me"), we used a 9-item measure adapted from Bartholomew et al,[37] with each being rated on a 7-point scale ranging from "strongly disagree" to "strongly agree."

Need Satisfaction From Physical Activity

To analyze autonomy satisfaction (3 items, eg, "I exercise because I like to rather than because I feel I have to"), competence satisfaction (3 items, eg, "I feel capable of completing physical activities

that are challenging to me"), and relatedness satisfaction (3 items, eg, "I get connected to others when we do physical activity together"), was adapted and used.[38–40] This scale comprises 9 items and includes the initial sentence: People have different feelings when they engage in PA.

Motivation for Physical Activity

To evaluate the motivational regulations for PA: a motivated, external, introjected, identified, and intrinsic regulation, an adaptation from the Behavioral Regulation in Exercise Questionnaire-2,[36] was used. The Behavioral Regulation in Exercise Questionnaire-2 is a validated instrument extensively used to assess motivation for exercise across diverse populations, including fitness users.[41–43] Researchers have found that the Behavioral Regulation in Exercise Questionnaire-2 offers a reliable and valid multidimensional view of motivation and provides insights into individuals' exercise behavior. For this study, as in others, an index of autonomous motivation was used instead of measuring the motivational regulations separately.[44] The Relative Autonomy Index (RAI) is a score that measures the degree to which respondents feel self-determined. It is derived from multiple subscales, which are weighted and then summed to obtain the final score.[45]

Physical Activity and Sedentary Behavior Measures

Objective measures such as accelerometers and wearable monitors are more accurate in quantifying sedentary behavior than self-report methods. This is essential in obtaining reliable data and reducing biases inherent in self-reports. In addition, these measures provide continuous monitoring of sedentary behavior, which offers a more comprehensive understanding of activity patterns.[46] The present study aimed to investigate changes in total PA, measured in terms of steps per day; total sedentary time, measured in terms of minutes per day spent sitting; and sit-to-stand transitions using an activPAL activity monitor (model activPAL™ micro, PAL Technologies Ltd). The activPAL is a small, 9-g monitor taped to the front of the thigh and has been found to have good measurement properties to assess sitting, standing, stepping, and postural transitions in adults.[47–50] Participants were asked to wear the device 24 hours a day for 7 consecutive days, including during showering, and to temporarily remove the device only during water submersion activities, such as swimming or bathing. Participants kept a monitoring log to record when the device was removed and replaced and work and sleep times. To meet the inclusion criteria for the present study, participants needed to provide at least 4 valid days of activPAL data at baseline. Data from the attachment and removal day were not used for analysis as these were incomplete days when the participant started or finished wearing the activPAL during the day. ActivPAL data were considered valid when the participant wore the device for at least 10 hours of the waking day.

Daily routine-related activity and sedentary behaviors were captured using the Activity Choice Index,[51] measured on a 5-point scale (from "never" to "always"). The index included items such as using stairs instead of escalators or lifts, walking instead of driving or taking public transport, parking away from the destination or getting off public transport early to have a longer walk, using work breaks to be physically active, choosing to stand up instead of sitting, and choosing to do things by hand instead of using mechanical/automatic tools. The Activity Choice Index encapsulates the rationale for replacing sedentary behaviors with more vigorous PA, a dimension often overlooked in traditional self-report PA assessments.[51]

Statistical Procedures

Initially, descriptive analyses, bivariate correlation (Pearson coefficient), and reliability analysis (Cronbach alpha) were conducted using an SPSS 23.0 version. Then, we used the Mplus version 7.3[52] to test a path analysis (structural equation modeling) with the aim of examining variables at different time points in order to assess the scores of the motivational climate employed by coaches (ie, need-supportive/thwarting behaviors) postintervention (time 2), as well as the long-term after 12 months from baseline (time 3), and the relationship of these variables with motivational constructs (ie, need satisfaction and RAI) and consequences related to PA and sedentary behavior (ie, number of daily steps, lifestyle PA, sit-to-stand transitions, and sitting time). Similar to previous studies,[53] to simplify the analysis and interpretation, the composite scores calculating the average of the 3 categories of need support/thwarting and need satisfaction were estimated. We also included the participants' age, club (ie, supporters from specific teams), and sport spectator identifications (ie, the degree to which sport spectators feel psychologically connected to a team)[29] as covariates in the analyses). Model fit was assessed using chi-square (χ^2), degrees of freedom (df), the comparative fit index, the Tucker–Lewis Index, the root mean square error approximation, and the standardized root mean square residual. Comparative fit index and Tucker–Lewis Index values equal to or greater than .90 are indicative of a good fit.[54] Likewise, root mean square error approximation and standardized root mean square residual scores equal to or less than .06 are considered acceptable.[55]

In addition, indirect effects between variables were calculated using the bias-corrected bootstrap method (10,000 samples with 95% bias-corrected CIs),[56] with the maximum likelihood procedure (bootstrapping is unavailable using maximum likelihood robust estimation). The mediated relation is considered significantly different from zero when the CI does not cross zero.

Results

Preliminary Analysis

The descriptive statistics (mean [SD]) and correlations among the factor score values are displayed in Table 1. At time 2 (at the end of the 3-mo program), perceived autonomy-, competence-, and relatedness-support by the coach were negatively and significantly related to perceived autonomy-, competence-, and relatedness-thwarting by the coach. At time 3 (after 12 mo from baseline), RAI was positively associated with the perceived need support by the coach (at 3 mo), perceived need satisfaction, number of steps, lifestyle PA and sit-to-stand transitions and was negatively related to perceived need thwarting by the coach. The number of steps was also positively related to autonomy thwarting, perceived need satisfaction variables, lifestyle PA, and sit-to-stand transitions, and it was negatively associated with sitting time. The lifestyle PA was positively related to perceived autonomy support, perceived need satisfaction, and sit-to-stand transitions. Finally, sit-to-stand transitions were positively associated with autonomy and relatedness satisfaction.

Table 1 also shows the internal reliability coefficients (Cronbach alpha) of each one of the variables. The values were all acceptable and above .70.[57]

Table 1 Descriptive Statistics and Correlational Analysis Among the Study Variables in Time 2 (Post-Intervention) and in Time 3 (After 12 mo From Baseline)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Time 2 (postintervention)														
Need support by coach	–	–	–	−.239**	−.180**	−.124*	.087	.121*	.230**	.150**	.047	.113*	−.072	−.002
1. Autonomy support	–													
2. Competence support	.809**	–												
3. Relatedness support	.765**	.790**	–											
Need thwarting by coach	−.208**	−.219**	−.207**	–	–	–	−.145*	−.219**	−.207**	−.196**	.084	.013	−.008	.039
4. Autonomy thwarting	−.192**	−.242**	−.227**	–										
5. Competence thwarting	−.187**	−.163**	−.152**	.530**	–									
6. Relatedness thwarting	−.135**	−.108*	−.106*	.439**	.844**	–								
Time 3 (after 12 mo from baseline)														
Need satisfaction	.201**	.170**	.175**	−.147**	−.165**	−.084*	–	–	–	.556**	.173**	.323**	−.086	.126*
7. Autonomy satisfaction	.113*	.058	.081	−.175**	−.130**	−.015	–							
8. Competence satisfaction	.139**	.092	.114*	−.067	−.115*	−.065	.550**	–						
9. Relatedness satisfaction	.209**	.226**	.201**	−.115*	−.143**	−.106*	.359**	.442**	–					
10. Self-determination for PA (RAI)	.188**	.132**	.115*	−.205**	−.154**	−.107*	.415**	.482**	.428**	–				
11. Number of steps	.074	.033	.027	.128**	.033	.011	.119*	.192**	.104*	.198**	–			
12. Lifestyle PA	.141**	.096	.079	.007	.013	.016	.193**	.366**	.211**	.366**	.218**	–		
13. Sit-to-stand transitions	−.008	.005	−.005	.005	.047	.071	.102*	.090	.107*	.118*	.157**	.020	–	
14. Sitting time	−.062	−.082	−.051	−.009	−.008	.022	−.017	−.088	−.088	−.076	−.368**	−.056	.073	–
M	13.24	17.68	13.46	5.75	3.66	3.51	15.77	14.26	14.40	13.41	9233.86	2.96	51.07	611.57
SD	2.28	3.00	2.28	3.89	2.28	2.03	2.48	2.97	3.47	6.48	3529.55	0.71	15.15	108.94
Cronbach alpha	.840	.878	.911	.822	.945	.949	.927	.901	.723	–	–	–	–	–

Abbreviations: PA, physical activity; RAI, Relative Autonomy Index. Note: Need support ($M = 14.80$ [2.34]); need thwarting ($M = 4.31$ [2.32]); need satisfaction ($M = 14.81$ [2.37]).
*$P < .05$. **$P < .01$.

Main Analysis

The path model for the full sample (see Figure 1) adjusted by age, club, and sport spectator identifications was tested considering perceived need-supportive and need-thwarting behaviors by the coach ($r = -.765$) as predictor variables in time 2 (postintervention); need satisfaction as a composite factor and RAI as mediators variables in time 3 (after 12 mo from baseline); and the number of daily steps, lifestyle PA, sit-to-stand transitions, and sitting time as consequences (also at time 3). Significance differences were found in the target variables by age (Wilks $\Lambda = .920$, $F[1,919]$, $P = .016$), club (Wilks $\Lambda = .581$, $F[1,780]$, $P < .001$), and sport spectator identification (Wilks $\Lambda = .923$, $F[1,860]$, $P = .021$). The results showed an acceptable to excellent fit for the data: $\chi^2 = 200.204$; df = 87; $P = .000$; comparative fit index = .956; Tucker–Lewis Index = .933; root mean square error approximation = .050 (90% CI, .041 to .059); standardized root mean square residual = .056. Furthermore, Figure 1 also presents the direct associations between study variables. Coaches' need-supportive behavior was directly and positively associated with need satisfaction from PA ($\beta = 0.204$; $P < .001$; 95% CI, .082 to .326), whereas coaches' need-thwarting style was directly and negatively related to need satisfaction from PA ($\beta = -0.168$; $P < .001$; 95% CI, −.322 to −.013). In addition, need satisfaction was a positive and significant predictor of RAI ($\beta = 0.661$; $P < .001$; 95% CI, .554 to .767), and RAI was positively and significantly associated with the number of steps ($\beta = 0.207$; $P < .001$; 95% CI, .123 to .290), physically active lifestyle ($\beta = 0.295$; $P < .001$; 95% CI, .203 to .386), and sit-to-stand transitions ($\beta = 0.120$; $P < .001$; 95% CI, .035 to .206). Regarding covariates, age was a negative predictor of need satisfaction ($\beta = -0.152$; $P < .05$; 95% CI, −.258 to −.047) and a positive predictor of RAI ($\beta = 0.119$; $P < .05$; 95% CI, .037 to .200) and sitting time ($\beta = 0.121$; $P < .05$; 95% CI, .031 to .211). Finally, sport spectator identification was a significant and negative predictor of sit-to-stand transitions ($\beta = -0.144$; $P < .05$; 95% CI, −.229 to −.058).

Overall, the variance explained that all of the endogenous and latent variables ranged between 3% (for sitting time) to 46% (for RAI; see R^2s in Figure 1).

Indirect Effects

In Table 2, indirect associations obtained between study variables when the model was reestimated using the bootstrap resampling procedures are shown. First, the need support by the coach was positively and indirectly associated with self-determination for PA via need satisfaction from PA ($\beta = 0.135$; 95% bias-corrected confidence interval, .068 to .217), whereas need thwarting by the coach was negatively and indirectly related to self-determination for PA, via need satisfaction from PA ($\beta = -0.111$; 95% BcCI, −.209 to −.027). Second, need satisfaction was positively and indirectly related to the number of steps ($\beta = 0.137$; 95% BcCI, .084 to .193) and lifestyle for PA ($\beta = 0.195$; 95% BcCI, .134 to .261), respectively, via self-determination for PA. In addition, the need support by the coach was also positively and indirectly associated with the number of steps ($\beta = 0.028$; 95% BcCI, .012 to .054) and lifestyle for PA ($\beta = 0.040$; 95% BcCI, .019 to .072), respectively, via need satisfaction from PA and self-determination for PA, whereas any indirect association was found between need thwarting by the coach and PA outcomes via need satisfaction from PA and self-determination for PA. Finally, need thwarting by the coach was not indirectly related to the PA outcomes via need satisfaction from PA and self-determination for PA.

Discussion

The motivational mediation sequence theoretically proposed by SDT demonstrated an acceptable to excellent fit for the data. The primary findings indicated that coaches' perceived need support was positively correlated with greater satisfaction of all 3 basic psychological needs. This need satisfaction was, in turn, associated with higher levels of self-determination, daily steps, lifestyle PA, and sit-to-stand transitions after 12 months of the intervention. Conversely, perceived need-thwarting behaviors were negatively associated with need satisfaction and indirectly with self-determination.

It is crucial to critically evaluate the application of theory to achieve a more integrated understanding of behavior change interventions. Notably, despite being theory-based, many interventions fail to describe the strategies and behavior change

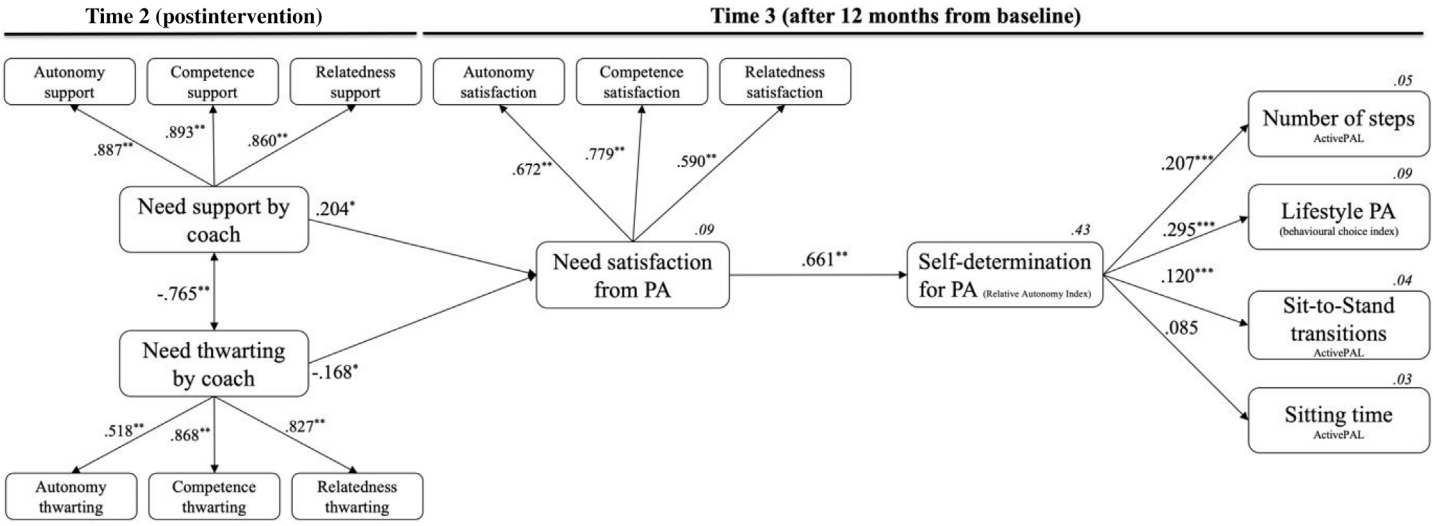

Figure 1 — Structural equation modeling adjusted by age, club, and sport spectator identifier. $^*P < .05$. $^{**}P < .01$. $^{***}P < .001$. PA indicates physical activity.

Table 2 Standardized Parameter Estimates of Indirect Effects

	β	SE	Bootstrap (95% CI)	*P*
Need support by coach → Self-determination				
Indirect effect (via need satisfaction PA)	0.135	0.045	0.068 to 0.217	.003
Need thwarting by coach → Self-determination				
Indirect effect (via need satisfaction PA)	–0.111	0.055	–0.209 to –0.027	.045
Need satisfaction PA → Number of steps				
Indirect effect (via self-determination)	0.137	0.034	0.084 to 0.193	.000
Need satisfaction PA → Sit-to-stand transitions				
Indirect effect (via self-determination)	0.080	0.031	0.033 to 0.133	.010
Need satisfaction PA → Sitting time				
Indirect effect (via self-determination)	–0.056	0.035	–0.114 to 0.001	.104
Need satisfaction PA → Lifestyle for PA				
Indirect effect (via self-determination)	0.190	0.040	0.130 to 0.263	.000
Need support by coach → Number of steps				
Indirect effect (via need satisfaction PA and self-determination)	0.028	0.012	0.012 to 0.054	.024
Need support by coach → Sit-to-stand transitions				
Indirect effect (via need satisfaction PA and self-determination)	0.016	0.009	0.006 to 0.035	.059
Need support by coach → Sitting time				
Indirect effect (via need satisfaction PA and self-determination)	–0.012	0.008	–0.029 to –0.001	.172
Need support by coach → Lifestyle for PA				
Indirect effect (via need satisfaction PA and self-determination)	0.040	0.016	0.019 to 0.072	.012
Need thwarting by coach → Number of steps				
Indirect effect (via need satisfaction PA and self-determination)	–0.023	0.012	–0.049 to –0.006	.066
Need thwarting by coach → Sit-to-stand transitions				
Indirect effect (via need satisfaction PA and self-determination)	–0.013	0.008	–0.032 to –0.003	.110
Need thwarting by coach → Sitting time				
Indirect effect (via need satisfaction PA and self-determination)	0.009	0.008	0.001 to 0.029	.241
Need thwarting by coach → Lifestyle for PA				
Indirect effect (via need satisfaction PA and Self-determination)	–0.033	0.018	–0.068 to –0.009	.067

Abbreviation: PA, physical activity.

techniques utilized or measure the constructs that predict behavior. This study investigated the motivational mechanisms embedded in SDT, specifically examining supportive versus thwarting motivational climates, basic psychological needs, and the RAI of self-determination. In addition, it detailed the integration of SDT into the program, elucidating long-term PA levels, including steps, moderate-to-vigorous physical activity, sedentary behavior, and sit-to-stand transitions, alongside subjectively measured lifestyle PA habits.

Overweight, middle-aged men have traditionally been categorized as a challenging demographic for engagement in health behavior change interventions.[29] The current study explores putative theoretical constructs of SDT at multiple time points, specifically postintervention and in the long term, as predictors of increased PA levels, assessed through both objective and subjective measurements. These findings underscore the potential efficacy of the EuroFIT program in promoting active lifestyles within this population. Notably, longitudinal support for psychological needs from the coach significantly and positively correlated with the satisfaction of these needs. Indeed, need support by the coach longitudinally and positively predicted need satisfaction. These findings are consistent with the SDT basic tenets[12] and recent meta-analyses of SDT-based interventions assessing the impact on motivation, health behaviors, physical health, and psychological health.[15,16] Psychological needs satisfaction is linked to autonomous motivation, adaptive behaviors, and overall health outcomes. By fostering feelings of autonomy and competence in individuals, practitioners and educators can promote positive social connections and a sense of belonging, ultimately leading to greater well-being and fulfillment.[58,59] In addition, this connection may be attributed to the coaches' emphasis on intervention climate and relatedness support. In contrast and as predicted, participants who perceived coaches as need-thwarting showed lower levels in satisfaction of their basic psychological needs. The nonfulfillment of fundamental needs can adversely impact an individual's motivation and behavior.[15]

Perceived need satisfaction predicted higher self-determination at 12 months. Participants who felt autonomous at the end of EuroFIT, effective in implementing PA (competence need satisfaction), and emotionally close to those who carried it out (relatedness need satisfaction) presented higher levels of self-determined motivation. These effects are comparable to those observed in meta-analyses, highlighting the significance of these factors in influencing behavior change outcomes.[60]

Higher levels of self-determined motivation at the intervention end (3 mo) were a significant antecedent to higher levels of objectively reported daily steps, lifestyle PA, and sit-to-stand transitions at 12 months. Previous studies of the influence of need

support and satisfaction on self-reported PA maintenance have shown similar results.[15,16,19]

Behavior change mediators are the crucial factors that connect an intervention with a shift in behavior. They offer insight into the underlying causes behind the success or failure of a PA intervention.[21] According to this data set, participants' perceptions of autonomy, competence, and relatedness support positively and longitudinally mediated the effect of coaches' need-supportive styles and their self-determined motivations. Conversely, need satisfaction negatively and longitudinally mediated the effect between the coaches' need-thwarting styles and self-determined motivations.

Data from the present study also suggests a positive association between participants' needs satisfaction and objectively measured PA-related lifestyle behaviors, such as the number of steps, sit-to-stand transitions, and PA, through self-determination. Participants who perceived their basic psychological needs to be met and reported self-determined motivations toward PA also reported higher levels of PA in variables such as the number of daily steps, their lifestyle PA, and sedentary time. In addition, perceived need for support positively and longitudinally predicted the fans' daily steps and lifestyle PA via need satisfaction and self-determination.

Limitations, Strengths, and Future Directions/ Practical Implications

This study tested SDT-related mechanisms in the context of a multicountry behavior change intervention to increase objectively measured PA and sedentary time. Key strengths of the current study pertain to the cultural and societal diversity of the sample (from 4 European countries), and the assessment of key putative motivational mediators from SDT at different time points (eg, postprogram need satisfaction/thwarting from coach; PA need satisfaction/thwarting and motivational regulations at 12 mo), allowing for testing the motivational sequence embedded in SDT at different time points. Another key strength of the study includes the objective analysis of measured PA and sedentary time. In addition, it measured sit-to-stand transitions, a crucial health outcome in the domain of PA.

This study has certain limitations. First, only overweight or obese men were recruited for the study, thereby limiting the generalizability of the results. The extensive interaction between participants and coaches, as well as club affiliation, may have triggered social desirability mechanisms, which would affect some of the findings.

It would be compelling to include more frequent assessments of mediators and outcomes or tracking predictor–outcome relationships to provide insights into longitudinal fluctuations and causal sequences of impact. By following and monitoring these assessments, the content of interventions can be personalized to suit individual needs, like just-in-time adaptive interventions, increasing engagement and providing additional support. To enhance the comprehensiveness of future studies, it is recommended that elaborate longitudinal data on behavior dynamics be gathered throughout the intervention. This can be achieved by utilizing electronic tracking mechanisms and ecological momentary assessments.

Conclusions

The present study demonstrated the effectiveness of the EuroFIT intervention in positively influencing theory-driven mediators, resulting in a significant internalization of autonomous motivation (via coach need-support and need-satisfaction). The associations between theoretical constructs were consistent with expected patterns and were significantly related to step count, PA, and sit-to-stand transitions. In the context of long-term physically active lifestyles, autonomous regulatory mechanisms were found to play a significant role, whereas the same was not observed for sedentary behavior. It was noted that self-determined motivational regulation did not significantly predict sedentary behavior, suggesting the influence of nonmotivation-related factors. The results align with SDT's basic tenets and confirm that interventions can create conditions for individuals to experience psychological need satisfaction and self-determined motivation, leading to health behavior change. The expansion of the EuroFIT program presents a compelling opportunity to effectively reach and engage individuals within a specific demographic identified as markedly resistant to conventional health behavior modification interventions. Furthermore, pivotal figures within this target population, including football coaches, can be equipped with the necessary training to communicate and implement strategies recognized as need-supportive behaviors. This approach is crucial as it is linked to fostering more self-determined motivation and promoting physically active lifestyles.

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