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Measuring Need-Supportive and Need-Thwarting Behaviors Among Athletes from Different Sports: Scale Validity and Reliability

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ABSTRACT

The objective of the present research is to examine the factor structure of the Interpersonal Behavior Questionnaire (IBQ) and the Interpersonal Behavior Self Questionnaire (IBQ-Self) in the sport context. Confirmatory factor analyses were used to assess the psychometric properties and measurement invariance across sex and sports. For the IBQ, a sample of 813 Portuguese athletes aged between 15 and 32 years ($M = 23.46$; $SD = 4.92$) took part in this study. They had an average sports experience of approximately 7.62 ± 3.23 years. For the IBQ-Self, a sample of 606 Portuguese coaches aged between 20 and 73 years ($M = 34.43$; $SD = 11.56$) participated in this study. Both scales demonstrated good fit, achieved convergent and discriminant validity, exhibited acceptable internal consistency, and demonstrated invariance across sex and sports. Regarding the analysis of psychometric properties, the IBQ and IBQ-Self can be applied to Portuguese athletes and their coaches to measure perceived behaviors of others and self-reported behaviors.

KEYWORDS

Athletes; interpersonal behavior; multigroup analysis; psychometric properties; self-determination theory

Introduction

In the sport context, the quality of engagement, characterized by factors such as pleasure and interest, plays a crucial role in determining individuals' participation and potential dropout (Castillo et al., 2000). Moreover, athletes who perceive that their fundamental psychological needs have been fulfilled exhibit enhanced self-regulation of behavior, leading to a more self-determined motivational orientation, positive outcomes, and greater dedication and commitment to sports participation (Jowett et al., 2017; Sarrazin et al., 2002). Conversely, individuals who perceive frustrated psychological needs are inclined to exhibit less self-determined regulation of behavior, resulting in a decline in the quality of sports motivation and unfavorable outcomes (Duda, 2013; Gould et al., 2002).

Interpersonal behaviors

Drawing upon Self-Determination Theory (SDT), it is evident that the behavior of others, including coaches, plays a crucial role in shaping athletes' experiences and outcomes in terms of need satisfaction or frustration. Specifically, the motivational climate fostered by coaches

has a significant influence on athletes' levels of intrinsic motivation (Monteiro et al., 2018). Extensive research has consistently demonstrated the significance of coaches' behaviors in shaping the experiences and performance outcomes of athletes (Rocchi et al., 2020; Teixeira et al., 2020). Notably, studies have documented that coaches' need-supportive behaviors, particularly those promoting autonomy, are positively associated with adaptive psychological outcomes and performance, while behaviors that frustrate athletes' needs, specifically autonomy-frustrating behaviors, are associated with negative consequences (Chu & Zhang, 2019; Raabe et al., 2019). Moreover, the social environment within the sport context further influences the subjective experience of need satisfaction or frustration, leading to diverse behavioral responses during sports practice (Ryan & Deci, 2017). In essence, the way individuals within the sport context, including coaches and the overall social environment, support or undermine the three basic psychological needs can significantly impact the quality of athletes' motivation and level of engagement.

Researchers have identified six distinct interpersonal behaviors that can influence the satisfaction or

frustration of the three basic psychological needs: autonomy-supportive behaviors, autonomy-thwarting behaviors, competence-supportive behaviors, competence-thwarting behaviors, relatedness-supportive behaviors, and relatedness-thwarting behaviors (Rocchi et al., 2016). Autonomy-supportive behaviors involve granting individuals freedom of choice and providing alternative options, while autonomy-thwarting behaviors involve the imposition of control, such as the use of rewards. Competence-supportive behaviors encompass providing positive feedback and reinforcement related to specific tasks, whereas competence-thwarting behaviors involve expressing behaviors that undermine individuals' sense of competence through blame and doubt. Similarly, relatedness-supportive behaviors entail demonstrating understanding, support, and care for others, while relatedness-thwarting behaviors involve perceived rejection.

It is important to recognize that these behaviors, although they may seem similar, differ in the extent to which they provide support or frustration to individuals' psychological needs and should be analyzed separately (Rodrigues et al., 2021b). By acting in ways that either support or frustrate the psychological needs of others, coaches have the power to either enhance or hinder the quality of athletes' motivation and the outcomes they ultimately experience. Understanding the distinctiveness of these behaviors and their impact on psychological needs satisfaction or frustration is crucial for researchers, practitioners, and coaches in fostering optimal motivation and well-being in various contexts, including the realm of sports. By promoting autonomy-supportive, competence-supportive, and relatedness-supportive behaviors, while mitigating autonomy-thwarting, competence-thwarting, and relatedness-thwarting behaviors, individuals can create environments that foster the satisfaction of athletes' psychological needs, thereby promoting positive outcomes and enhancing overall motivation and engagement.

In the realm of physical activity, exercise, and sports, a substantial body of research has consistently demonstrated the significant relationship between the quality of interpersonal behaviors and various outcomes. Specifically, in students-athletes populations, when individuals experience need support from coaches, teachers, or parents, positive consequences ensue, including enhanced performance and increased persistence (Rocchi et al., 2016, 2017; Standage et al., 2008). Conversely, interpersonal behaviors that frustrate individuals' psychological needs yield negative outcomes, such as heightened levels of depressive and anxious symptomatology (Soenens et al., 2008; Yli-Piipari et al., 2009). The aforementioned findings highlight

the fundamental significance of interpersonal interactions in influencing individuals' experiences and outcomes within the realm of physical activity. The provision of supportive behaviors that address individuals' psychological needs emerges as a critical factor in facilitating positive psychological functioning, cultivating optimal engagement, and enhancing performance. Conversely, when individuals are confronted with behaviors that undermine their psychological needs, it not only diminishes their overall well-being but also impairs their capacity to derive maximum benefits from their involvement in physical activity.

Therefore, the coach's interpersonal behaviors become important because they can support or hinder basic psychological needs (Rocchi et al., 2016, Ryan & Deci, 2000; Ryan & Deci, 2017). When coaches' interpersonal behavior supports athletes' BPNs, these are satisfied and positive outcomes emerge; whereas, when coaches' interpersonal behavior hinders athletes' BPNs, these needs are frustrated, and thwarted, and negative outcomes will be achieved (Deci & Ryan, 1985; Rocchi et al., 2016; Rodrigues et al., 2021; Ryan & Deci, 2000)

Current study

The Interpersonal Behavior Questionnaire (IBQ), developed by Rocchi et al. (2017) and Rocchi et al. (2016), is a valuable tool that assesses six dimensions of interpersonal behaviors based on Self-Determination Theory and measured need-supportive autonomy, relatedness, competence, and need thwarting behaviors. This questionnaire holds significant utility as it can be applied across various domains and is suitable for assessing how individuals perceive the interpersonal behaviors of specific targets, such as teachers, coaches, or supervisors (Burgueño & Medina-Casaubón, 2021; Rocchi et al., 2016, 2017; Rodrigues et al., 2021; Vosylis & Erentaitė, 2022; Wekesser et al., 2023). Additionally, the IBQ-Self enables the target to report their own interpersonal behaviors (IBQ-SELF). In their validation research, Rocchi et al. (2017) obtained validity evidence for a 24-item, six-factor correlation model. Furthermore, the results of various correlational analyses ranged from 0.61 to 0.78, signifying support for conceptual differentiation among the six factors that constitute the instrument's internal structure. The estimated Cronbach's alpha, with values ranging from 0.75 to 0.81, and the Average Variance Extracted (AVE) exceeding 0.50 for the six dimensions of the IBQ, offer strong support for reliability. A series of partial correlation analyses revealed indications of criterion validity. The resulting 24-item, three-factor correlated IBQ model demonstrated excellent psychometric performance in its

adaptation to both the Canadian sports environment and the Portuguese exercise context (Rocchi et al., 2017) (Rocchi Rocchi et al., 2016). By utilizing the IBQ, researchers gain insights into all six interpersonal behaviors and their associations with the satisfaction and frustration of three basic psychological needs. This comprehensive assessment contributes to a complete understanding of interpersonal dynamics and their impact on psychological well-being (Rodrigues et al., 2021b).

To validate the universal applicability of the IBQ and IBQ-Self in various social contexts and cultures, it is imperative to analyze the questionnaire within these specific contexts (Cid et al., 2022). Previous research, such as the study conducted by Rodrigues et al. (2021b), focused on examining perceptions of interpersonal behaviors among exercise professionals and the participants, while also exploring sex invariance. Adapting questionnaires to specific contexts is crucial in ensuring the relevance and accuracy of the collected data. Contextual and situational factors can influence individuals' perceptions and responses (Rodrigues et al., 2020; Vallerand & Lalande, 2011), making it essential to tailor the questionnaire to the specific context of interest (Rodrigues et al., 2020). By adapting questionnaires, researchers can capture the nuances and intricacies of the target population, enhancing the validity of the instrument. Ultimately, the utilization of valid and reliable questionnaires in psychometric testing strengthens the quality of research, enabling researchers to make meaningful contributions to their respective fields (Cid et al., 2022).

In line with this previous validation works (Burgueño & Medina-Casabón, 2021; Rodrigues et al., 2021; Vosylis & Erentaitė, 2022), the current study aims to investigate the perceptions of Portuguese athletes and their coaches using the IBQ and IBQ-SELF. Furthermore, this study aims to investigate invariance concerning sex, age, and sports within the measurement model. This is consistent with prior studies that have either demonstrated invariance or recommended such analysis across sexes, age-groups, and various sports. While the original scale showed invariance between sexes (Rocchi et al., 2017), more recent research has unveiled invariance across sex and age categories, suggesting potential distinctions in how individuals of different ages perceive the six specific dimensions of interpersonal behaviors exhibited by coaches (Burgueño & Medina-Casabón, 2021; Sabaliauskas et al., 2023). Additionally, previous studies have advised examining invariance with regards to different sports, as the coach-athlete relationship may differ based on the type of sport, for instance, team sports versus individual

sports (Cáceres et al., 2021). Therefore, analyzing invariance across groups with distinct characteristics, such as different sports, age-groups, and sex, can contribute to expanding our scientific knowledge and further our understanding of the universality of the underlying factors within self-determination theory, as suggested by Deci and Ryan (2008).

In essence, this research endeavors to assess the suitability of the IBQ and IBQ-SELF within the sport context. The study's hypotheses propose that: a) both scales will show strong reliability when assessing interpersonal behaviors among Portuguese sports participants; b) The measurement model will display invariance across sex; c) The measurement model will demonstrate invariance across various age-groups; d) The measurement model will exhibit invariance across different sports.

Methods

Participants

Sample size calculations were conducted a priori using the Soper Calculator (2023) for structural equation modeling. The purpose of these calculations was to determine the optimal sample size needed to adequately test the hypothesized factor structure of the measurement model. Factors such as the desired level of statistical power ($p = .9$), significance level ($p = .05$), latent variables (6), and the number of observed variables (24) were considered. By employing the Soper Calculator, we ensured that the sample size was sufficient to achieve reliable and meaningful results (minimum sample size to detect effect = 502 participants). This rigorous approach to sample size determination enhances the validity and precision of the factor analysis, providing more accurate insights into the underlying structure of the variables under investigation (Soper, 2023; White, 2022).

A total of 813 Portuguese athletes (330 male and 483 female), ranging in age from 15 to 32 years ($M = 23.46$; $SD = 4.92$), participated in the present study (≤ 22 years old - $n = 368$; ≥ 23 years old - $n = 445$). The sample included participants from football ($n = 269$), basketball ($n = 275$), and swimming ($n = 269$). The athletes' sport experience varied from 1 to 14 years ($M = 7.62$; $SD = 3.23$), with the number of training sessions per week ranging from 1 to 4 ($M = 3.13$; $SD = 0.84$), and the duration of training sessions varying from 45 to 90 minutes ($M = 61.05$; $SD = 14.73$).

Additionally, a total of 606 Portuguese coaches (279 male and 327 female), aged between 20 to 73 years ($M = 34.43$; $SD = 11.56$), participated in the study. The coaches represented football ($n = 279$), basketball ($n = 59$),

and swimming ($n = 268$). The coaches' training experience ranged from 1 to 40 years ($M = 7.95$; $SD = 5.43$).

These participants were recruited to examine various aspects related to the psychological needs and behaviors within the sports context. The diverse representation of athletes and coaches from different sports and a wide age range aimed to provide a comprehensive understanding of the dynamics involved in the present study.

Procedures: data collection

Prior to data collection, ethical approval was obtained from the institution of the first author (CE/IPLEIRIA/26/2021) in accordance with the guidelines outlined in the Helsinki Declaration of the World Medical Association (2013). To ensure a representative sample of athletes, several sport associations ($n = 8$) were contacted during the recruitment process. This approach aimed to include a diverse range of clubs and increase the generalizability of the study findings within the context of interest. The selection of sport clubs, namely basketball, football, and swimming, that are affiliated in the sport association was based on practical considerations and availability, considering factors such as geographic location and the type of sports practiced. It should be emphasized that the sport clubs involved in this research were selected through convenience sampling. It is noteworthy that, after supplying contacts of the sport clubs affiliated in the regional association, all contacted clubs willingly agreed to participate in the study, indicating their cooperation and support. Subsequently, permissions were sought from the relevant sports clubs, and informed consent was obtained from all participants, ensuring adherence to ethical considerations, and protecting the rights and confidentiality of the individuals involved. Additionally, for underage athletes, signed informed consent was obtained from their parents or legal guardians, ensuring that their participation in the study was authorized and in compliance with ethical guidelines. To safeguard the confidentiality and independence of the participants, the questionnaires were administered in dedicated spaces, ensuring that athletes were not in the presence of their coaches. Likewise, head coaches and assistant coaches completed the questionnaire in separate designated rooms, away from their athletes. Furthermore, participants were specifically instructed to provide their perceptions of their current coach, rather than previous coaches, to capture their current experiences and perceptions accurately. The data collection process involved anonymous administration of the questionnaires, and participants were assured that their responses would be treated with strict

confidentiality. The questionnaires were conducted at the commencement of training sessions, with each questionnaire taking approximately 12 minutes for both coaches and athletes to complete. All data was collected in person.

Procedures: adaptation of the questionnaires to the sport context

The adaptation of the IBQ and IBQ-SELF based on the Portuguese exercise version (Rodrigues et al., 2021) into the sport context adhered to the recommended procedures outlined by Cid et al. (2022). The process involved several sequential steps: (i) initial adaptation of the IBQ and IBQ-SELF, as created by the authors, involved modifying the stems of the questionnaires to transition from an exercise to a sports context. Specifically, "My exercise instructor" was changed to "My coach" for the IBQ, and "When I am with my clients" was modified to "When I am with my athletes" for the IBQ-SELF; (ii) submission of the adapted stems to a first panel of specialists in sports sciences and psychometric analysis. We specifically inquired with the panel whether the stem adaptation would suffice or if a complete questionnaire revision would be necessary; (iii) subsequent submission to a second panel of specialists, distinct from the first panel, who possessed expertise in sports sciences and psychometric analysis; (iv) The assessment of temporal stability, conducted through a test-retest method involving a sample of more than 40 athletes and 40 coaches with a two-week interval, included the calculation of the intraclass correlation coefficient; (v) final revision performed by two Portuguese teachers who meticulously reviewed the final version of the questionnaires, ensuring proper syntax, spelling, and grammar. The final version is a Portuguese adaptation of the IBQ, tailored to the sports context. The items remain consistent with the Portuguese exercise version, with only the stems being modified as described previously.

Instruments

A Portuguese version of the IBQ adapted to sport based on the exercise version developed by Rodrigues et al. (2021), was employed to assess athletes' perceptions of their coaches' interpersonal behaviors in the sport domain. The questionnaire, adapted to the specific context, consists of 24 items, organized into six factors, with four items each. These factors include Autonomy Support (e.g., "My coach supports my choices"), Competence Support (e.g., "My coach encourages me to improve my skills"), Relatedness Support (e.g., "My coach really likes to spend time with me"), Autonomy Thwarting (e.g., "My coach imposes his opinions"),

Competence Thwarting (e.g., “My coach questions my ability to overcome challenges”), and Relatedness Thwarting (e.g., “My coach does not build empathy with me”). Participants responded to each item using a 7-point Likert scale ranging from 1 (“do not agree at all”) to 7 (“completely agree”). Previous research studies (Rocchi & Pelletier, 2018; Rocchi et al., 2016, 2017) have provided support for the use of this scale in measuring perceived interpersonal behaviors from others.

Similarly, coaches completed the IBQ-SELF adapted to sport based on the exercise version (Rodrigues et al., 2021) to assess their interpersonal behaviors while coaching their athletes. The IBQ-SELF was also adapted to the sport context based on previous reported procedures. It consists of 24 items, organized into the same six factors as the IBQ, with four items each. These factors include Autonomy Support (e.g., “When I am with my athletes, I support their decisions”), Competence Support (e.g., “When I am with my athletes, I provide valuable feedback”), Relatedness Support (e.g., “When I am with my athletes, I take the time to get to know them”), Autonomy Thwarting (e.g., “When I am with my athletes, I limit their choices”), Competence Thwarting (e.g., “When I am with my athletes, I question their capacity to improve”), and Relatedness Thwarting (e.g., “When I am with my athletes, I do not connect with them”). Coaches rated their agreement with each item on a 7-point Likert scale ranging from 1 (“do not agree at all”) to 7 (“completely agree”). Previous studies (Rocchi & Pelletier, 2018; Rocchi et al., 2016, 2017) have provided empirical support for the use of this scale in assessing perceived interpersonal behaviors from others.

Statistical analysis

Test-retest analysis

The test-retest analysis took place during the data collection, and it was administered at the outset of training sessions for both athletes and coaches. Furthermore, the test-retest assessments were conducted by the first author of the current study. To assess the temporal reliability of the IBQ and IBQ-SELF, the intraclass correlation coefficient (ICC) was computed using SPSS (IBM Corp., 2020). The ICC was calculated for each item and factor, with predefined cutoff values employed to determine the level of reliability. According to Koo and Li (2016), ICC values $\leq .05$ indicate poor reliability, values ranging from 0.5 to 0.75 indicate moderate reliability, values ranging from 0.75 to 0.90 indicate good reliability, and values ≥ 0.90 indicate excellent reliability. These cutoff values were applied to evaluate the temporal reliability of the questionnaires in the present

study (see step iv off the Procedures: Adaptation of the questionnaires to the sport context).

Confirmatory factor analysis

A CFA using the full information maximum likelihood approach and covariance matrix was conducted in AMOS version 27 (IBM Corp., 2020), following recommendations from various authors (Hair et al., 2019; Marsh et al., 2004). The CFA aimed to assess the goodness-of-fit of the measurement model. Several indices were employed to evaluate the fit, including the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA) with its 90% confidence interval. Acceptable cutoff values for these indices were set as CFI and TLI ≥ 0.90 , SRMR and RMSEA ≤ 0.08 (Hair et al., 2019; Marsh et al., 2004). The extent of missing data in our study was less than 5% of the entire dataset, and it occurred randomly. To address this issue, we employed Full Information Maximum Likelihood (FIML) imputation, which is widely accepted for managing missing data in structural equation modeling and other statistical analyses (Lee & Beretvas, 2023).

Convergent validity was evaluated using the Average Variance Extracted (AVE), a common method for construct validation. AVE measures the proportion of variance captured by a construct in relation to the variance attributed to measurement error. Values equal to or greater than 0.50 were deemed acceptable (Hair et al., 2019). Values equal to or higher than 0.50 were considered acceptable. Discriminant validity was established when the AVE of each construct exceeded the squared correlations between all factors in the model (Hair et al., 2019). Lastly, the internal consistency of each subscale was evaluated using composite reliability estimated through Raykov’s formula (Raykov, 1997). Values equal to or higher than 0.70 were considered indicative of good composite reliability.

Invariance analysis and latent mean differences analysis

To examine the equivalence of the measurement model underlying the IBQ and IBQ-SELF across sex, age group (15–22, $n = 368$ vs 23 and older, $n = 445$) and type of sport (the samples of basketball coaches were not included in the analysis due to the insufficient sample size for conducting invariance analysis), a multigroup analysis was conducted. This analysis is guided by established guidelines and procedures proposed by several authors (Byrne, 2016; Cheung & Rensvold, 2002; Pacewicz et al., 2022; Sass, 2011). The evaluation of measurement invariance involves two

key steps. First, the measurement model should demonstrate a good fit to the data for each group being compared. Second, different levels of invariance, including configural, weak (metric), strong (scalar), and strict invariance, need to be assessed. Specific criteria were applied to evaluate the different types of invariances. Configural invariance assesses whether identical latent factors exist within each group and if the identical arrangement of free and fixed factor loadings is evident in each group. Weak invariance tests the equivalence of factor loadings across groups. Strong invariance tests the equivalence of intercepts across groups. Strict invariance assesses the uniformity of the residual covariance matrix across groups. It examines whether there are comparable residual variances for the observed variables and comparable residual covariances (if modeled) between the observed variables across different groups (Pacewicz et al., 2022). For configural invariance, a Δ CFI value of less than .01 was considered acceptable. For weak invariance, Δ SRMR values less than .030 and Δ RMSEA values less than .015 were used. Strong invariance required Δ SRMR values less than .010, and measurement invariance required Δ RMSEA values less than .015. By applying these criteria, the analysis aimed to assess the measurement invariance of the IBQ and IBQ-SELF across different groups in the study. According to Marsh (1993), when employing this procedure to analyze models, measurement invariance is regarded as a fundamental criterion, while the strict invariance (the final criterion) does not necessarily imply a lack of model invariance. Some authors have even regarded the examination of this criterion as infrequent due to its highly restrictive nature (Byrne, 2016). However, there is no consensus on the necessity of evaluating strict invariance (Byrne, 2016). Thus, the assessment of this assumption is considered optional by researchers because it is exceedingly restrictive and challenging to attain in social sciences research, which does not necessarily indicate a lack of invariance (Cheung & Rensvold, 2002).

We utilized structural analyses of means and covariances to examine disparities in latent means across sex, sports, and age-groups within each factor. In the male samples, the latent mean values were consistently set to zero, while in the female samples, they were freely estimated. Simultaneously, for the football sample and the youngest age group, the latent mean values were consistently fixed at zero. In the analysis of Swimming-Basketball, the swimming sample's latent mean values were consistently set to zero. To assess the statistical significance of latent mean differences between sample groups and sex, we employed the z statistic. These comparisons of latent mean differences were conducted only

after establishing a robust invariance multi-group model. In the event of significant differences, Cohen's d effect sizes will be calculated (Byrne, 2016).

Results

Test-retest analysis

Tables 1 and 2 present the results of the test-retest analysis, measured by the ICC. The findings revealed good reliability for the items, as indicated by ICC values exceeding 0.75 for both the IBQ and IBQ-SELF questionnaires. This suggests that the items demonstrated consistent responses over time, enhancing the reliability of the measures.

Confirmatory factor analysis

The measurement model of the IBQ and IBQ-Self was assessed for its fit to the data in all analyzed samples. Table 3 presents the goodness-of-fit indices of the model. The results indicate an acceptable fit, as evidenced by incremental indices exceeding the threshold of 0.90 and absolute indices below the threshold of 0.08. These findings support the adequacy and validity of the IBQ and IBQ-Self measurement model in capturing the

Table 1. Intraclass correlation coefficient of the IBQ.

Factors/Items	ICC
Autonomy Support	.897**
Item 1	.731**
Item 7	.765**
Item 13	.843**
Item 19	.788**
Autonomy Thwarting	.822**
Item 2	.754**
Item 8	.752**
Item 14	.767**
Item 20	.761**
Competence Support	.841**
Item 3	.791**
Item 9	.795**
Item 15	.721**
Item 21	.824**
Competence Thwarting	.801**
Item 4	.797**
Item 10	.810**
Item 16	.797**
Item 22	.773**
Relatedness Support	.867**
Item 17	.785**
Item 18	.898**
Item 19	.868**
Item 20	.751**
Item 21	.760**
Relatedness Thwarting	.831**
Item 5	.893**
Item 12	.788**
Item 18	.794*
Item 24	.799**

ICC = intraclass correlation coefficient.

Table 2. Intraclass correlation coefficient of the IBQ-SELF.

Factors/Items	ICC
Autonomy Support	.846**
Item 1	.831**
Item 7	.896**
Item 13	.853**
Item 19	.888**
Autonomy Thwarting	.852**
Item 2	.804**
Item 8	.798**
Item 14	.847**
Item 20	.772**
Competence Support	.881**
Item 3	.891**
Item 9	.895**
Item 15	.767**
Item 21	.812**
Competence Thwarting	.817**
Item 4	.799**
Item 9	.816**
Item 16	.897**
Item 22	.876**
Relatedness Support	.897**
Item 6	.885**
Item 7	.875**
Item 8	.868**
Item 9	.849**
Relatedness Thwarting	.821**
Item 1	.873**
Item 2	.881**
Item 3	.794*
Item 4	.800**

ICC = intraclass correlation coefficient;
* $p < .05$; ** $p < .001$.

intended constructs and their relationships within the observed data.

All items in the IBQ and IBQ-SELF measurement scales exhibited factor loadings equal to or greater than .50, as displayed in Figures 1 and 2, indicating that they accounted for a minimum of 25% of the variance in their respective latent factors. Furthermore, the composite reliability (CR) scores for all subscales surpassed the recommended threshold ($CR > .70$) in both scales, indicating satisfactory internal consistency

and suggesting that the items effectively measure the intended constructs (Table 4). The convergent validity of the scales was also established, with all scores exceeding .50, affirming that the items within each subscale were positively related. Additionally, the scales demonstrated adequate discriminant validity, as the squared correlations between factors were lower than the AVE, except for the correlations between autonomy-support and relatedness-support, as well as between competence-thwarting and relatedness-thwarting, which were observed in both scales (refer to Table 5).

The results of the invariance analysis indicated that both the IBQ and IBQ-SELF measurement models were equivalent across different sexes and sports, namely football, swimming, and basketball for IBQ, and football and swimming for IBQ-SELF. The fit indices of the models, as presented in Table 6, demonstrated a good fit to the data. Moreover, the models met the established criteria for invariance, as the cutoff values specified in the methodology for invariance analysis were satisfied. There are no strict invariance identified in the IBQ for the Football-Swimming, Football-Basketball, and Swimming-Basketball analyses, as well as in the IBQ-Self for the Football-Swimming and Male-Female analyses.

The data showed that there were no significant differences in the perception of interpersonal behaviors among sports practitioners and coaches across different sexes, sports, and age-groups, as indicated in Table 6. Since there were no significant differences, it was not necessary to calculate the respective effect sizes.

Discussion

The primary objective of the current study was to investigate the factorial structure and nomological

Table 3. Measurement fit indexes.

Model	χ^2	df	χ^2/df	B-S p	CFI	TLI	SRMR	RMSEA	90%CI
IBQ									
Total sample	816.56*	237	3.44	<.001	.933	.922	.039	.055	.051, .059
Male sample	542.77*	237	2.29	<.001	.919	.905	.053	.063	.056, .070
Female sample	606.346*	237	2.55	<.001	.927	.9165	.041	.057	.051, .062
Football sample	465.681	235	1.96	.002	.920	.907	.053	.060	.052, .068
Swimming sample	464.363	237	1.96	.002	.924	.912	.054	.060	.052, .068
Basketball sample	493.475	237	2.08	<.001	.916	.902	.049	.063	.055, .071
Age: 15–22 years old	568.4	237	2.40	<.001	.921	.907	.046	.062	.055, .068
Age: 23 years old and older	545	237	2.29	<.001	.933	.922	.045	.045	.048, .060
IBQ-SELF									
Total sample	547.43*	237	2.30	<.001	.949	.940	.038	.047	.041, .052
Male Sample	450.247*	237	1.89	.018	.927	.914	.048	.057	.049, .065
Female Sample	422.85*	237	1.78	.026	.945	.936	.045	.049	.041, .057
Football sample	547.432	237	2.31	<.001	.949	.940	.038	.047	.041, .052
Swimming sample	386.213	237	1.63	.09	.942	.933	.048	.049	.040, .057

χ^2 = chi-square; df = Degrees of freedom; χ^2/df = The ratio of χ^2 to df; Bollen-Stine p-value; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; SRMR = Standardized Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; 90%CI = 90% Confidence Interval.

Table 4. Composite reliability, convergent and discriminant validity.

Latent variables	CR	AVE	1	2	3	4	5	6
IBQ								
1. Autonomy Support	.732	0.50	1					
2. Autonomy Thwarting	.785	0.50	.33	1				
3. Competence Support	.838	0.56	.46	.10	1			
4. Competence Thwarting	.804	0.51	.19	.47	.16	1		
5. Relatedness Support	.842	0.57	.70	.32	.36	.31	1	
6. Relatedness Thwarting	.807	0.51	.23	.49	.05	.57	.46	1
IBQ-SELF								
1. Autonomy Support	.717	0.50	1					
2. Autonomy Thwarting	.790	0.50	.37	1				
3. Competence Support	.834	0.55	.40	.07	1			
4. Competence Thwarting	.808	0.51	.20	.46	.14	1		
5. Relatedness Support	.816	0.52	.68	.31	.34	.31	1	
6. Relatedness Thwarting	.814	0.52	.25	.49	.06	.56	.48	1

CR = Composite reliability; AVE = Average Variance Extracted; squared correlations are reported below the diagonal line.

validity of the Portuguese versions of the IBQ and IBQ-Self within the context of sports practice and their respective coaches. Additionally, an important aspect of this study was to examine the measurement invariance of these instruments across sex, and age-groups and different sports. By exploring these aspects, we aimed to provide valuable insights into the psychometric properties and applicability of the IBQ and IBQ-Self in the Portuguese sporting context. Based on the SDT framework, the findings of this study indicate that the Portuguese versions of the IBQ and IBQ-Self, comprising 24 items and a six-factor correlated model, exhibited a satisfactory fit in both samples of athletes and coaches. Moreover, the measurement model demonstrated consistency across male and female athletes, as well as across different sports. These results align with previous research conducted on the original version of the questionnaire (Rocchi et al., 2017) and its adaptations (Burgueño & Medina-Casabón, 2021; Rodrigues et al., 2021; Vosylis & Erentaitė, 2022). The consistency of the findings across multiple studies and diverse populations underscores the robustness and generalizability of the IBQ and IBQ-SELF, supporting their utility in assessing interpersonal behaviors within the sports domain. Moreover, in the 24-item version, all factor loadings were statistically significant, showing strong associations with their respective factors and no evidence of cross-loading, thus providing further support for factor validity (Byrne, 2016; Hair et al., 2019).

Regarding internal consistency, the findings of the present study indicate that all factor coefficients for both the IBQ and IBQ-Self exhibited satisfactory levels of internal consistency, consistent with established guidelines (Hair et al., 2019). These coefficients align with those reported in the original studies (Rocchi et al., 2016, 2017) as well as the study examining the applicability of the scales among Portuguese exercisers and

their trainers (Rodrigues et al., 2021a, 2021b) and with adolescents (Burgueño & Medina-Casabón, 2021). Additionally, all factors demonstrated acceptable convergent validity, as indicated by the AVE values exceeding the recommended threshold of 0.50.

Discriminant validity was also examined, and the results demonstrated that the squared correlations between the subscale scores were lower than the AVE values in thirteen out of fifteen correlations. Although the correlations between autonomy-support and relatedness-support, as well as between competence-thwarting and relatedness-thwarting displayed lack of discriminant validity, these relationships did not reach levels indicative of multicollinearity ($<.80$), mitigating concerns about shared variance (Field, 2009). From a theoretical perspective, autonomy-support refers to behaviors that promote individuals' sense of autonomy, choice, and volition, while relatedness-support involves behaviors that foster a sense of connection, belonging, and social support. On the other hand, competence-thwarting refers to behaviors that undermine individuals' feelings of competence and confidence, and relatedness-thwarting involves behaviors that hinder social connection and support. While the squared correlations between autonomy-support and relatedness-support, as well as between competence-thwarting and relatedness-thwarting, may suggest some overlap or shared variance, it is important to consider the nuanced nature of these constructs. Theoretically, it is plausible that individuals can perceive autonomy-supportive behaviors without necessarily perceiving relatedness-supportive behaviors, and vice versa. Previous studies have demonstrated that the lack of discriminant validity could also be associated by the fact that needs are interdependent and that the experience of one need satisfaction could lead to the satisfaction of all basic psychological needs

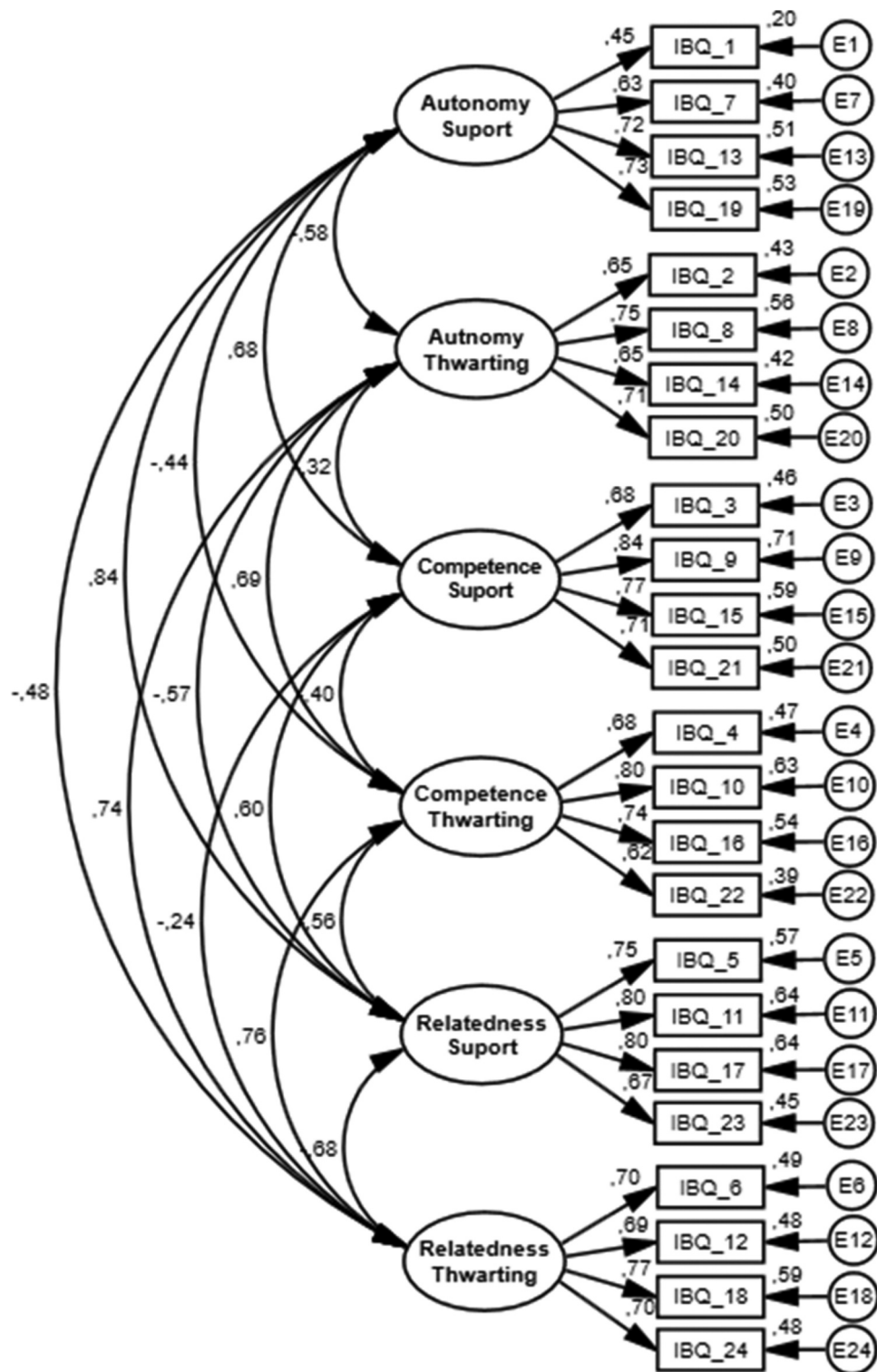


Figure 1. Standardized factor loadings of the IBQ.

(Rodrigues et al., 2021a; Ryan & Deci, 2017). Similarly, individuals may experience competence-thwarting behaviors that are distinct from experiences of relatedness-thwarting behaviors. Theoretical arguments support the idea that these constructs capture different aspects of interpersonal behaviors, with each

playing a unique role in individuals' motivation and psychological well-being.

Furthermore, empirical evidence from previous studies supports the distinctiveness of these constructs (Rocchi et al., 2016, 2017). While the lack of discriminant validity in the squared correlations between

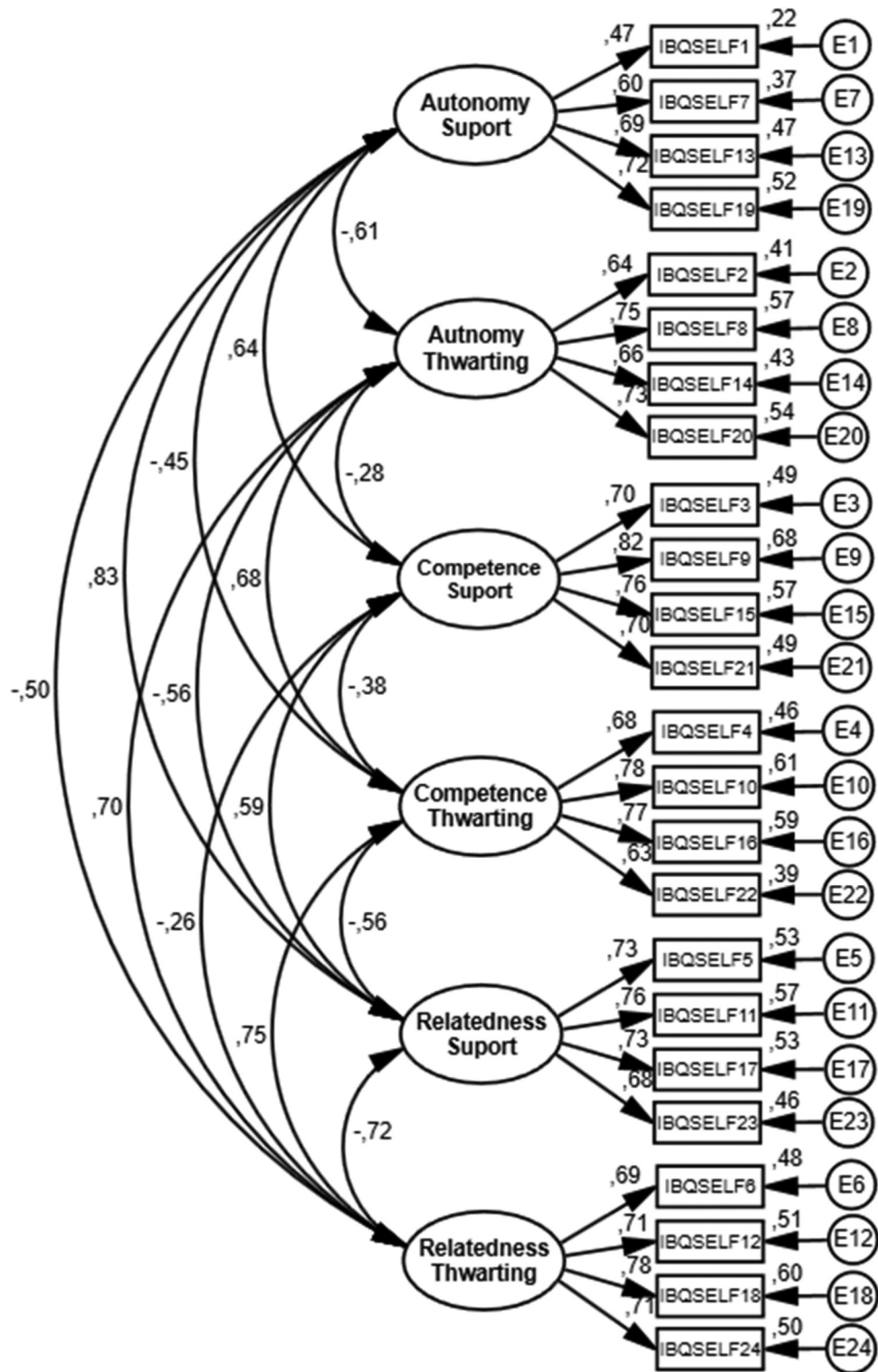


Figure 2. Standardized factor loadings of the IBQ-Self.

autonomy-support and relatedness-support, as well as between competence-thwarting and relatedness-thwarting, might suggest some shared variance, it does not necessarily imply that the constructs are not distinct. It is possible that these correlations reflect

conceptual overlap or common underlying mechanisms between these constructs (Ryan & Deci, 2017). However, previous research has consistently demonstrated the distinct effects of autonomy-support, relatedness-support, competence-thwarting, and

Table 5. Measurement invariance across sports, age group and sex.

Models	χ^2	df	$\Delta \times 2$	Δdf	p	CFI	ΔCFI	SRMR	$\Delta SRMR$	RMSEA	$\Delta RMSEA$
IBQ											
Football – Swimming											
Configural Invariance	930.040	474	-	-	-	.922	-	.053	-	.042	-
Metric Invariance	979.722	492	49.68	18	≤.001	.917	.005	.054	.001	.043	.001
Strong Invariance	1033.139	513	103.09	39	≤.001	.912	.010	.067	.010	.043	.001
Strict Invariance	1126.052	537	196.01	63	≤.001	.899	.023	.069	.016	.045	.003
Football – Basketball											
Configural Invariance	959.156	474	-	-	-	.918	-	.053	-	.043	-
Weak Invariance	984.301	492	25.14	18	.121	.916	.002	.053	.000	.043	.000
Strong Invariance	1009.581	513	50.42	39	.104	.916	.002	.055	.002	.042	.001
Strict Invariance	1088.253	537	129.09	63	≤.001	.906	.012	.058	.005	.044	.001
Swimming – Basketball											
Configural Invariance	957.838	474	-	-	-	.920	-	.054	-	.043	-
Weak Invariance	985.813	492	27.97	18	.062	.918	.002	.054	.000	.043	.000
Strong Invariance	1040.907	513	83.06	39	≤.001	.913	.007	.061	.007	.044	.001
Strict Invariance	1149.415	537	191.577	63	≤.001	.899	.021	.062	.008	.046	.003
Male – Female											
Configural Invariance	1149.190	474	-	-	-	.923	-	.053	-	.042	-
Weak Invariance	1166.719	492	17.529	18	.487	.923	.000	.053	.000	.041	.001
Strong Invariance	1200.951	513	51.761	39	.083	.922	.001	.059	.006	.041	.001
Strict Invariance	1284.794	537	135.604	63	≤.001	.915	.008	.061	.008	.041	.001
Age: 15–22 vs 23 and older											
Configural Invariance	1149.190	474	-	-	-	.923	-	.0535	-	.042	-
Weak Invariance	1166.719	492	17.530	18	≤.001	.923	.000	.0529	.006	.041	.001
Strong Invariance	1196.628	516	51.761	39	≤.001	.923	.000	.0531	.004	.040	.002
Strict Invariance	1313.993	561	135.604	63	≤.001	.915	.008	.0618	.083	.041	.001
IBQ-SELF											
Football – Swimming											
Configural Invariance	902.259	474	-	-	-	.924	-	.053	-	.041	-
Weak Invariance	928.589	492	26.33	18	.092	.922	.002	.056	.003	.040	.001
Strong Invariance	992.160	513	89.901	39	≤.001	.915	.009	.061	.008	.041	.000
Strict Invariance	1107.155	537	204.896	63	≤.001	.899	.025	.062	.009	.044	.003
Male – Female											
Configural Invariance	873.131	474	1.842	-	-	.936	-	.048	-	.037	-
Weak Invariance	896.899	492	1.823	18	.163	.935	.001	.049	.001	.037	.000
Strong Invariance	1016.321	513	1.981	39	≤.001	.926	.010	.062	.010	.040	.003
Strict Invariance	1107.717	537	2.063	63	≤.001	.909	.021	.069	.021	.042	.005

Df = degrees of freedom; $\Delta \times 2$ = differences in χ^2 ; Δdf = differences in df; CFI = comparative fit index; ΔCFI = differences in CFI; SRMR = standardized root mean square residual; $\Delta SRMR$ = differences in SRMR; RMSEA = root mean square error of approximation; $\Delta RMSEA$ = differences in RMSEA.

relatedness-thwarting on individuals' psychological needs and motivation (Rodrigues et al., 2021, 2021b). These findings provide empirical support for the idea that these factors represent distinct dimensions of interpersonal behaviors.

In this study, invariance tests were carried out to evaluate the performance of both the IBQ and IBQ-Self. Specifically, for IBQ invariance was tested across sexes (male and female), age-groups (15–22 vs 23 and older), and various sports (swimming, basketball, and football). Regarding to IBQ-SELF invariance between sexes (male and female), and between swimming and football was performed. While the original scale demonstrated invariance between sexes for both IBQ and IBQ-SELF (Rocchi et al., 2017), recent research has also revealed invariance across both sexes and different age-groups, suggesting potential distinctions in how individuals of varying ages perceive the six specific dimensions of coaches' interpersonal behaviors (Burgueño & Medina-Casabón, 2021; Sabaliauskas et al., 2023).

Similarly, previous studies have advised conducting invariance analyses based on the type of sport, for IBQ, as there may be variations in the coach-athlete relationship depending on the nature of the sport, such as team sports versus individual sports (Cáceres et al., 2021). The findings indicated that the measurement models displayed invariance across these groups, demonstrating consistent performance for both men and women, across various sports, and age-groups. Regarding strict invariance, this aspect was rarely examined in this study, except in the cases of Male-Female and age-group (IBQ). Nevertheless, there is no consensus in the literature regarding the necessity of evaluating strict invariance (i.e., strict invariance), and its assessment is considered optional by some researchers, as suggested by Cheung and Rensvold (2002). Additionally, according to Byrne (2016), the lack of consensus on this type of invariance is seen as overly restrictive, as it implies that the factorial weights, intercepts, and variance and covariance of residuals should

Table 6. Latent mean differences on interpersonal behavior constructs across sports, sex and ages.

Models	difference	z	p
IBQ			
Football – Swimming			
Autonomy Support	.051	1.471	.141
Autonomy Thwarting	-.113	-1.971	.049
Competence Support	.040	.782	.434
Competence Thwarting	-.064	-1.368	.171
Relatedness Support	.039	.869	.385
Relatedness Thwarting	-.054	-.815	.415
Football – Basketball			
Autonomy Support	.035	.807	.420
Autonomy Thwarting	-.028	-.545	.585
Competence Support	.038	.806	.420
Competence Thwarting	-.036	-.843	.400
Relatedness Support	.021	.452	.652
Relatedness Thwarting	-.072	-1.147	.251
Swimming – Basketball			
Autonomy Support	.078	2.207	.06
Autonomy Thwarting	-.137	-2.278	.06
Competence Support	.080	1.496	.135
Competence Thwarting	-.106	-2.070	.07
Relatedness Support	.059	1.381	.167
Relatedness Thwarting	-.125	-1.974	.06
Male – Female			
Autonomy Support	.025	.768	.443
Autonomy Thwarting	-.016	-.334	.739
Competence Support	-.007	-.170	.865
Competence Thwarting	.016	.413	.680
Relatedness Support	-.007	-.187	.852
Relatedness Thwarting	-.008	-.145	.885
Age: 15–22 vs 23 and older			
Autonomy Support	-.025	-.768	.443
Autonomy Thwarting	.016	.334	.739
Competence Support	.007	.170	.865
Competence Thwarting	-.016	-.413	.680
Relatedness Support	.007	.187	.852
Relatedness Thwarting	.008	.145	.885
IBQ-SELF			
Football – Swimming			
Autonomy Support	-.024	-.589	.556
Autonomy Thwarting	-.015	-.266	.790
Competence Support	.097	1.841	.066
Competence Thwarting	.073	1.511	.131
Relatedness Support	-.051	-1.126	.260
Relatedness Thwarting	.102	1.568	.117
Male – Female			
Autonomy Support	-.010	-.245	.807
Autonomy Thwarting	-.045	-.795	.427
Competence Support	.112	2.078	.063
Competence Thwarting	-.027	-.578	.563
Relatedness Support	-.079	-1.789	.074
Relatedness Thwarting	.124	2.048	.061

not differ significantly. This level of strict invariance is particularly challenging to achieve in the social sciences, but its absence does not necessarily indicate a lack of model invariance, as noted by Cheung and Rensvold (2002). Invariance analysis is essential as it allows researchers to ascertain whether the measurement scales capture the same underlying constructs and exhibit similar psychometric properties across diverse groups (Chen, 2007). By demonstrating measurement invariance, it provides evidence that the scales are robust and reliable in capturing the intended constructs across various contexts. The adherence to invariance assumptions, as outlined by Byrne (2016), further strengthens

the validity of the results. These assumptions include configural invariance, where the same factorial structure holds across groups, metric invariance, where factor loadings are equivalent across groups, strong invariance, where item intercepts are equivalent across groups, and strict invariance, where residual variances and covariances are equivalent across groups. The successful fulfillment of these assumptions suggests that the measurement models of both the IBQ and the IBQ-Self are consistent and comparable across sex and different sports (Hair et al., 2019). Overall, the invariance tests conducted in this study provide robust evidence supporting the equivalence and applicability of the IBQ and the IBQ-SELF across diverse groups. This finding is particularly valuable for researchers and practitioners working in the sport context, as it assures the consistency and reliability of these instruments in assessing interpersonal behaviors in both male and female athletes, as well as across different sports.

Our study did not reveal any significant differences in terms of latent means between the samples for the IBQ and IBQ-Self. This implies that both sexes, sports, and age-groups perceived similar levels of interpersonal behaviors, regardless of whether they were sports participants or coaches. In essence, these findings suggest that various groups appear to experience sports in a comparable manner, similar to the exercise version (Rodrigues et al., 2021). In summary, these results affirm the effectiveness of the IBQ and IBQ-Self in evaluating supportive and oppositional interpersonal behaviors among sports practitioners and their coaches.

Limitations and agenda for future research

While the present study is grounded in a robust theoretical framework, it is important to acknowledge certain limitations. Firstly, the generalizability of our findings may be limited to the specific context and culture in which the study was conducted. Therefore, caution should be exercised when applying the scales in different countries or contexts, as cultural variations may impact the interpretation and relevance of the measurement. Future research should aim to establish the validity of the IBQ and IBQ-Self in diverse cultural settings to ensure their cross-cultural applicability. Additionally, the present study primarily focused on athletes from a specific sport, and the sample may not fully represent the entire population of athletes. It is crucial to conduct further investigations with more diverse samples, encompassing athletes from various sports and levels of expertise, to strengthen the generalizability of the findings. Furthermore, expanding the scope of analysis to

include other groups involved in the sports context, such as parents, managers, or teammates, would provide a more comprehensive understanding of the interpersonal dynamics and the validity of the scales across different perspectives. Despite these limitations, our study contributes to the existing literature by providing evidence for the construct validity of the IBQ and IBQ-Self instruments. The distinction between supportive and frustrating interpersonal behaviors is reinforced, emphasizing the importance of assessing athletes' perceptions of these behaviors. In conclusion, we recommend that future studies consider the use of exploratory structural equation modeling (ESEM) as a promising alternative to address certain analytical challenges. ESEM allows for a more flexible and nuanced exploration of the data, which can be particularly beneficial in complex research scenarios, providing a valuable tool for enhancing our understanding of the underlying structures and relationships within the observed variables. By incorporating ESEM into their analyses, researchers may gain new insights and perspectives, leading to more robust and comprehensive findings.

Practical implications

Measuring need-supportive and need-thwarting behaviors using the IBQ and IBQ-Self instruments in the sport context is of great significance due to various reasons. Firstly, it is essential for understanding the interpersonal behaviors displayed by coaches, as it allows for the creation of a supportive and positive environment for athletes. By assessing the extent to which coaches and athletes engage in behaviors that fulfill athletes' psychological needs for autonomy, competence, and relatedness, areas requiring improvement can be identified, and interventions can be implemented to enhance athletes' motivation and well-being. Secondly, the IBQ and IBQ-Self provide a comprehensive framework for examining interpersonal interactions within the sports setting. By capturing athletes' perceptions of their coaches' behaviors and coaches' self-perceptions, a more complete understanding of interpersonal dynamics and potential discrepancies between perceived and actual behaviors is obtained (Rocchi & Pelletier, 2018). This understanding enables the customization of interventions that cater to athletes' specific needs and preferences, thereby fostering a supportive and motivating environment. Additionally, the use of the IBQ and IBQ-Self instruments in the sport context facilitates the identification of need-thwarting behaviors that may hinder athletes' motivation and well-being. By

pinpointing behaviors that undermine athletes' autonomy, competence, or relatedness, appropriate interventions can be implemented to mitigate their negative impact and promote positive coaching practices. Ultimately, measuring need-supportive and need-thwarting behaviors using the IBQ and IBQ-Self instruments enables evidence-based decision-making, enhances coaching effectiveness, and contributes to the overall positive development and experiences of athletes in the sport context.

Conclusion

The utilization of the IBQ and IBQ-Self scales within the sports context offers valuable insights into athletes' perceptions of need-supportive and need-thwarting behaviors exhibited by coaches, thereby enhancing our understanding of athletes' sport experiences. Moreover, it is crucial to assess sports coaches' self-perceived behaviors as they may differ from how others perceive their interpersonal behaviors. By employing these instruments, we can investigate how athletes perceive the six distinct types of coaches' interpersonal behaviors, and how these perceptions may fluctuate over time, thereby influencing the development and maintenance of their dynamic motivation throughout the sports season. Furthermore, conducting a proactive analysis of sports coaches' behaviors can equip clubs with the necessary tools to strategically plan the season, promoting the utilization of more need-supportive behaviors while mitigating the occurrence of need-thwarting behaviors, ultimately reducing the likelihood of dropout among athletes.

Disclosure statement

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Approval

Approval from the Ethical Committee of IP Leiria (CE/IPLEIRIA/26/2021) was obtained.

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