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Factorial Expressions of Specific Skill Test Variables As Indicators of Performance Proficiency in Female Handball Players

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ABSTRACT
This research explored the factorial structure of handball-specific skill tests conducted on 50 female players using Principal Component Analysis to identify core performance dimensions. Nine skill test and anthropometric variables were analyzed, including defensive movement, various passing and shooting techniques, and dribbling ability. The analysis revealed three principal components explaining 55.72% of the total variance. The first (23.34%, eigenvalue = 2.33) represented passing and shooting precision, dominated by the 22 m ground pass (0.82) and face shooting (0.77). The second (19.10%, eigenvalue = 1.91) illustrated defensive agility and coordination, characterized by defensive movement (0.62) and the 10 m wall pass (0.60). The third (13.28%, eigenvalue = 1.33) reflected endurance-based passing and finishing, defined by 30 s wall pass (0.79) and penalty shooting (0.80). High communalities were observed for zigzag dribble (0.76), face shooting (0.69), and 22 m ground pass (0.68), confirming handball performance as multidimensional.

Keywords: factor analysis, handball skills, female players, performance proficiency, principal component analysis.

1. INTRODUCTION

Handball is a fast, intermittent sport that combines technical, tactical, and physical demands [1]. Accurate performance evaluation requires valid, sport-specific tests that assess key skills such as passing, ball control, defense, and shooting in an integrated manner [2]. However, traditional assessments often rely on isolated tests and fail to capture the relationships among skills [3]. Evaluating female handball players presents additional complexity due to differences in physical and tactical characteristics. Principal Component Analysis provides a suitable method to identify underlying performance factors and simplify complex skill data [4]. Identifying latent performance dimensions is essential for developing normative standards and evidence-based applications in talent identification, training design, and performance monitoring [5]. This study therefore examined nine handball-specific skills in female university players to establish a reliable and evidence-based assessment framework.

2. METHODS

2.1 Participants and Procedures

This investigation included 50 female handball players (mean age = 21.52 years, SD = 1.69; mean height = 164.96 cm, SD = 6.10; mean weight = 49.63 kg, SD = 8.84) recruited from multiple university sport programs. Participants represented varying levels of University, National, State and College competitive experience, with competition levels ranging from 1 to 4 (mean = 2.44, SD = 0.99), ensuring representation across skill gradations.

2.2 Skill Test Battery and Assessment

Nine skill-specific and one anthropometric variable were assessed using validated handball skill tests with established reliability and objectivity coefficients (average r = 0.86 and r = 0.83, respectively).

2.3 Statistical Analysis

Data were analyzed using IBM SPSS Statistics (Version 26). Assumptions for Principal Component Analysis were satisfied based on adequate Pearson correlations, a valid Kaiser–Meyer–Olkin measure, and a significant Bartlett's test of sphericity ($p < 0.001$). PCA was applied to ten variables using the eigenvalue ≥ 1.0 criterion with Varimax rotation. Communalities assessed explained variance, while two-tailed correlations examined relationships among skill variables at $p < 0.05$ and $p < 0.01$ levels.

3. RESULTS

3.1 Factor Extraction and Variance Explanation

Principal Component Analysis identified three components explaining 55.72% of total variance. **Component 1** (23.34%, eigenvalue = 2.33) represented passing and shooting precision, with strong loadings for the 22 m ground pass (0.82), face shooting (0.77), jump shooting (0.47), and penalty shooting (0.44), and a negative loading for zigzag dribbling (−0.83). **Component 2** (19.10%, eigenvalue = 1.91) reflected defensive agility, defined by defensive movement (0.62), 10 m wall pass (0.60), height (0.51), and negative loadings for jump (−0.57) and pivot shooting (−0.55). **Component 3** (13.28%, eigenvalue = 1.33) described endurance finishing, dominated by penalty shooting (0.80), 30 s wall pass (0.79), and pivot shooting (0.52). Communalities ranged from 0.29 to 0.76, and significant correlations supported inverse speed–accuracy and skill-specific relationships.

TABLE-1 : IDENTIFIED HANDBALL SKILL TEST BATTERY

Skill Test	Criteria Measured	Component	Loadings	Communality	Reliability	Objectivity
22 meter Ground Pass	Passing Accuracy	**1**	**.82**	**.68**	**.93**	**.88**
D' Defensive Movement	Defensive Agility	**2**	**.62**	**.45**	**.81**	**.82**
Penalty Shooting	Shooting Ability	**3**	**.80**	**.66**	**.76**	**.74**

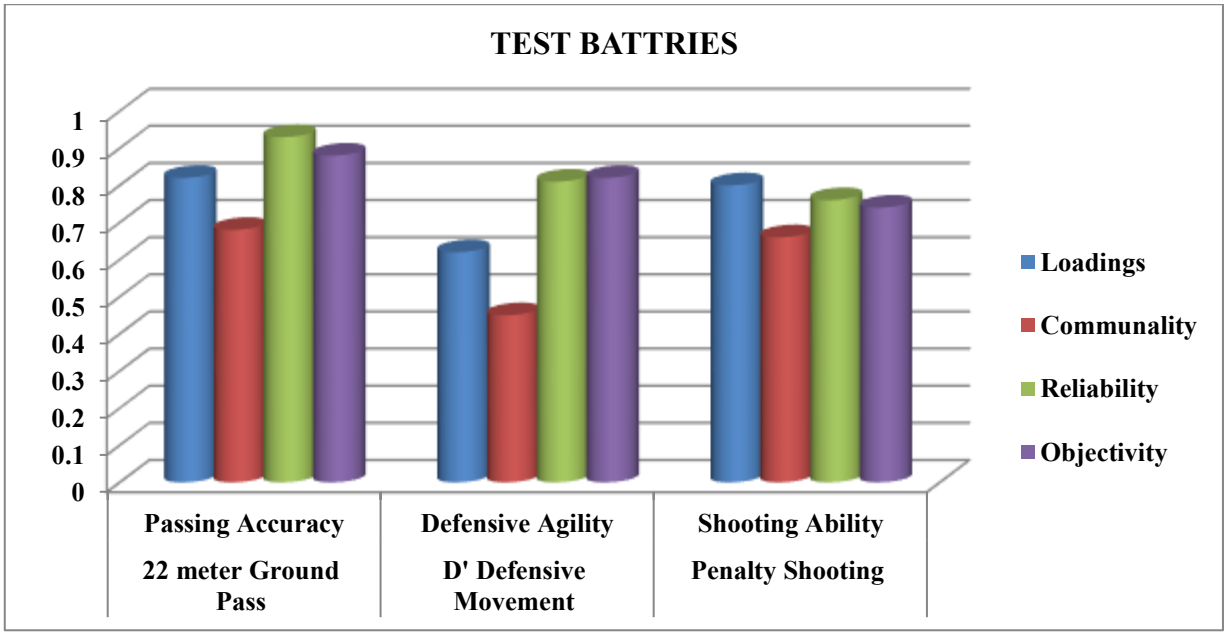

FIGURE-1 IDENTIFIED HANDBALL SKILL TEST BATTERY

4. DISCUSSION

The analysis revealed three meaningful dimensions underlying handball skill performance in female players. Passing and shooting precision was the primary factor (23.34% variance), reinforcing the importance of offensive execution in handball [7], while the inverse association with dribbling speed suggests that technical accuracy relies on controlled movement rather than maximal velocity, consistent with motor learning theory [8]. Defensive agility and coordination (19.10% variance) reflected core competitive abilities, with height contributing positively (0.51), supporting its role in defensive reach and positioning [9]. Endurance passing and finishing (13.28% variance) captured sustained technical efficiency under fatigue, highlighted by wall pass and penalty shooting performance. High communalities (>0.68) for key skills confirmed their structural importance, whereas height showed relative independence (0.29), supporting skill-focused training models [10]. The cumulative variance of 55.72% indicates a robust factorial structure suitable for performance evaluation and talent development.

5. CONCLUSION

Principal Component Analysis revealed three underlying factors structuring handball-specific skills in female athletes: passing and shooting precision, defensive agility and coordination, and endurance-related finishing ability. Together, these dimensions represent complementary aspects of performance necessary for competitive effectiveness. The resulting factorial structure supports the establishment of component-based proficiency standards and offers coaches a multidimensional framework for athlete assessment. Further research is recommended to validate these factors across different age categories and competitive levels, enabling the development of normative reference values for talent identification and long-term player development programs [6].

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