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Initial validation of the ITF World Tennis Number (WTN) on-court assessment

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ABSTRACT

This study validates an initial on-court assessment for the International Tennis Federation (ITF) World Tennis Number (WTN), designed for players without prior ratings. The research followed a multi-phase approach: (1) literature review, (2) ITN-WTN equivalence analysis, (3) evaluation of existing on-court tests, and (4) validation with 106 recreational players across six countries. Pearson's correlation and stepwise multiple regression identified ITN-based test as the strongest predictor of WTN ($r = -0.45$, $p < 0.05$), followed by serve ($r = -0.39$, $p < 0.05$) and volley ($r = -0.31$, $p < 0.05$). The final model ($\beta = -0.0464$, $p < 0.001$) explained 19.8% of WTN variance. These results confirm the ITN-based on-court test as a reliable tool for assigning initial WTN ratings. The implemented tests assessed serve, groundstrokes depth, groundstrokes accuracy, and volleys. Their strong correlation with WTN supports their validity in structured player classification. This assessment offers a standardized, accessible approach for players without match history, ensuring a fairer rating system.

Key words: rating, skill, level, competency, evaluation, technique

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INTRODUCTION

A player tennis rating is a numerical representation of a tennis player's skill level, designed to facilitate fair and competitive matchups. Systems such as the International Tennis Federation's World Tennis Number (WTN) and those used by several national tennis federations, provide a standardized measure of a player's abilities based on their performance in matches (ITF, 2025). These ratings consider various factors, including match outcomes, the strength of opponents, and the competitiveness of the matches. By offering a consistent and objective assessment, tennis ratings help players, coaches, and organizers to gauge skill levels accurately, ensuring that players compete against others of similar proficiency, which enhances the overall competitive experience. While rating systems typically rely on match data, such approaches may be impractical or inaccurate for players without a competition history. Alternative methods, such as self-assessment or coach-reported ratings, are susceptible to subjective bias and inconsistencies across contexts. In contrast, an on-court assessment offers a standardized and objective means to evaluate technical competencies, providing a more equitable entry point into the rating system. This is particularly crucial for newcomers or recreational players, for whom reliable competitive data may be unavailable.

The importance of an appropriate initial on-court test for tennis ratings cannot be overstated. Such assessments are crucial for establishing a reliable baseline rating for players who lack prior ratings, ensuring that their skill levels are accurately reflected from the outset. This initial evaluation usually focuses on technical competencies, such as serve, forehand, and backhand strokes, which are fundamental to

a player's performance (Strecker et al., 2011). In addition to traditional models like the ITN or NTRP, recent developments in performance rating systems have incorporated advanced computational methods to improve accuracy and applicability. Kyriakides et al. (2015) introduced AccuRATE, a hybrid approach that combines linear algebra models with machine learning to enhance prediction capabilities in football. Similarly, Ismail (2023) proposed the Estimated Performance Rating (PRe), a novel system designed to overcome the limitations of traditional Tournament Performance Ratings (TPR), particularly in cases of perfect or null scores, and applicable across tennis, football, and chess. These models highlight the ongoing evolution of rating systems toward more robust and adaptable frameworks.

Implementing a scientifically validated on-court test helps to maintain the integrity of the rating system, providing a fair and equitable starting point for all players. This approach

not only promotes fair competition but also aids in the development of tailored training programs that address individual strengths and weaknesses, ultimately contributing to the player's growth and progression in the sport (Šlosar et al., 2019).

The ITF continues to successfully roll out the ITF World Tennis Number (WTN) product with the aim to build a large, engaged community of global players in all nations of the world. The ITF World Tennis Number is a real-time skill level rating system designed for tennis enthusiasts of all levels (Santilli & Crespo, 2024). Like a golf handicap, the WTN provides a numerical representation of a player's ability, enabling them to find opponents who match their skill level anywhere in the world. This global rating system simplifies the process of identifying suitable playing opportunities, making tennis more accessible and enjoyable for everyone. It also serves as a tool to track the development of one's game over time. One of the largest and more accurate database of match records from close to nations is used to power both a singles and a doubles algorithm that updates globally on each Wednesday of each week. In 2023, the Intercollegiate Tennis Association (ITA) adopted ITF World Tennis Number as its exclusive rating. The WTN and is now seen on rosters and player profiles for all US College players (Santilli & Crespo, 2023).

Research has explored the validity and accuracy of the ITF WTN and has concluded that its accuracy levels are statistically greater than chance and is a valid measure of player skill based upon its ability to predict match outcomes (Im & Lee, 2023; Krall et al., 2024; Mayew & Mayew, 2023).

Following the ITF WTN current success and mirroring the steps taking for the implementation of the ITF WTN, it was suggested to create an on-court assessment to facilitate the delivery of this new rating system. The aim of the new on-court assessment was structured around various terms of reference. Initially, it would be geared towards individuals who had no ITF WTN rating. The assessment would not provide an indication of the player's tennis skill level but rather its equivalency to the ITF WTN. It would be intended as a one-off assessment to provide the initial ITF WTN rating and would not be used for periodic ratings, which would only be achieved through participation in competitions.

The development of the assessment would be evidence-based, following a scientific study conducted in the field, and would incorporate practical experience and knowledge from previous on-court rating assessments, such as the ITN. The assessment would be designed to be technically sound, focusing on the technical competency of the player. In principle, it would not consider tactical, physical, mental, or competitive competencies as variables to facilitate its practical implementation in a variety of tennis settings worldwide.

LITERATURE REVIEW

As part of this process, and in line with usual research processes, a literature review was deemed necessary. This section will cover previous assessments of tennis skill levels, including the ITN and other relevant tests. Key studies and methodologies will be discussed highlighting the skills measured in tennis and their correlation with performance levels.

Historically, research has explored the use of on-court tennis assessments to provide accurate player ratings (Broer & Miller, 1950; Digennaro, 1969; Dyer, 1935; Fox, 1953; Hewitt, 1965, 1966, 1968; Kemp & Vincent, 1968; Miller, 1953; Purcell, 1981). As an example, the National Tennis Rating Program (NTRP) has been used in the USA (Delaney, 1982) to rate the tennis ability of amateur players for a considerable number or years.

In 2003, the ITF launched the International Tennis Number (ITN) as an instrument to increase participation in the ITF's member nations. The ITN was structured in a 1-10 rating system which was very straightforward and simple for tennis players around the world to comprehend. The introduction of sub-categories for beginner players (ITN 10.3, ITN 10.2, and ITN 10.1) facilitated the inclusion of players of all skill levels to have an ITN (ITF, 2003a). It was also related with existing national rating systems in some nations (such as the NTRP in the USA, the "classement" system in France, and the British rating system) using an ITN Conversion Chart (ITF, 2003b) as well as a description of standards (ITF, 2003c). It was adopted by close to 40 nations worldwide. Furthermore, since its launch, the ITN has been used as an indicator of the skill level of tennis players in multiple research studies related to physical fitness (Olcucu & Vatansever, 2015), health benefits (Fernandez Fernandez et al., 2009), psychology (Cherappurath et al., 2020), or stroke classification (Wu et al., 2022) among others. Apart from research projects, the ITN was also used by sport organisations such as Special Olympics for the classification of the tennis players participating in their competitions (Special Olympics, 2025).

To emphasise the practical application of the ITN, an objective on-court assessment was developed. This tool was created specifically for the ITN and was an important instrument to facilitate the adoption of the rating. It was developed to engage recreational players who did not regularly participate in competitions. It served as an objective method for initially rating players at this level. While some limitations acknowledged as related to assessments non based on tennis match results (such as static feeding, assessing strokes in a closed situation, and only evaluating certain strokes), it was felt that the assessment could be used alongside the ITN. It not only provided an objective method for initially rating players without previous competition results but also served as an instrument that would assist in the promotion of the game and motivate players of all levels to have a more objective awareness of the level of their game (ITF, 2004).

The assessment measured certain key strokes on consistency, accuracy (1st bounce), power (2nd bounce) and measures mobility. Coaches were registered as official assessors to use the instrument to rate players for competition and training (Sharp, 2007). The ITN on-court assessment was also included in the syllabi of the ITF coach education courses as part of the content for the first certification levels.

Therefore, following the steps taken in the implementation of the ITN and the ITN on-court assessment, the goal of this article is to outline the development and validation of an initial on-court assessment for the ITF World Tennis Number (WTN). This assessment is designed for players without a prior WTN rating and focuses on their technical competencies. The assessment is evidence-based, drawing from scientific research and practical experience with previous on-court rating assessments, such as the ITN.

METHODOLOGY

Study design and implementation phases

The research was conducting following several implementation phases. The first one was the literature review which encompassed a comprehensive examination of existing studies on tennis skill assessments and their pertinence to the World Tennis Number (WTN) as shown previously. The second phase consisted in an initial search for equivalence between the ITN and WTN was explored, considering various tests. This exploration aimed to establish a foundational equivalency between the two rating systems.

Subsequently, the third phase involved the analysis of the most pertinent tests undertaken based on the literature. Notable examples of these tests included the Avery Richardson Tennis Serve Test (Avery et al., 1979, 1981; McGhee, 1981), the ITN on-court assessment, and the Dutch Technical-Tactical Tennis Test (D4T) (Kolman et al., 2017). These tests were chosen for their relevance and ability to accurately measure tennis skills. The initial conclusion of this phase was that the ITN on-court test seemed the most accurate and viable according to the goals of the study.

Finally, the fourth phase consisted in the establishment of an equivalency between the ITN-based on-court test and the WTN. This validation was conducted through practical on-court testing involving 106 players, who were later categorized into four distinct WTN level groups. Statistical analysis was employed to identify the sections of the ITN-based on-court test that most effectively predicted the players' WTN, ensuring the reliability and accuracy of the assessment process.

Sample

The sample included 106 recreational players, with a mean age of 18.62 ± 9.33 years and a WTN between 20 and 40, representing the national federations from the following nations: Argentina, Brazil, Colombia, Singapore, the United Kingdom, and the United States. The selection criteria for these nations included the degree of implementation of the ITF WTN, availability of test deliverers, availability of players, regional distribution, and recognition of their Coach Education System.

All players joined voluntarily to take part in the study, they were informed of the research procedure prior to commencement by the test deliverer, they all indicated that were healthy and injury free, were given the opportunity to ask any questions regarding the process and agreed to participate freely in the activity. Table 1 shows the geographical distribution of the players participating in the study.

Table 1
Geographical distribution of the players participating in the study.

Countries	Number of players
Argentina	17
Brazil	15
Colombia	20
Singapore	17
United Kingdom	16
United States	21
TOTAL	106

Instrument

As indicated, it was considered that the ITN was the on-court assessment test that would better adapt to the goals of the study. Furthermore, due to previous challenges in the implementation and measurement of the mobility section of the ITN test, it was agreed that the test would comprehensively cover all the basic tennis strokes — serve, groundstrokes depth, groundstrokes accuracy and volleys — ensuring that players were assessed across the full range of fundamental techniques. The decision to exclude physical components from the assessment was made deliberately to ensure broad applicability and ease of implementation across diverse tennis settings. While tactical decision-making and physical fitness are undoubtedly integral to overall tennis performance, their reliable measurement typically requires more complex testing protocols, greater assessor expertise, and specific equipment or match-play conditions. These constraints would hinder the scalability of the tool, particularly in developing contexts or grassroots programs. Therefore, prioritizing technical stroke execution allows for a valid and objective assessment that remains accessible, time-efficient, and consistent across settings, without compromising the purpose of initial classification. It was believed that this inclusion guarantees a holistic evaluation of a player's on-court capabilities as per stroke production. For a description of the main characteristics of the ITN on-court assessment test interested readers are directed to its guide (ITF, 2004). The ITN-based on-court assessment tests selected for this study are shown in Figure 1.

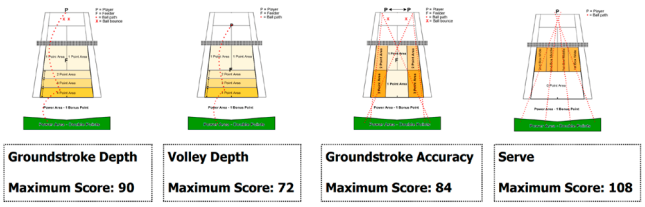

Figure 1. *ITN-based on-court assessment tests selected for this study.*

Data analysis

Descriptive statistics were calculated for all variables, expressed as means and standard deviations. The normality of the distribution was assessed using the Shapiro-Wilk test, revealing that all variables followed a normal distribution. Given these results, parametric tests were applied for normally distributed variables. A Pearson's correlation analysis was computed to assess the relationships between the variables. Correlations were classified as trivial (0–0.1), small (0.1–0.3), moderate (0.3–0.5), large (0.5–0.7), very large (0.7–0.9), nearly perfect (0.9), and perfect (1.0) Additionally, a stepwise multiple regression analysis was performed to determine the best predictors of WTN, retaining only the most relevant variables based on Akaike Information Criterion (AIC). The final predictive model was evaluated in terms of its explanatory power, using the adjusted R^2 value and the Root Mean Square Error (RMSE), obtained through cross-validation. Statistical significance was established at an alpha level of $p \leq 0.05$. All statistical analyses were performed using RStudio (Version 2024.04.1+748.)

RESULTS

Table 2 presents the descriptive statistics for each of the analysed variables. The results indicate that the mean serve score was 66.30 (SD = 16.23), ranging from 25 to 96. The average groundstrokes depth was 52.33 (SD = 12.28), with values between 20 and 80, while groundstrokes accuracy had a mean of 55.08 (SD = 14.65), ranging from 23 to 91. The mean volley score was 34.51 (SD = 10.62), with a minimum value of 14 and a maximum of 60.

Regarding rating systems, the International Tennis Number had a mean value of 211.86 (SD = 37.43), ranging from 118 to 305. The World Tennis Number showed an average of 27.81 (SD = 3.83), with a minimum of 20 and a maximum of 40.

Table 2
Descriptive statistics of performance and rating variables.

Variable	Mean (SD)	Min-Max
Serve	66.30 (16.23)	25-96
Groundstrokes depth	52.33 (12.28)	20-80
Groundstrokes accuracy	55.08 (14.65)	23-91
Volley	34.51 (10.62)	14-60
ITN-based on-court test	211.86 (37.43)	118-305
World Tennis Number	27.81 (3.83)	20-40

SD: Standard deviation; Min: Minimum; Max: Maximum; ITN: International Tennis Number.

The correlation coefficients between the variables are shown in Figure 2. The ITN-based test had the strongest negative correlation with WTN (r = -0.45, p < 0.05), followed by Serve (r = -0.39, p < 0.05) and Volley (r = -0.31, p < 0.05). Other variables (Groundstrokes depth and Groundstrokes accuracy) showed weaker correlations with WTN. These results indicate that higher ITN scores are associated with lower WTN scores, suggesting that ITN-based test is a critical factor in predicting WTN.

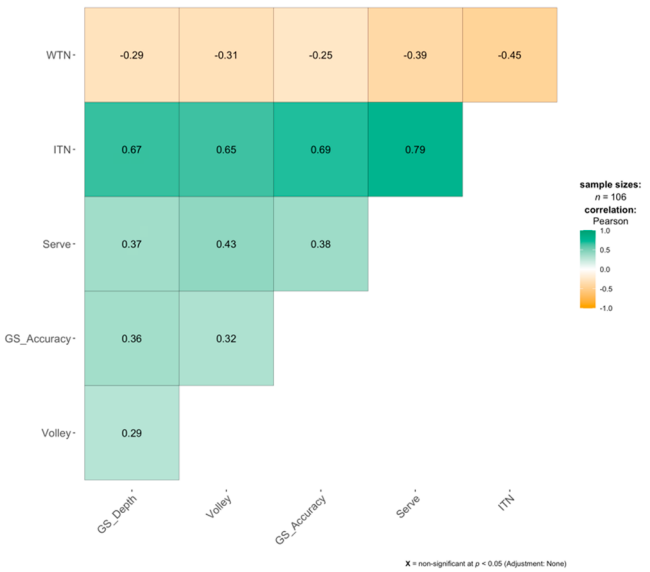

Figure 2. *Correlation between the tests of the ITN-based test with the WTN.*

Note: GS: Groundstrokes

As shown in Table 3, the stepwise multiple regression analysis retained ITN as the only significant predictor of WTN, removing groundstrokes depth, Volley, groundstrokes accuracy, and serve due to their lack of statistical significance. The final regression equation was: WTN=37.64−0.0464×ITN-based.

Table 3
Stepwise regression model results.

Predictor	Estimate	Std. Error	t-value	p-value	AIC
Intercept	37.6429	1.9229	19.577	<0.001	263.17
ITN-based test	-0.0464	0.0089	-5.194	<0.001	

The model was statistically significant (F (1, 104) = 26.98, p < 0.001), indicating a meaningful relationship between ITN-based test and WTN. The adjusted R^2 value was 0.198, suggesting that ITN explains approximately 19.8% of the variance in WTN. The negative coefficient for ITN (-0.0464, p < 0.001) confirms that as ITN-based test increases, WTN decreases. The residual standard error of the model was 3.428, and the Root Mean Square Error (RMSE) on the test dataset was 3.54, indicating moderate predictive accuracy.

DISCUSSION

The findings of this study provide strong support for the initial validation of the ITF World Tennis Number (WTN) on-court assessment as a reliable method for assigning initial player ratings. The observed correlations between WTN ratings and on-court performance indicators align with previous research validating rating systems such as the ITN and UTR (Im & Lee, 2023; Krall et al., 2024). This reinforces the legitimacy of using standardized assessment methods to determine player skill levels, particularly for those without prior match results.

A key implication of our results is that the assessment offers a practical and scientifically grounded solution for assigning initial WTN ratings. Prior to this, rating systems like the WTN relied primarily on competitive match data (Santilli & Crespo, 2023). However, this approach posed challenges for new players, as they required match history to receive an accurate rating. The introduction of an on-court assessment addresses this gap, ensuring that all players, regardless of competition history, receive an initial rating that reflects their technical abilities.

Our findings are in line with previous research highlighting the importance of objective skill assessments in tennis. For example, standardized rating scales such as the ITN have been successfully utilized in junior player evaluations, demonstrating high validity and reliability (Ngatman et al., 2023). Similarly, studies on tennis ratings have shown that structured assessment methodologies contribute to improved match predictability (Im & Lee, 2023; Krall et al., 2024). The results of our study further confirm that structured on-court assessments can serve as effective tools for categorizing player skill levels in a manner consistent with broader rating frameworks. While the predictive accuracy of the WTN system has been affirmed in prior studies (Im & Lee, 2023; Mayew & Mayew, 2023), questions remain regarding the impact of algorithm modifications on rating stability (Krall et al., 2024). Future research should examine whether adjustments to the WTN algorithm, such as those

implemented in 2023, enhance the predictive capacity of the system or introduce new biases (Krall et al., 2024). Moreover, further investigations should explore the extent to which on-court assessments predict future match performance, especially among junior and recreational players.

Another important consideration is the potential integration of physical and tactical components into the on-court assessment. Although our study focused primarily on technical competencies, prior research suggests that physical attributes, such as agility and endurance, also correlate with player performance (Morais et al., 2024; Olcucu & Vatansever, 2015). However, the objective of this initial validation was to provide a test that is as simple as possible to apply, ensuring that coaches can implement it with ease. Objective and standardized measurement of these components typically requires either advanced monitoring equipment (e.g., wearable sensors or video analysis) or simulated match-play conditions, which may not be accessible in all implementation contexts. Moreover, such additions could increase administration time, reduce portability, and complicate scoring reliability. As such, while theoretically valuable, the practical integration of physical and tactical aspects must be carefully weighed against the assessment's intended simplicity and scalability.

In summary, our study demonstrates that the WTN on court assessment is a valid and practical method for establishing initial player ratings.

LIMITATIONS

Despite the promising findings, this study has some limitations. First, the sample size was limited, and further research with a larger and more diverse participant pool is needed to confirm the generalizability of the results. Second, the assessment strictly considers technical competencies, excluding physical, mental, and tactical aspects. While this is a limitation, it was intentionally designed this way to ensure a simple and easily applicable test for coaches. Third, external factors such as player motivation and environmental conditions were not considered, aligning with the study's focus on an objective, skill-based evaluation.

PRACTICAL APPLICATIONS

From a practical standpoint, the implementation of the WTN on court assessment offers a valuable tool for coaches and tennis organizations seeking to integrate a standardized and accessible rating system. The ease of administration makes it a practical solution for evaluating players who lack match history. Additionally, by providing an objective measure of technical ability, the WTN on court assessment can assist in training program design and player development strategies. By providing a standardized approach to rating assignment, the WTN on court assessment enhances the inclusivity and accessibility of the WTN system. Furthermore, organizing tournaments often presents challenges in accurately determining player levels, and this tool could help address that issue by offering a reliable initial classification. Future research should continue to refine the assessment methodology and investigate its long-term implications for player development and competitive fairness.

CONCLUSIONS

The decision to implement the on-court test for ITN-based test has proven to be appropriate, providing a highly accurate correlation between on-court performance and WTN classification. The developed formula allows for consistent and objective calculation of a player's WTN rating based on their on-court performance. This on-court assessment provides a highly accurate correlation between on-court performance and the classification within the ITF World Tennis Number, ensuring that players are rated reliably based on their skills and abilities displayed during actual play.

It was also concluded that the ITN on-court test does not need to be conducted in its entirety. The final physical test segment has been eliminated, as it was found to be unnecessary for predicting WTN ratings. The streamlined test structure focuses on essential components while maintaining the accuracy and validity of the results, ensuring a holistic evaluation of players' capabilities. By focusing solely on the most critical performance components, the revised structure ensures a comprehensive yet practical assessment, making it more accessible for a broader range of players and evaluators.

The WTN On-Court Assessment could transform the landscape of tennis, particularly for recreational players, over the next few years. Through the WTN On-Court Assessment, there would be opportunities not only to attract new individuals to the sport but also to retain and motivate both new and existing players to engage more with tennis. It is anticipated that, in a short time, most tennis players worldwide would hold a WTN On-Court Assessment, which would be recognized as the most objective procedure to access the ITF WTN, thus incorporating this crucial rating language in the tennis community.

As the ITF World Tennis Number continues to evolve, it is suggested that its on-court assessment will have to be committed to refining and expanding to be used by as many interested parties as possible. Future research should explore additional variables that may enhance the predictive accuracy of WTN ratings while ensuring the system remains adaptable to diverse playing conditions and competitive levels. Moreover, continuous feedback from players, coaches, and tennis organizations will be crucial in optimizing the assessment protocol, ensuring it meets the needs of a growing and diverse tennis-playing population. By embracing these developments, the WTN On-Court Assessment has the potential to become a cornerstone of modern tennis evaluation, supporting data-driven player progression at all levels of the sport.

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CONFLICT OF INTEREST AND DECLARATION OF FUNDING

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