MERSİN ÜNİVERSİTESİ
EĞİTİM FAKÜLTESİ DERGİSİ
ARAŞTIRMA MAKALESİ
DOI: 10.17860/mersinefd.1739580

MERSİN UNIVERSITY
JOURNAL OF THE FACULTY OF EDUCATION
RESEARCH ARTICLE
2025; 21(3): 1019-1033

Subjective Effort Scale for Athletes (SESA): A Validity and Reliability Study

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Abstract: This study aimed to develop a valid and reliable measurement tool to assess athletes' subjective effort levels by evaluating their psychological and physical efforts toward their athletic goals. The scale development process involved focus group interviews, open-ended compositions, literature reviews, and expert opinions. Based on content validity analyses, a pilot draft form comprising 34 items was created. The scale was designed as a 7-point Likert-type instrument, ranging from 1 = "Does Not Describe Me at All" to 7 = "Describes Me Completely." Exploratory factor analysis revealed a two-factor structure—Psychological Effort and Physical Effort—which explained 56.47% of the total variance. The factor structure was tested through confirmatory factor analysis, and the model fit indices indicated acceptable levels (χ^2/df = 4.46, RMSEA = .055, CFI = .98, GFI = .95). Reliability analysis yielded Cronbach's alpha coefficients of α = .90 for Psychological Effort, α = .71 for Physical Effort, and α = .88 for the overall scale. The findings suggest that the Subjective Effort Scale for Athletes is a valid and reliable instrument for measuring subjective effort levels in athletes.
Keywords: Subjective effort, athlete, scale development, validity, reliability.

Sporcularda Öznel Çaba Ölçeği (SÖÇÖ): Geçerlik Güvenirlik Çalışması

Öz: Bu araştırma, sporcuların sportif hedeflerine yönelik psikolojik ve fiziksel çaba düzeylerini değerlendirerek öznel çaba düzeyleri tespit eden geçerli ve güvenilir bir ölçme aracı geliştirmek üzere gerçekleştirilmiştir. Ölçek geliştirme süreci; odak grup görüşmeleri, açık uçlu kompozisyonlar, literatür taramaları ve uzman görüşleri doğrultusunda yürütülmüş, kapsam geçerliği analizleri sonucunda 34 maddelik deneme form oluşturulmuştur. Ölçek, 1 = "Beni Hiç Tanımlamıyor" ile 7 = "Beni Tamamen Tanımlıyor" arasında puanlanan 7'li derecelendirme tipi bir ölçme aracı olarak yapılandırılmıştır. Keşfedici Faktör Analizi (KFA) sonucunda ölçeğin iki faktörlü (Psikolojik Çaba ve Fiziksel Çaba) bir yapıya sahip olduğu ve toplam varyansın %56,47'sini açıkladığı belirlenmiştir. Faktör yapısı, Doğrulayıcı Faktör Analizi (DFA) ile test edilmiş ve modelin uyum iyiliği indeksleri kabul edilebilir düzeyde bulunmuştur (χ^2/sd = 4,46, RMSEA = ,055; CFI = ,98; GFI = ,95). Güvenirlik analizinde, Psikolojik Çaba için Cronbach α = ,90 Fiziksel Çaba için α = ,71 ve tüm ölçek için α = ,88 olarak hesaplanmıştır. Bulgular, Sporcularda Öznel Çaba ölçeğinin geçerli ve güvenilir bir yapı sunduğunu ve sporcularda öznel çaba düzeyini değerlendirmede kullanılabilecek uygun bir ölçme aracı olduğunu ortaya koymaktadır.
Anahtar Kelimeler: Öznel çaba, sporcu, ölçek geliştirme, geçerlik, güvenirlik.

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Geliş tarihi: 10 Temmuz 2025 / Kabul tarihi: 25 Kasım 2025

Introduction

The pursuit of meaningful goals constitutes a fundamental mechanism by which individuals derive purpose and experience a sense of personal worth. As Frankl (2009) observed, humans are inherently goal-oriented beings who construct meaning through the establishment and pursuit of objectives that provide direction and structure to their existence. This goal-directed behavior not only shapes life trajectories but also influences motivational processes (Adler, 2011). Motivation, conceptualized as the driving force that enables individuals to focus attention and direct action toward specific objectives (Ryan & Deci, 2000), represents a critical psychological construct in understanding human performance and persistence.

The positive outcomes resulting from goal-directed effort can enhance an individual's motivation to sustain or expand their pursuits, suggesting a dynamic relationship between motivation and effort expenditure. Defined as the sustained and intentional deployment of emotional, cognitive, and physical resources toward goal achievement (Pintrich & De Groot, 1990), effort encompasses more than mere behavioral output. Eccles and Wigfield (2020) characterize effort as the deliberate and persistent application of willpower and self-discipline in service of successful performance. These conceptualizations reveal effort's intimate connection with executive functions such as discipline—the capacity to prioritize long-term objectives over immediate gratification (Moffitt et al., 2011)—and willpower, which serves as a regulatory mechanism enabling goal-directed behavior despite internal and external distractions (Corno, 1993).

Synthesizing these perspectives, effort emerges as a multifaceted process involving the conscious and sustained utilization of mental, emotional, and physical resources, mediated by willpower and self-discipline (Baumeister & Tierney, 2011; Duckworth et al., 2007; Eisenberger, 1992). This multidimensional concept could be particularly relevant in high-performance contexts, where an athlete's subjective evaluation of their effort—their phenomenological experience and evaluation of their resource deployment. The athletic domain exemplifies this phenomenon, as the mental, emotional, and physical effort athletes invest in pursuing their objectives directly influences performance outcomes across training and competitive environments (Duckworth et al., 2007; Ericsson et al., 1993). Athletes' awareness of their internal resource utilization enables them to evaluate their subjective effort levels—their personal perception and assessment of the quality of psychological, physical, and emotional investment toward goal attainment (Marcora, Staiano, & Manning, 2009; Peterson & Seligman, 2004). Given the potential relationship between effort quality and internal motivational orientation, self-determination theory (Deci & Ryan, 1985) provides a theoretical framework for understanding the motivational foundations underlying subjective effort.

Self-determination theory offers a detailed account of human motivation by examining the degree to which behavior stems from autonomous versus controlled motivational sources (Deci & Ryan, 1985). This theoretical perspective provides invaluable insights into why individuals persist in activities and the motivational resources they draw upon during sustained engagement, particularly within athletic contexts (Ryan & Deci, 2007). The distinction between intrinsic and extrinsic motivational orientations may be particularly crucial for understanding the nature and sustainability of athletes' subjective effort (Ryan & Deci, 2000; Pelletier et al., 2004). Athletes driven primarily by intrinsic motivation—characterized by inherent satisfaction and enjoyment derived from the activity itself—may demonstrate more consistent and enduring effort patterns, potentially influencing their subjective effort perceptions (Deci & Ryan, 2000; Gagné & Deci, 2005). Therefore, self-determination theory offers important theoretical insights into both the origins and characteristics of subjective effort in athletic populations.

Recent research grounded in self-determination theory has provided comprehensive evidence regarding the interplay between autonomy support, motivational quality, and sustained effort in athletic contexts (Ryan & Deci, 2020; Mossman, Slemp, et al., 2022). These contemporary findings indicate that the satisfaction of athletes' basic psychological needs meaningfully influences not only performance outcomes but also their subjective experience of effort during both training and competition. Moreover, the explanatory strength of self-determination theory in accounting for athletes' effort perceptions, voluntary engagement, and long-term motivational sustainability has been reinforced by growing empirical evidence in sport settings (Mossman, Slemp, et al., 2022).

Although existing instruments such as the Rating of Perceived Exertion scale (Borg, 1982), the Feeling Scale (Hardy & Rejeski, 1989), and other psychophysiological indicators are widely used to evaluate athletes' exertion, these measures primarily capture physical strain or broad exertional responses rather than athletes' subjective and phenomenological perceptions of effort. Importantly, they do not incorporate the volitional, self-regulatory, and motivational components emphasized within self-determination theory—such as willpower, self-discipline, and autonomous regulation—which constitute core elements of subjective effort. This conceptual gap highlights the need for a psychometrically robust instrument specifically designed to assess athletes' subjective effort in a multidimensional and theoretically grounded manner. Building upon this theoretical foundation, the present study aimed to develop a psychometrically reliable scale to assess subjective effort in athletes.

Methods

Research Design

This study employed a scale development methodology designed to measure subjective effort levels among athletes affiliated with various sports federations in Turkey. Conducted as a fundamental psychometric investigation, it utilized the summated ratings approach—a subject-response-based scaling method (DeVellis, 2017). The development process adhered to established psychometric principles to ensure the creation of a reliable and valid instrument.

Although widely used instruments such as the Rating of Perceived Exertion Scale (Borg, 1982) and other exertion-based or psychophysiological assessment tools exist, these measures do not capture the motivational, volitional, and self-regulatory dimensions that characterize subjective effort within the framework of self-determination theory. Therefore, a new scale development process was initiated to address this conceptual gap and ensure that the construct of subjective effort—encompassing willpower, self-discipline, and autonomous motivation—was operationalized in a psychometrically sound manner. Accordingly, the methodological procedures followed the scale development stages recommended by DeVellis (2017), including item generation, expert review, content validity assessment, pilot administration, exploratory factor analysis, and confirmatory factor analysis.

Participants and Ethical Considerations

All procedures were conducted in accordance with the Declaration of Helsinki and received ethical approval from the Hatay Mustafa Kemal University Social and Human Sciences Ethics Committee (Decision No. 06, dated May 8, 2025, Protocol No. 66). The study employed two independent samples to evaluate the psychometric properties of the developed scale through sequential exploratory and confirmatory analyses.

Exploratory Factor Analysis Sample

Data for the exploratory phase were collected from 15 May to 25 May 2025 from actively licensed athletes aged 18 years and older. The exploratory factor analysis (EFA) sample comprised 520 participants, a size sufficient for factor extraction and initial scale validation. Exploratory factor analysis was employed to identify underlying factor structures based on inter-item relationships and to establish the theoretical foundation for the measurement model. Descriptive characteristics of the EFA sample are presented in Table 1.

Table 1.
Descriptive Characteristics of the EFA Sample

Characteristic	Category	N	%
Gender	Female	192	36.9
	Male	328	63.1
Sport Category	Individual	194	37.3
	Team	326	62.7
Athletic Experience	1-3 Years	217	41.7
	4-6 Years	129	24.8
	7-9 Years	71	13.7
	10 Years and Above	103	19.8
Total		520	100

The demographic profile of the EFA sample began with its gender distribution, which included 192 female (36.9%) and 328 male (63.1%) athletes. These participants were drawn from a diverse array of competitive settings, with 194 athletes (37.3%) engaged in individual sports and 326 (62.7%) in team sports. The sample also reflected a wide spectrum of competitive experience: 217 athletes (41.7%) had 1–3 years of licensed participation, followed by those with 4–6 years (*N* = 129; 24.8%), 7–9 years (*N*= 71; 13.7%), and 10 or more years of experience (*N* = 103; 19.8%).

Confirmatory Factor Analysis Sample

Following the exploratory phase, a second independent sample was recruited for confirmatory factor analysis (CFA) to evaluate construct validity, convergent validity, and discriminant validity of the final scale structure. Data collection for the confirmatory phase occurred from June 5 to June 15, 2025, involving 558 voluntarily participating licensed and active athletes. Using independent samples for the EFA and CFA enhanced the representativeness of the population and strengthened the model's validation. Descriptive characteristics of the CFA sample are presented in Table 2.

Table 2.
Descriptive Characteristics of the CFA Sample

Characteristic	Category	N	%
Gender	Female	204	36.6
	Male	354	63.4
Sport Category	Individual	200	35.8
	Team	358	64.2
Athletic Experience	1-3 Years	225	40.3
	4-6 Years	140	25.1
	7-9 Years	85	15.2
	10 Years and Above	108	19.4
Total		558	100.0

The CFA sample featured a demographic profile comparable to the EFA group. It was composed of 204 female (36.6%) and 354 male (63.4%) athletes, who were drawn from both individual (*N* = 200; 35.8%) and team sports (*N* = 358; 64.2%). The distribution of competitive experience was also consistent with the prior sample, reflecting a wide range: a plurality of athletes had 1–3 years of licensed participation (*N* = 225; 40.3%), followed by those with 4–6 years (*N* = 140; 25.1%), 7–9 years (*N* = 85; 15.2%), and 10 or more years of competitive experience (*N* = 108; 19.4%).

Development of Draft Scale

Item Pool Generation

The initial item pool was developed through a multi-method approach designed to capture the full breadth of the subjective effort construct among athletes.

Focus Group Interviews

Semi-structured interviews were conducted with a purposive sample comprising seven national-level athletes and three academic experts specializing in sport psychology and performance. Convenience sampling was employed to identify accessible participants who could provide rich insights into the subjective effort phenomenon (Yıldırım & Şimşek, 2022). This sampling strategy was chosen due to the specialized nature of the population and practical constraints on expert availability.

Open-Ended Composition Writing

In an attempt to further enrich the item pool, 40 actively licensed athletes aged 18 years and older, currently enrolled in the Faculty of Sports Sciences at Mustafa Kemal University, were invited to write open-ended compositions. Participants responded to open-ended prompts designed to elicit their personal experiences and perceptions regarding subjective effort in athletic contexts. This approach ensured that the scale items would reflect authentic athlete experiences and language patterns.

Literature Review

A review of existing instruments assessing subjective effort and related psychological constructs (including determination, willpower, and self-regulation) was conducted to identify validated items and theoretical frameworks. The item development process was further informed by self-determination theory principles, ensuring theoretical consistency and construct clarity.

Content Validity Assessment

Following item pool compilation, the candidate scale underwent content validity evaluation using the Lawshe technique. An initial 45-item trial form was developed and subjected to expert review for representativeness and clarity. The trial form was first pilot-tested with six active athletes to assess comprehensibility and face validity before formal expert evaluation.

The content validity assessment involved 12 subject matter experts who evaluated each item using Lawshe's content validity ratio (CVR) criteria. At $\alpha = 0.05$ significance level, the critical CVR value for 12 experts was established at 0.680

(Lawshe, 1975). Items failing to meet this criterion were then removed, resulting in the elimination of 11 items. Additionally, four items were removed based on expert recommendations regarding clarity and relevance, while four new items were added following expert suggestions for improved construct coverage.

The expert panel recommended a 7-point Likert scale (1 = Does not describe me at all to 7 = Describes me completely) to maximize response sensitivity. The final pilot version comprised 34 items reflecting the refined theoretical framework and expert recommendations.

Pilot Administration of the Draft Scale

The finalized pilot version of the scale, comprising 34 items rated on a 7-point Likert scale, was administered to 600 active athletes using both in-person and online methods to enhance accessibility and ensure representative sampling across diverse athletic populations.

Data Analysis Techniques

Exploratory Factor Analysis and Confirmatory Factor Analysis

In order to determine athletes' subjective effort levels, both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were employed as primary statistical approaches. Scale reliability was assessed through Cronbach's α internal consistency coefficients and composite reliability values. Prior to conducting factor analyses, assumption testing evaluated data suitability for analysis. The initial dataset of 600 observations underwent examination for missing data, sample adequacy, outlier presence, multicollinearity, R matrix factorizability, normality, and linearity, with these evaluations conducted separately for EFA and CFA samples.

Exploratory factor analysis serves as a statistical technique for revealing the underlying structure among variables (Tabachnick et al., 2019). Sample size adequacy is a critical determinant of a study's reliability and validity. While Krichbaum et al. (2011) suggest 125 participants may suffice for a 25-item scale, Comrey and Lee (2013) recommend exceeding 500 participants for EFA in scale validation. The present study's initial dataset of 600 observations satisfied these more stringent requirements.

The dataset underwent a multi-stage outlier analysis to ensure data integrity before factor extraction. Central tendency measures for the scale items—median, mode, and arithmetic mean—demonstrated close proximity, indicating a normal distribution of the measured trait within the sample (Kara et al., 2023). The outlier screening proceeded as follows:

- A preliminary analysis of the 600 observations identified and removed 13 initial outliers, reducing the sample to 587 cases for further examination.
- Univariate outliers were then assessed via Z-scores. In accordance with established recommendations (Mertler et al., 2005), Z scores were evaluated within a ±3 parameter. One observation was excluded for exceeding this range, with the remaining Z values ranging from -2.57 to 2.91.
- Finally, multivariate outliers were identified through Mahalanobis distance. This procedure led to the exclusion of 66 additional observations that surpassed the critical chi-square distribution threshold (χ^2_{34}, 0.001 = 59.703).

After these sequential procedures, the final analysis proceeded with the remaining 520 valid observations, providing a robust sample for the exploratory factor analysis.

Testing Statistical Assumptions

In line with the assertion by Kara et al. (2023) that relationships between variables are seldom perfectly linear, the analyses in the present study were nonetheless conducted under the assumption of linear associations. To evaluate the normality assumption, each item was examined individually. Measures of central tendency, along with skewness and kurtosis coefficients, were assessed. The proximity of these values to expected thresholds suggests that univariate normality was achieved (Can, 2018). Specifically, the skewness values for the 34 scale items ranged from –0.908 to 0.051, and the kurtosis values ranged from –0.850 to –0.832. According to Bernstein (2000), skewness coefficients between –3.3 and +3.3 and kurtosis coefficients between –7 and +7 are acceptable indicators of normal distribution. Based on these criteria, the data were deemed to meet the assumption of normality.

To further assess the dataset's suitability for analysis, multicollinearity diagnostics were conducted by calculating Tolerance and Variance Inflation Factor (VIF) values. Analysis revealed Tolerance values ranging from 0.390 to 0.811 across the 34 items, with corresponding VIF values between 1.38 and 2.383. As all Tolerance values exceeded the recommended minimum of 0.20 and all VIF values remained below the threshold of 5.0, it was concluded that

multicollinearity did not pose a concern and that all items were suitable for inclusion in the analysis (Tabachnick & Fidell, 2015).

Besides, autocorrelation assessment addressed potential relationships between error terms across different time intervals, which could elevate Type I error risk (Jenson et al., 2007). The Durbin-Watson test yielded a value of 2.02, demonstrating error term independence and confirming absence of autocorrelation problems (Kalaycı, 2010).

Assessment of Suitability of Factor Analysis

The appropriateness of the dataset for factor analytic procedures was evaluated through examination of the factorizability of the correlation matrix, employing both the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity as primary diagnostic indicators. The KMO coefficient achieved a value of .930, representing an exceptional level of sampling adequacy that exceeds conventional thresholds for reliable factor extraction. This finding provides compelling evidence that the sample size not only meets but considerably surpasses the minimum requirements for factor analytic investigation.

The interpretative framework proposed by Sofroniou and Hutcheson (1999) outlines specific benchmarks for evaluating KMO values: coefficients between .50 and .70 indicate “moderate” adequacy, those from .70 to .80 suggest “good” adequacy, values between .80 and .90 reflect “very good” adequacy, and coefficients above .90 are considered “excellent” (as cited in Dağlı, 2015). According to this classification, the obtained KMO value of .930 places the dataset within the highest tier of sampling adequacy, thereby providing empirical justification for the analytical approach adopted.

Complementing the KMO assessment, Bartlett’s test of sphericity yielded a significant result ($\chi^2 = 2885.858$, $p < .05$), indicating that inter-item correlations were sufficiently strong and significantly different from zero. This finding confirms that the correlation matrix was not an identity matrix, thereby supporting the presence of an underlying factorial structure appropriate for analysis (Gürbüz & Şahin, 2014). These results collectively verify that the data satisfy the necessary assumptions for factor analysis.

Preparation for Confirmatory Factor Analysis

The transition to CFA necessitated a re-evaluation of the refined 13-item scale through a new and independent sample of 580 active athletes recruited to ensure the robustness of the validation process. This methodological approach ensured independence between exploratory and confirmatory phases while maintaining ecological validity within the target population. Prior to executing the CFA procedures, a series of preliminary analyses was undertaken to verify that the dataset satisfied the assumptions underlying confirmatory modeling, including assessments of missing data patterns, distributional normality, relationship linearity, sample adequacy, and multicollinearity concerns.

The initial data screening process involved an examination of missing data patterns, followed by comparative analysis of central tendency measures—mode, median, and arithmetic mean—for each scale item to evaluate univariate normality characteristics. The convergence observed among these statistical indicators provided strong evidence of normal distributional properties within the dataset (Tabachnick & Fidell, 2015). Subsequent outlier analysis identified 10 extreme observations positioned at the distributional periphery, which were removed to preserve data integrity, reducing the analytical sample to 570 cases.

Further distributional assessment through skewness and kurtosis coefficients revealed values ranging from –0.944 to 0.074 for skewness and –0.821 to 0.131 for kurtosis, demonstrating symmetrical distribution characteristics that align with normality expectations. These findings conform to established statistical criteria, as Göldağ (2019) advocates for skewness values within ±1 as acceptable parameters, while Bernstein (2000) extends this threshold to ±3.3 for more liberal normality assessments. Based on these benchmarks, univariate normality assumptions were satisfied across all scale dimensions.

Multivariate outlier identification employed Mahalanobis distance calculations to detect observations exhibiting unusual patterns across variable combinations. 9 cases exceeded the chi-square threshold ($\chi^2_{(13)}$, $p < .001 = 34.528$), warranting their exclusion from subsequent analyses. Standardized Z-score analysis identified 3 observations falling beyond ±3 standard deviations, which were eliminated as univariate outliers. Through these screening procedures, 22 observations were ultimately excluded, establishing a final analytical dataset comprising 558 valid cases that demonstrated optimal distributional characteristics.

An assessment of multicollinearity revealed Variance Inflation Factor (VIF) values (1.201 to 2.366) and Tolerance statistics (0.423 to 0.832) that were comfortably within accepted limits, indicating multicollinearity was not a concern. These preparatory analyses collectively confirmed that the refined dataset met all essential assumptions required for CFA, which proceeded with the 558 validated observations, incorporating evaluation of item error variances,

standardized factor loadings, and multiple model fit indices to assess the structural integrity and theoretical coherence of the proposed measurement model.

Results

Validity Findings

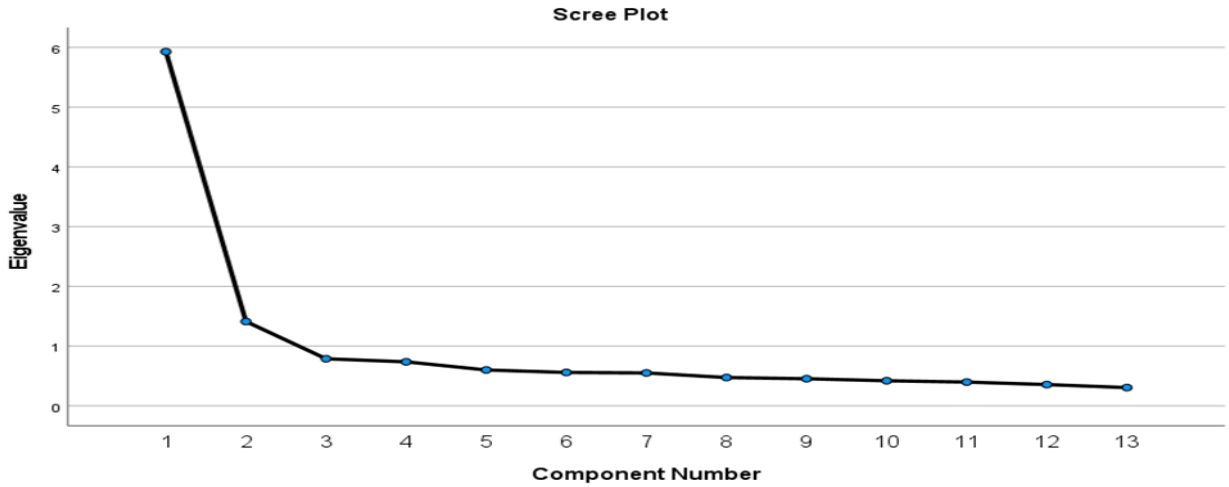
Exploratory Factor Analysis Findings

The exploratory factor analysis began with an initial dataset of 600 observations; however, sample size criteria and data quality assessments reduced the analytic sample to 520 valid cases for factor extraction. This approach ensured sufficient statistical power while preserving the integrity of the underlying factorial structure under investigation.

The analysis revealed communality values—reflecting the proportion of variance in each item explained by the extracted factor structure—ranging from .443 to .646. Although Büyüköztürk (2022) considers communality values below .10 as indicative of poor factor representation, relying solely on a single statistical criterion is insufficient for assessing factorial adequacy. Therefore, multiple methods were employed to evaluate each item's contribution to the construct.

The factor extraction process adopted a multifaceted approach, incorporating the Scree Plot visualization, Percentage of Total Variance criterion, Kaiser's Eigenvalue Rule, and Explained Variance benchmarks to triangulate the optimal factor solution. According to Cattell's (1966) framework, the scree plot identifies factorial breakpoints through visual examination of eigenvalue discontinuities, where plateau formations indicate the emergence of distinct factors. The scree plot produced during analysis (Figure 1) provided visual confirmation of the appropriate number of factors to retain, clearly highlighting inflection points that distinguished meaningful factorial structures from statistical artifacts.

Figure 1.
Scree Plot



The scree plot shows a sharp decline after the first component, followed by a plateau starting at the second component, indicating a clear "elbow" consistent with Cattell's (1966) method for identifying factors. This pattern supports a two-factor structure in the dataset, with the main dimensions emerging as distinct and meaningful constructs. Kaiser's eigenvalue criterion confirms this, as components after the second factor have eigenvalues below one, meaning they explain less variance than a single observed variable. Together, these criteria provide strong evidence to retain two factors. To further support this conclusion, a table of total variance explained is included for objective interpretation.

The percentage of total variance explained is a widely used statistical method for determining the number of factors that adequately represent the data (Kalaycı, 2010). According to this method, if the additional variance explained by a newly introduced factor drops below 5%, it is generally accepted that the optimal number of factors has been reached. In line with this principle, Table 3 demonstrates that the two retained factors sufficiently explain the structure of the data, confirming the appropriateness of the two-factor solution.

Table 3.
Total Variance Explained

	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %

1	5.929	45.604	45.604	5.013	38.558	38.558
2	1.413	10.870	56.474	2.329	17.916	56.474
13	.307	2.363	100.000			

As detailed in Table 3, the final two-factor solution explained 56.474% of the total variance, which falls within acceptable parameters for social science research (Tabachnick & Fidell, 2013). The first factor contributed 38.558% of the variance, while the second factor contributed 17.916%, with both factors demonstrating eigenvalues exceeding 1.0. The third component was excluded based on the Kaiser criterion, as its eigenvalue fell below 1.0, aligning with established recommendations that factors with eigenvalues below 1.0 should not be retained in the model (Kalaycı, 2010). The explained variance exceeding 50% meets acceptable thresholds for factor retention (Büyüköztürk, 2022), and these results provide evidence supporting the construct validity of the scale. Further details on excluded items and the rationale for their removal are provided in Table 4.

Table 4.
Exploratory Factor Analysis Item Exclusions and Reasons

Communalities< 0.30 (Items)	FactorLoading Below 0.45 (Items)	Cross-Loading Items (Difference < 0.10)	Rational Reasons (Factor Naming, Language and Expression)
28, 29, 30, 34	6, 19	1, 2, 8, 12, 23, 25, 27	9, 10, 11, 18, 21, 31, 32, 33

During the exploratory factor analysis, several items that failed to meet analytical criteria were removed from the scale. Items demonstrating common variance below 0.30 (items 28, 29, 30, and 34), factor loadings below 0.45 (items 6, 19), and items that loaded similarly across multiple factors without meaningful differentiation (items 1, 2, 8, 12, 23, 25, and 27) were excluded from the analysis. Furthermore, items identified as problematic regarding language clarity, content relevance, and conceptual consistency (items 9, 10, 11, 18, 21, 31, 32, and 33) were removed on theoretical grounds. These exclusions were implemented to enhance the psychometric properties of the scale and clarify its underlying factor structure. Table 5 presents detailed information regarding item communalities, factor loadings, and factor assignments.

Table 5.
Common Variances, Factor Loadings, and Factors Clustered by Items

No	Item	Factor 2	Factor 1	Communalities (h^2)
M16	I strive to distance myself from situations that negatively affect my performance.		0.769	0.646
M15	Even when I feel mentally fatigued, I focus on completing the training session.		0.757	0.603
M17	Facing opponents who are better than me does not prevent me from putting in effort.		0.752	0.575
M14	I try to manage stress by thinking positively before performance.		0.751	0.602
M20	When my motivation declines, I visualize myself achieving my goals.		0.738	0.589
M13	I imagine myself achieving great success.		0.732	0.569
M24	Before training, I visualize my goals in my mind.		0.715	0.562
M22	When I lose focus, I give myself verbal cues (e.g., "keep going", "focus").		0.653	0.475

M26	I confront my fear of failure.		0.652	0.443
M5	I monitor my weight to prevent any decline in my performance.	0.761		0.633
M4	I try to increase my explosive power by consuming food supplements.	0.735		0.541
M3	I focus on endurance exercises outside my regular program to improve my conditioning.	0.671		0.551
M7	I eat regularly for a better performance.	0.655		0.553
Explained Variance (%)		17.916%	38.558%	56.474%
Cronbach's alpha Values		%71	%90	%88

Table 5 presents the communalities (h^2), factor loadings, and factor structure of the retained items, illustrating a robust psychometric profile that supports the theoretical basis of the construct. The factor analysis explained a cumulative variance of 56.47%, exceeding the 50% threshold commonly recommended in social science research (Büyüköztürk, 2022; Tabachnick & Fidell, 2013), indicating that the extracted factors adequately represent the latent dimensions of the measured phenomenon. The variance decomposition shows a hierarchical pattern: the first factor accounts for 38.56% of the variance, while the second explains 17.92%, reflecting a complementary multidimensional structure. This two-factor solution demonstrates both statistical adequacy and conceptual coherence, aligning with theoretical expectations of the complex interpersonal dynamics underlying the construct. Overall, the scale items effectively operationalize distinct but related dimensions, providing sufficient explanatory power for empirical use (Kline, 2015).

The reliability coefficients of the scale were acceptable across all levels: Cronbach's α values were .90 for the first factor, .71 for the second factor, and .88 for the overall scale. These coefficients indicate satisfactory internal consistency from a psychometric perspective (Tabachnick & Fidell, 2013). The naming of the subdimensions and item distribution within each factor—determined through consideration of item-factor relationships, conceptual coherence, and semantic consistency—are detailed in Table 6.

Table 6.
Factor Names and Reliability Coefficients

Factor Number	Factor Names	Number of Items	Cronbach's α
1	Psychological Effort	9	0.90
2	Physical Effort	4	0.71
	Overall Scale	13	0.88

Table 6 presents the item distribution and reliability coefficients for each subdimension of the scale. The Cronbach's α coefficient of .90 for the nine items comprising the *Psychological Effort* subdimension indicates strong internal consistency for this factor. The α coefficient for the four items within the *Physical Effort* subdimension was .71, which represents an acceptable level of reliability for psychological measurement instruments. Following established conventions, α values of .70 and above are considered adequate, values exceeding .80 indicate good reliability, and values above .90 reflect excellent reliability (Tavşancıl, 2014; Büyüköztürk, 2022). The overall Cronbach's α value for the scale was .88, suggesting that the instrument demonstrates good internal consistency.

Confirmatory Factor Analysis Findings

The confirmatory factor analysis validated the hypothesized two-factor structure of the Subjective Effort Scale for Athletes, establishing its factorial validity. Standardized factor loadings for the *Psychological Effort* subdimension ranged from .62 to .79, indicating strong covariance between observed indicators and the latent construct. The *Physical Effort* subdimension showed loadings between .41 and .71, reflecting moderate to strong associations with its underlying

dimension. All critical ratio values (t-statistics) far exceeded the ±1.96 significance threshold, ranging from 8.90 to 21.78, confirming the statistical significance of all parameter estimates (Kara et al., 2023). Collectively, these findings provide strong evidence for the model's convergent validity, affirming that the instrument effectively distinguishes between the cognitive-emotional and somatic-physical dimensions of athletic effort.

Figure 2.
Standardized Loadings of the Tested Model

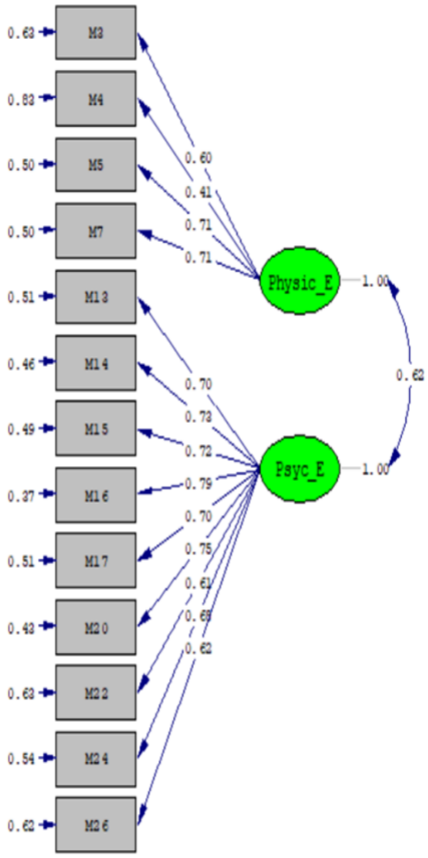
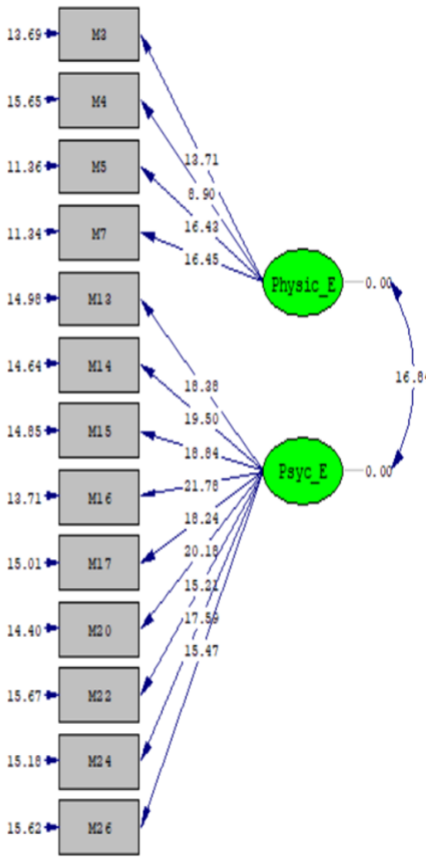


Figure 3.
Significance Levels of t-values (p ≤ .05)



The model presented in the diagram in Figure 2 shows that all items were significantly and consistently associated with their respective factors. As detailed in Figure 3, all t-values exceeded the ±1.96 threshold, confirming statistical significance. These findings suggest that the Subjective Effort Scale for Athletes demonstrates item-level discrimination and provides evidence for construct validity (Hair et al., 2014). The model fit indices further support the validity of the proposed factor structure for the study sample.

Table 7.
Goodness-of-Fit Criteria and Observed Values

Fit Criterion	Excellent Fit	Good-Acceptable Fit	Observed Value
χ2/df	< 2	< 5	4.46
RMSEA	0 ≤ RMSEA ≤ 0.05	0.05 < RMSEA ≤ 0.08	0.055
SRMR	0 ≤ SRMR ≤ 0.05	0.05 < SRMR ≤ 0.10	0.085
NFI	0.95 ≤ NFI ≤ 1.00	0.90 ≤ NFI < 0.95	0.97
NNFI	0.97 ≤ NNFI ≤ 1.00	0.95 ≤ NNFI < 0.97	0.98
CFI	0.97 ≤ CFI ≤ 1.00	0.95 ≤ CFI < 0.97	0.98
IFI	0.95 ≤ IFI ≤ 1.00	0.90 ≤ IFI < 0.95	0.98
RFI	0.95 ≤ RFI ≤ 1.00	0.90 ≤ RFI < 0.95	0.97
GFI	0.95 ≤ GFI ≤ 1.00	0.90 ≤ GFI < 0.95	0.95
AGFI	0.90 ≤ AGFI ≤ 1.00	0.85 ≤ AGFI < 0.90	0.94

Table 7 presents the model fit evaluation results. The χ^2/df ratio was calculated as 4.46, based on $\chi^2 = 387.86$ and df = 87. Considering the chi-square statistic's sensitivity to sample size, this ratio falls within acceptable parameters (Kline, 2015; Sümer, 2000). Additional fit indices provide further support for model adequacy: RMSEA = .055, SRMR = .085, NFI = .97, NNFI = .98, CFI = .98, GFI = .95, and AGFI = .94. These values fall within acceptable to good fit ranges, suggesting that the proposed model demonstrates adequate validity for the study sample. The findings indicate that the developed scale, with its 13-item, two-factor structure, provides satisfactory model fit (Jöreskog & Sörbom, 1993).

Conclusion

This study aimed to develop a valid and reliable measurement instrument for assessing subjective effort in athletes. The scale development process drew upon multiple sources of evidence, including focus group interviews, written compositions, literature reviews, and expert evaluations. Based on content validity analyses, a preliminary 34-item version of the scale was constructed. Following exploratory factor analysis, the scale emerged with a two-factor structure encompassing *Psychological Effort* and *Physical Effort* dimensions. This structure was subsequently validated through confirmatory factor analysis.

The first factor, *Psychological Effort*, appears to capture an individual's psychological resilience, motivation, and mental effort processes directed toward achieving goals. This dimension may represent athletes' capacity to recover mentally when facing adversity, maintain focus on objectives, and sustain intrinsic motivation (Duckworth et al., 2007; Ryan & Deci, 2000). The second factor, *Physical Effort*, encompasses behaviors related to maintaining physical readiness, including consistent nutrition practices, improved conditioning, and healthy lifestyle habits. This factor seems to reflect the self-regulatory skills necessary for sustaining physical performance (Baumeister & Tierney, 2011).

The model fit indices obtained for construct validity (RMSEA = .055, CFI = .98, GFI = .95) suggest that the proposed model demonstrates adequate validity within the study sample (Kline, 2015). Furthermore, the Cronbach's α values for both subdimensions (.90 and .71) and the overall scale reliability coefficient (α = .88) indicate that the instrument possesses satisfactory internal consistency (Tavşancıl, 2014; Büyüköztürk, 2022). These findings suggest that the Subjective Effort Scale for Athletes (SESA) is a potentially useful measurement tool that may contribute to the literature by providing a means to assess athletes' psychological and physical effort levels.

Recommendations

While this study establishes the scale's foundational validity, future work should prioritize confirming its structural integrity across diverse populations. Testing measurement invariance across key demographic groups—such as different age cohorts and sport disciplines—is a critical next step to ensure the generalizability of the two-factor model. Further investigations should establish the scale's temporal stability via test-retest reliability and build its nomological network by assessing convergent and discriminant validity against related constructs. Cross-cultural validation studies are also essential to determine the instrument's utility across different cultural settings. These empirical efforts will solidify the scale's psychometric profile and confirm its value for both sports psychology research and applied practice.

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Genişletilmiş Özet

Giriş

Bireyler yaşamlarına yön ve anlam kazandırmak için anlamlı hedefler belirler ve bu hedeflere ulaşma sürecinde çaba harcarlar (Frankl, 2009; Adler, 2011). Bu çaba, yalnızca davranışsal bir çıktı değil; bilişsel, duygusal ve fiziksel kaynakların bilinçli şekilde harekete geçirilmesidir (Pintrich & De Groot, 1990; Eccles & Wigfield, 2020). Spor bağlamında ise bu kaynakların etkili kullanımı, performans ve motivasyon üzerinde doğrudan belirleyicidir (Duckworth et al., 2007; Ericsson et al., 1993).

Sporcularda öznel çaba; bireyin fiziksel, zihinsel ve duygusal kaynaklarını ne ölçüde ve nasıl kullandığına dair kendi farkındalığına dayalı değerlendirmesidir (Marcora et al., 2009; Peterson & Seligman, 2004). Bu değerlendirme hem öznel hem de duruma özgü nitelikler taşıdığından, ölçülebilir ve güvenilir bir ölçekle belirlenmesi önem arz etmektedir. Öz-belirlenim kuramı (Deci & Ryan, 1985), bireylerin içsel ve dışsal motivasyon kaynaklarını açıklarken, öznel çaba dinamiklerinin dayandığı psikolojik temeli ortaya koymaktadır. İçsel motivasyonu yüksek bireylerin, çabalarını daha tutarlı ve sürdürülebilir bir biçimde sergilediği öne sürülmektedir (Ryan & Deci, 2007; Gagné & Deci, 2005). Bu doğrultuda, bu çalışmanın amacı, sporcuların öznel çaba düzeylerini değerlendirebilecek geçerli ve güvenilir bir ölçme aracı geliştirmektir.

Yöntem

Bu araştırma, temel psikometrik araştırma türünde desenlenmiştir. Çalışma, Türkiye'deki farklı spor branşlarında aktif olarak lisanslı sporcularla yürütülmüştür. Ölçek geliştirme süreci, DeVellis'in (2017) ölçekleme modeline uygun şekilde odak grup görüşmeleri, açık uçlu kompozisyonlar, literatür incelemesi, kapsam geçerliği analizi ve faktör analizleri ile yapılandırılmıştır.

Araştırmanın ilk aşamasında Keşfedici Faktör Analizi (KFA) için 520 sporcuya ulaşılmış; ikinci aşamada Doğrulayıcı Faktör Analizi (DFA) için 558 ayrı sporcudan veri toplanmıştır. Katılımcılar 18 yaş ve üzeri, farklı branşlarda aktif olarak yarışan lisanslı sporculardır. Tüm süreç Helsinki Deklarasyonu ilkelerine uygun olarak yürütülmüş ve Hatay Mustafa Kemal Üniversitesi Sosyal ve Beşeri Bilimler Etik Kurulu'ndan gerekli onay alınmıştır (08.05.2025, Protokol No: 66).

Ölçeğe temel oluşturacak madde havuzu, 7 milli sporcu ve 3 uzman akademisyenle yapılan yarı yapılandırılmış görüşmeler ile oluşturulmuştur. Ayrıca 40 sporcunun yazdığı kompozisyonlardan elde edilen verilerle desteklenmiştir. Literatür taramasıyla mevcut kavramlara uygun teorik yapı oluşturulmuş ve ilk taslakta 45 madde yer almıştır. Lawshe (1975) yöntemiyle yapılan kapsam geçerliği analizleri sonucunda 11 madde elenmiş, uzman önerileriyle 4 madde eklenmiş ve nihai pilot form 34 maddeye indirgenmiştir. Ölçek, 7'li Likert tipi yapıdadır.

KFA ve DFA öncesinde normallik, aykırı değer, çoklu doğrusal bağlantı ve örneklem yeterliliği gibi varsayımlar test edilmiştir. KFA örnekleminde KMO değeri ,930, Bartlett testi anlamlı bulunmuştur (χ^2 = 2885,858, p < ,001). DFA örnekleminde ise Mahalanobis uzaklığına göre 22 aykırı gözlem elenmiştir. Her iki analiz de SPSS ve LISREL programları ile gerçekleştirilmiştir.

Bulgular

KFA sonucunda ölçek, iki faktörlü bir yapıda toplanmıştır: Psikolojik Çaba (9 madde) ve Fiziksel Çaba (4 madde). Bu iki faktör toplam varyansın %56,47'sini açıklamaktadır. Psikolojik Çaba faktörü varyansın %38,55'ini, Fiziksel Çaba faktörü %17,91'ini açıklamaktadır. Faktör yükleri ,62 ile ,79 arasında; madde ortak varyansları ise ,44 ile ,64 arasındadır.

DFA bulguları doğrultusunda, modelin uyum iyiliği indeksleri kabul edilebilir düzeydedir: χ^2/sd = 4,46, RMSEA = ,055, CFI = ,98, GFI = ,95, SRMR = ,085. Tüm maddelerin t-değerleri istatistiksel olarak anlamlı bulunmuştur. Psikolojik Çaba faktöründe maddeler bireyin zihinsel direnci, içsel motivasyonu ve duygusal düzenleme kapasitesine işaret ederken; Fiziksel Çaba faktörü performans öncesi fiziksel hazırlık, beslenme ve kondisyon gibi davranışları kapsamaktadır.

Cronbach Alfa katsayıları Psikolojik Çaba için ,90, Fiziksel Çaba için ,71 ve ölçeğin tamamı için ,88 olarak hesaplanmıştır. Bu değerler, yüksek iç tutarlılığa işaret etmekte ve ölçeğin güvenilirliğini desteklemektedir. Ayrıca birleşik güvenirlik (CR) değerleri de ,70'in üzerindedir.

Tartışma ve Sonuç

Araştırma sonuçları, sporcularda öznel çabanın iki temel boyutta yapılandığını ve bu boyutların hem kuramsal hem de ampirik olarak ayırt edilebilir nitelikte olduğunu göstermektedir. Psikolojik Çaba faktörü, özellikle bireyin içsel motivasyonu, dikkat sürdürülebilirliği ve zihinsel esnekliği ile ilişkilidir. Bu yapı, öz-belirlenim kuramının "otonom

motivasyon" kavramıyla örtüşmektedir (Deci & Ryan, 1985). Sporcuların içsel güdülerle hareket ettiğinde çabalarını daha sürekli ve kaliteli biçimde ortaya koydukları görülmektedir.

Fiziksel Çaba faktörü ise daha çok dışsal düzenlemelerle ilişkili olup, sporcuların fiziksel dayanıklılık geliştirme, beslenme düzenine dikkat etme ve performans hazırlıklarına yönelik davranışlarını ifade etmektedir. Bu durum, çaba kavramının yalnızca zihinsel değil, davranışsal bileşenlerinin de olduğuna işaret etmektedir.

Elde edilen bulgular, özellikle spor psikolojisi ve sporcu izleme süreçlerinde bireyselleştirilmiş müdahalelerin geliştirilmesine olanak tanımaktadır. Ayrıca öznel çaba düzeyi ile tükenmişlik, dikkat dağınıklığı, mental yorgunluk gibi değişkenler arasındaki ilişkileri ele alan ileri düzey araştırmalara zemin hazırlayabilir.

Bu araştırmada geliştirilen Sporcularda Öznel Çaba Ölçeği (SÖÇÖ), sporcuların psikolojik ve fiziksel düzeyde sergiledikleri çabayı güvenilir ve geçerli biçimde değerlendiren özgün bir ölçme aracıdır. İki faktörlü yapısı sayesinde öznel çabanın çok boyutlu doğası yakalanmış ve literatürdeki önemli bir boşluk doldurulmuştur. Ölçeğin kuramsal dayanağı öz-belirlenim kuramıdır ve bu çerçevede bireyin motivasyonel kaynakları ile çaba dinamikleri arasında bağ kurulması mümkün kılınmıştır. SÖÇÖ, hem akademik araştırmalarda hem de uygulayıcılar (antrenör, psikolog, performans uzmanı) tarafından bireysel farkların belirlenmesinde kullanılabilir. Gelecekte farklı yaş gruplarında, branş türlerinde ve kültürel bağlamlarda yapısal eşitlik analizleri ile desteklenerek ölçme aracının geçerliği daha da güçlendirilebilir. Ayrıca test-tekrar test güvenirliği ve benzer yapılarla yakınsak geçerlik çalışmaları da yapılmalıdır.