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The Development of the Senior Golfers Movement Assessment (SGMA) and Its Associated Intra- and Inter-Rater Reliability

Sarah Martin[1,2], Vicki Evans[2], Josh Salmon[2], Sharon Dixon[1], Genevieve KR Williams[1]

[1] Department of Public Health and Sport Sciences, University of Exeter, [2] School of Sport, Exercise and Rehabilitation, Plymouth Marjon University

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Senior golfers are susceptible to declines in strength, flexibility, and coordination, which can impact performance and increase injury risk, making appropriate monitoring essential (Lindsay et al., 2000). This study introduces the Senior Golfers Movement Assessment (SGMA) and evaluates its intra- and inter-rater reliability. The SGMA consists of ten exercises for a 100-point composite score. Nineteen amateur senior golfers (age 67.16 ±6.44 years, handicap 20.3 ±6.4) were videoed performing the SGMA. Three raters independently assessed and scored each participant, with one rater reassessing after four weeks. Intraclass correlation coefficient (ICC) and standard error of measurement (SEM) values were calculated for composite scores, and weighted kappa values (Kw) were calculated for individual exercises. Reliability of the composite score was ICC=0.99, SEM=0.28 (intra-rater) and ICC=0.97, SEM=0.45 (inter-rater). Individual sub-test reliability ranged from Kw=0.02 to 0.78 (intra-rater) and Kw=-0.02 to 0.44 (inter-rater). While the SGMA demonstrates high reliability in the composite score, variation in reliability of individual exercise scores indicates that the criteria for these sub-tests require further refinement to enhance consistency across raters and reduce time to administer.

INTRODUCTION

Golf is a popular leisure activity among older adults, offering numerous health and social benefits (Stenner et al., 2019). However, the golf swing poses injury risks, especially for senior players over 50 years old, who often begin to experience age-related declines in physical function (Versteegh et al., 2008). Consequently, understanding and assessing the movement patterns of senior golfers are essential for enhancing performance and preventing injuries in this demographic.

Movement screening is widely used across sports to evaluate movement patterns and functional capabilities (Kraus et al., 2014). More specifically, these assessments identify limitations, imbalances and dysfunctions in movement quality which could predispose individuals to injuries or hinder performance. Over the past two decades, numerous movement screens have been developed for diverse populations (such as firefighters (Cornell et al., 2017), military service members (Lisman et al., 2013), children with developmental co-ordination disorder (DSD) (Schoemaker et al., 2003), elderly populations (Webb et al., 2018; Thaqi et al., 2023), and sports (for

example, the Soccer Injury Movement Screen (SIMS) (McCunn et al., 2017), Netball Movement Screening Tool (NMST) (Reid et al., 2015) and Athletic Ability Assessment (AAA) (McKeown et al., 2014). Establishing intra- and inter-rater reliability is essential because these assessments are often performed by various external raters; reliability ensures consistency, validity, clinical utility, and meaningful comparability of assessments across multiple raters.

The Functional Movement Screen (FMS) is the most widely used tool for movement screening in sport. The FMS comprises a battery of seven movement tasks and three clearing tests aimed at identifying functional deficits in strength, balance, flexibility, and neuromuscular control (Johnson et al., 2018). These are rated based on a systematic and standardised scoring criterion on a 0-3 scale, where zero represents pain presence, a score of one is given if the individual is unable to complete the movement pattern or assume the position to perform the movement, a two is given if there is some compensation whilst performing the movement and a three is given for correct execution without any compensatory movements (Cook et al., 2014; Moran et al., 2017). Demonstrating good reliability, the FMS has been extensively studied (Cuchna et al., 2016), with intra-rater reliability ranging between ICC 0.60-0.91, which indicates moderate to excellent reliability (Smith et al., 2013; Teyhen et al., 2012). Inter-rater reliability ranges from ICC 0.38-0.98, indicating fair to excellent reliability, depending on the raters' experience (Gulgin & Hoogenboom, 2014; Leeder et al., 2016; Onate et al., 2012; Smith et al., 2013; Teyhen et al., 2012). Movement deficits have been associated with history of injury (Chimera et al., 2015), age under 55 years (Chimera et al., 2015) and gender between younger adults aged 13-18 years (Anderson et al., 2015) although little is known about differences in movement patterns between genders in older adults aged 52-83 years (Mitchell et al., 2016).

To improve specificity of movement screening to the sport of golf, the Titleist Performance Institute (TPI) Level 1 screen (Gulgin et al., 2014) and Golf Movement Screen (GMS) (Gould et al., 2017) have been developed. These screens evaluate essential components related to the execution of the golf swing, including movement patterns, mobility, stability, and balance. Although the reliability of the TPI Level 1 screen has not been established, scores have been significantly correlated to golf ability (handicap) ($r=-0.779$, $p=0.005$) and performance metrics (clubhead speed ($r=0.701$, $p=0.016$), ball speed ($r=0.674$, $p=0.023$) and peak pelvis rotation speed ($r=0.687$, $p=0.019$) (Speariett & Armstrong, 2020)). However, inferences drawn from this study should be approached with caution due to the small sample size (5 males and 6 females). Additionally, as the reliability of the TPI Level 1 screen has not been established, these correlations may be misleading and should be interpreted carefully until reliability has been determined. Conversely, the GMS has demonstrated excellent intra- and inter-rater reliability (ICC 0.94) (Gould et al., 2017), however, when establishing the relationship between the GMS and golf performance, the side plank was the only exercise with

a significant moderate correlation to clubhead speed ($r=0.39$, $p<0.05$) in high level, youth golfers (Gould et al., 2017). The GMS therefore provides a validated tool for screening elite club golfers; however, this has not been extensively applied to other populations such as amateur or senior golfers.

As individuals age, physiological declines occur, including reduced muscle mass, bone density, joint flexibility, cartilage integrity, and neuromuscular coordination. These changes affect muscular strength, endurance, flexibility, speed of movement, and postural awareness, which may increase the risk of injury and reduce performance potential (Lindsay et al., 2000). To address this population, the Senior Golfers Movement Assessment (SGMA) was developed as a modified version of the GMS, tailored to the needs of older golfers. The SGMA focuses on mobility, stability, and balance - fundamental elements of the golf swing that often decline with age (Gould et al., 2021; Mitchell et al., 2016). It aims to provide insights into functional movement patterns and areas for improvement that may enhance both performance and injury prevention.

The aim of this study is to introduce the SGMA and its 100-point scoring criteria, present normative values, and evaluate its intra- and inter-rater reliability in amateur senior golfers. Establishing the reliability of the SGMA, this study will present the SGMA as a tool that coaches, trainers, and healthcare professionals can use to identify movement deficits and guide targeted interventions to optimise performance and reduce injury risk in senior golfers.

METHODS

Participants

A convenience sample of nineteen amateur senior golfers, comprising ten males (mean age 68.60 ± 5.52 years) and nine females (mean age 65.56 ± 7.32 years), voluntarily participated in the study. The sample size for this study was determined based on the feasibility of recruitment and practical considerations, aligning with similar studies evaluating intra- and inter-rater reliability of movement screens (Gould et al., 2017; Gulgin & Hoogenboom, 2014). All participants were aged over 55 years, held full golf club membership, played a minimum of 18 holes per week and had a minimum participation history of five years. Exclusion criteria included joint replacements, hypermobility, lower or upper limb injuries within the past three months leading to absence from golf, neurological conditions or impairments affecting balance or movement, or ongoing intensive golf coaching or personal training. Written, informed consent was obtained from all participants prior to taking part, and the study received approval from the Institutional Research Ethics Review Board before commencement.

Table 1. Individual exercises and total points available for the Senior Golfers Movement Assessment (SGMA)

Exercise	Total number of points available
Overhead Squat	8
Lunge (R/L)	20
Basic Balance (R/L)	10
Golf Posture	5
Rotation Over Fixed Foot (R/L)	10
Trunk Inclination	5
Seated Thoracic Rotation (R/L)	14
Shoulder 90/90 Rotation (R/L)	10
Seated Hamstring (R/L)	10
Side Plank (R/L)	8

Senior Golfers Movement Assessment (SGMA) Protocol

The SGMA consists of ten tests designed to evaluate mobility and stability, focusing on key fundamental movement patterns essential for the golf swing. Drawing from insights gained during pilot testing of the Golf Movement Screen (GMS) (Gould et al., 2017) in a cohort of senior golfers, adaptations for the SGMA were made to better accommodate the capabilities of older golfers. Notably, the shoulder external rotation assessment was modified due to challenges that seniors faced in assuming the prone position required for the 'Diamonds' exercise in the GMS. To address this, a shoulder 90/90 rotation test was introduced to the SGMA as it has previously been used in the TPI Movement Screen (Gulgin et al., 2014). Additionally, difficulties arose with the mini squat exercise instructions, prompting its replacement in the SGMA with an assessment of golf posture from a 5-iron stance for pelvic tilt evaluation.

While tailored to address the unique requirements of senior golfers, the SGMA protocol retains the core exercises and structure of the GMS. Refinements are made to the scoring criteria to align with the modifications made to the movements to ensure a comprehensive evaluation of movement competency. Individual exercises in the SGMA have specific criteria that are observed depending upon the complexity of the exercise and scored independently on a *met (1 point)/not met (0 points) basis*, contributing to a composite score out of 100 points (Table 1). The SGMA screening process, lasting 15 to 20 minutes, was conducted without warm-up, stretching, or movement preparation (Koźlenia & Domaradzki, 2021). Participants received a demonstration and scripted guidance, before one practice trial without corrective feedback (see supplementary file). The screening sessions were recorded using two tablets on tripods, capturing frontal and sagittal plane views (iPad Pro, Apple, USA).

Reliability Procedures

All testing sessions were conducted and recorded by the same individual to ensure consistency in the instruction and video capture. Before testing, two novice raters - a physical performance coach and an experienced PGA golf professional – who had basic experience with general movement screening but no prior knowledge of the SGMA, underwent one hour of training from the experienced lead researcher to familiarise themselves with the required scoring criteria. Intra-rater reliability was assessed on the videos by the same experienced lead rater on two occasions, four weeks apart to avoid any recall bias. Inter-rater reliability was determined independently by three separate raters: the lead rater and the two novice raters. Raters were blinded to previous ratings.

Statistical/Reliability Analysis

Data from completed screens were analysed in SPSS (v28, IBM, Armonk, NY). SGMA scores between males and females were compared by a Welch's t-test. Intraclass Coefficient Correlation ($ICC_{2,1}$) and Standard Error of Measurement (SEM) were used to assess the intra- and inter-rater reliability of the composite scores. Intra-rater reliability was analysed using ICC, weighted Cohen's Kappa and SEM, and inter-rater reliability was established using the Fleiss' Kappa to report the level of agreement. Significance was set at $\alpha < 0.05$.

ICC scores are interpreted as follows: < 0.50 = Poor reliability; 0.5 – 0.75 = Moderate reliability; 0.75 – 0.9 = Good reliability, and >0.90 = Excellent reliability (Koo & Li, 2016). Kappa scores are interpreted as follows: < 0 = Poor agreement; 0.01 – 0.2 = Slight agreement; 0.21 – 0.4 = Fair agreement; 0.41 – 0.6 = Moderate agreement; 0.61 – 0.8 = Substantial agreement, and 0.81 – 1.0 = Excellent agreement (Sim & Wright, 2005).

RESULTS

Demographic characteristics and SGMA scores by Rater 1 were taken from the first analysis and are shown in Table 2. The time taken for Rater 1 to assess the SGMA videos was 44.26 ±3.21 minutes.

Table 3 shows intra- and inter-rater reliability data for the composite score of the SGMA. ICC values were excellent (ICC = 0.99) for the same rater across repeated assessments and for consistency among different raters (ICC = 0.97). SEM values indicated good intra-rater (SEM = 0.28) and inter-rater (SEM = 0.45) reliability between the experienced and novice raters for the 100-point composite score.

The 100-point composite score demonstrated substantial reliability, indicating a high level of intra-rater agreement across repeated assessments (ICC = 0.99, SEM = 0.28) and agreement between raters (ICC = 0.97, SEM = 0.45).

Table 2. Demographic characteristics and SGMA results (Percentage score displayed in brackets) and differences between genders

	All	Males	Females	
Age	67.16 ± 6.44	68.60 ± 5.52	65.56 ± 7.32	P>0.05
Height (cm)	170.93 ± 11.25	177.78 ± 9.67	163.32 ± 7.47	*P<0.01
Weight (kg)	79.20 ± 19.49	88.42 ± 16.07	68.96 ± 18.42	*P=0.03
Handicap	20.3 ± 6.4	17.3 ± 5.5	23.7 ± 5.8	*P=0.02
Clubhead Speed (CHS) (mph)	77.21 ± 12.95	88.08 ± 5.61	65.13 ± 5.51	*P<0.01
Composite Score (0-100)	64.00 ± 11.02	59.20 ± 11.15	69.33 ± 8.50	*P=0.04
Overhead Squat (0-8)	3.53 ± 0.90 *(44.1%)*	3.60 ± 0.70 *(45.0%)*	3.44 ± 1.13 *(43.1%)*	P>0.05
Lunge (0-20)	11.63 ± 4.35 *(58.2%)*	11.30 ± 4.85 *(56.5%)*	12.00 ± 3.97 *(60.0%)*	P>0.05
Balance (0-10)	4.16 ± 3.25 *(41.6%)*	3.40 ± 2.50 *(34.0%)*	5.00 ± 3.91 *(50.0%)*	P>0.05
Golf Posture (0-5)	4.53 ± 0.61 *(90.5%)*	4.40 ± 0.70 *(88.0%)*	4.67 ± 0.50 *(93.3%)*	P>0.05
Rotation Over Fixed Foot (0-10)	6.89 ± 1.49 *(68.9%)*	6.60 ± 1.07 *(66.0%)*	7.22 ± 1.86 *(72.2%)*	P>0.05
Trunk Inclination (0-5)	3.68 ± 1.34 *(73.7%)*	3.10 ± 1.37 *(62.0%)*	4.33 ± 1.00 *(86.7%)*	*P=0.04
Seated Thoracic Rotation (0-14)	10.42 ± 2.29 *(74.4%)*	9.10 ± 1.73 *(65.0%)*	11.89 ± 1.96 *(84.9%)*	*P<0.01
Shoulder 90/90 Rotation (0-10)	5.32 ± 2.77 *(53.2%)*	4.80 ± 2.86 *(48.0%)*	5.89 ± 2.71 *(58.9%)*	P>0.05
Seated Hamstring (0-10)	6.79 ± 1.96 *(67.9%)*	5.90 ± 2.08 *(59.0%)*	7.78 ± 1.30 *(77.8%)*	*P=0.03
Side Plank (0-8)	7.05 ± 1.47 *(88.2%)*	7.00 ± 1.33 *(87.5%)*	7.11 ± 1.69 *(88.9%)*	P>0.05

* Significant difference between males and females (P <0.05)

Table 3. Intra- and Inter-rater reliability of the Senior Golf Movement Assessment (SGMA) composite score

Type	ICC	SEM
Intra-rater	0.99 (0.97, 0.95)	0.28
Inter-rater	0.97 (0.94, 0.99)	0.45

For intra-rater reliability data, ICC values for individual exercises ranged from 0.02 (overhead squat) to 0.95 (lunge – right leg) (Figure 1). SEM values ranged from 0.20 (lunge – right leg (10 points)) to 1.10 (overhead squat (8 points)). Kappa values ranged from 0.02 (golf posture) to 0.78 (lunge – right leg) (Table 4).

Inter-rater reliability analyses demonstrated varied consistency among different raters (Figure 1). The 5-point trunk inclination assessment revealed moderate reliability (ICC = 0.65, SEM = 0.45, Kw = 0.03), while other assessments, including seated hamstring, seated thoracic rotation, rotation over fixed foot, lunge, shoulder 90/90 rotation, and side plank, exhibited varying levels of reliability ranging from fair to substantial agreement between raters. However, the 8-point overhead squat (ICC = 0.01, SEM = 0.83, Kw = 0.01) and 5-point golf posture assessments (ICC = 0.16, SEM = 0.56, Kw = -0.05) had poor agreement between raters (Table 4).

The analysis revealed significant gender differences in both the composite SGMA score and individual tests (Table 2). In particular, female participants displayed a significantly higher composite score (mean ± SD 69.33 ± 8.50) compared to males (mean ± SD 59.20 ± 11.15, $t(17) = 2.207$, $p = 0.041$). Distinct differences between genders were observed in composite score for three key exercises: females scored significantly higher than males on trunk inclination (mean ± SD 4.33 ± 1.00 for females vs. 3.10 ± 1.37 for males, $t(17) = 2.218$, $p = 0.040$), seated hamstring flexibility (mean ± SD 7.78 ± 1.30

Table 4. Intra- and inter-rater reliability of the individual exercises of the Senior Golfers Movement Assessment (SGMA)

Type/Test	ICC (95% CI)	SEM	Kappa K_w
Intra-rater			
Overhead Squat	0.02 (-0.43, 0.46)	1.10	0.08
Lunge – R	0.95 (0.86, 0.98)	0.20	0.78
Lunge – L	0.75 (0.46, 0.90)	0.85	0.62
Basic Balance – R	0.73 (0.43, 0.89)	0.74	0.64
Basic Balance – L	0.83 (0.62, 0.93)	0.39	0.61
Golf Posture	0.10 (-0.36, 0.52)	0.90	0.02
Rotation Over Fixed Foot – R	0.44 (-0.00, 0.74)	0.78	0.15
Rotation Over Fixed Foot – L	0.49 (0.06, 0.77)	0.65	0.30
Trunk Inclination	0.78 (0.51, 0.91)	0.46	0.45
Seated Thoracic Rotation – R	0.73 (0.42, 0.89)	0.47	0.54
Seated Thoracic Rotation – L	0.72 (0.41, 0.88)	0.48	0.49
Shoulder 90/90 Rotation – R	0.82 (0.60, 0.93)	0.36	0.70
Shoulder 90/90 Rotation – L	0.81 (0.58, 0.92)	0.41	0.67
Seated Hamstring – R	0.49 (0.06, 0.77)	0.65	0.45
Seated Hamstring – L	0.64 (0.27, 0.84)	0.50	0.46
Side Plank – R	0.56 (0.15, 0.80)	0.46	0.34
Side Plank – L	0.78 (0.52, 0.91)	0.38	0.51
Inter-rater			
Overhead Squat	0.01 (-0.21, 0.33)	0.83	0.01
Lunge – R	0.78 (0.60, 0.90)	0.44	0.15
Lunge – L	0.73 (0.52, 0.88)	0.54	-0.02
Basic Balance – R	0.85 (0.72, 0.94)	0.22	0.44
Basic Balance – L	0.72 (0.50, 0.87)	0.42	0.29
Golf Posture	0.16 (-0.10, 0.48)	0.56	-0.05
Rotation Over Fixed Foot – R	0.32 (0.04, 0.62)	0.45	0.11
Rotation Over Fixed Foot – L	0.08 (-0.16, 0.41)	0.59	0.04
Trunk Inclination	0.65 (0.41, 0.83)	0.45	0.03
Seated Thoracic Rotation – R	0.52 (0.25, 0.76)	0.51	0.16
Seated Thoracic Rotation – L	0.61 (0.36, 0.81)	0.38	0.22
Shoulder 90/90 Rotation – R	0.76 (0.57, 0.89)	0.22	0.35
Shoulder 90/90 Rotation – L	0.70 (0.48, 0.86)	0.31	0.13
Seated Hamstring – R	0.38 (0.09, 0.66)	0.47	0.22
Seated Hamstring – L	0.34 (0.05, 0.63)	0.49	0.04
Side Plank – R	0.40 (0.11, 0.67)	0.33	0.33
Side Plank – L	0.80 (0.62, 0.91)	0.18	0.41

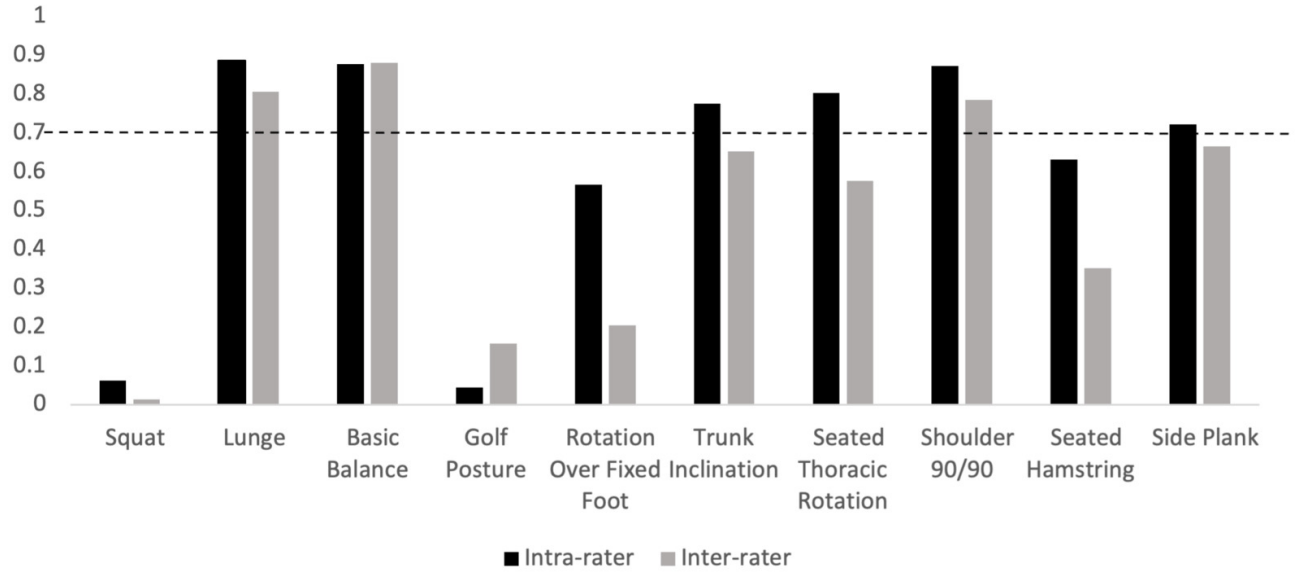

Figure 1. Intra (black) and inter-rater (grey) intra-class correlation coefficients of the reliability of total scores for each exercise in the Senior Golf Movement Assessment. Dashed line represents the threshold for good reliability (0.7)

for females vs. 5.90 ± 2.08 for males, $t(17) = 2.327$, $p = 0.033$), and seated thoracic rotation (mean ± SD 11.89 ± 1.96 for females vs. 9.10 ± 1.73 for males, $t(17) = 3.292$, $p = 0.004$) (Table 1). These scores reflect the cumulative binary sub-scores for each exercise rather than continuous measures.

DISCUSSION

The study aimed to introduce the 100-point Senior Golfers Movement Assessment (SGMA) and assess the intra- and inter-rater reliability in amateur senior golfers. Key findings established normative values of the composite score and individual sub-tests in amateur senior golfers, with the squat, basic balance and shoulder 90/90 rotation presenting the greatest challenge in this population. Significant differences between gender were apparent in the composite score, trunk inclination, seated hamstring and seated thoracic rotation exercises (Table 2). Intra- and inter-rater reliability of the composite score was excellent when assessed by individuals with basic training on scoring the SGMA. Individual exercises displayed variable reliability with good reliability in exercises such as the lunge and basic balance, and poor reliability in the squat and golf posture exercises.

SGMA Performance

The composite score (0-100) indicated significantly greater movement competency among female senior golfers compared to males, highlighting the importance of considering gender as a variable in future validity studies of movement assessments for senior golfers. Notably, females performed significantly better in trunk inclination, seated hamstring and seated thoracic rotation exercises than males. These findings align with existing literature documenting inherent mobility capabilities in older females, who tend to maintain flexibility more consistently from childhood into seniority, and experience slower age-related decline than males (Medeiros et al., 2013). These results highlight gender-specific variations in movement patterns and physical capabilities. The consistently higher scores in females suggest that gender-specific normative data could enhance the precision and applicability of the SGMA, enabling more tailored insights for intervention planning that reflect the unique movement competencies of each gender.

Additionally, movement screening should be quick, inexpensive, and easy to administer to allow the provision of timely and effective intervention strategies (Chimera & Warren, 2016). However, the SGMA analysis took approximately 45 minutes per assessment. While this may be potentially feasible in some settings where time permits, it raises questions regarding its practical application as a screening tool on a regular basis. This extended duration could limit the feasibility of the SGMA in real-world settings where time efficiency is vital.

Composite Score Reliability

The excellent intra- and inter-rater reliability for the composite score of the SGMA, indicates consistency in assessment across raters following one hour of basic training (Table 3). Comparing the reliability of the composite score with the 93-point Golf Movement Screen (GMS) (Gould et al., 2017), this study revealed similarly excellent levels of intra- and inter-rater reliability (ICC = 0.94). Meanwhile, the standard error of measurement (SEM) for the SGMA provided insights into the precision of the tool, suggesting minimal variation in scores around the true score for both intra- and inter-rater assessments (SEM = 0.28 points and 0.45 points, respectively). Similarly, the FMS in older adults aged 50 and over demonstrates good to high intra-rater reliability (ICC = 0.89) (Fawcett, 2014) which supports the reliable use of movement screening in the older population. Therefore, the high reliability and precision of the SGMA make it a dependable tool for assessing movement capabilities in senior golfers, ensuring consistent and accurate evaluations that can inform targeted intervention strategies. However, we acknowledge that a relatively small sample size limits the generalisability of these findings. Future studies with larger, more diverse populations are recommended to validate the SGMA further and enhance confidence in its broader application.

Individual Exercise Reliability

The study found variability in intra- and inter-rater reliability across individual exercises in the SGMA. This contrasts with findings from the individual exercises within the GMS which were all considered above the good threshold of ICC ≥ 0.75 for intra- and inter-rater reliability, except the side plank for the inter-rater analysis (Gould et al., 2017). The demographic differences between participants in the SGMA and GMS should be considered. Age-related declines in flexibility, musculoskeletal strength, balance, and physical function contribute to decreased performance on the FMS in older adults (Dietze-Hermosa et al., 2021; Milanović et al., 2013). Functional limitations such as hypomobility and decreased strength can affect the entire kinetic chain (Mitchell et al., 2016), which could contribute to inconsistencies in scoring, particularly with more complex movement patterns, and highlighting the importance of assessment tools developed specifically for older adults given factors such as age-related declines in mobility and stability, pre-existing health conditions, and variations in movement complexity. Regional interdependence suggests that impairments in one body region can influence the neuromusculoskeletal function of seemingly unrelated regions, which may further explain inconsistencies in inter-rater observations (Sueki et al., 2013). As balance and proprioception decline with age, the ability to maintain a stable movement is impacted. Variability in the golfer's movement can influence the movement quality, leading to inconsistencies in scoring among raters. If an individual is unable to maintain a stable position, their ability to effectively execute a movement

will be hindered and this may lead to some subjectivity surrounding the scoring criteria. Additionally, there are limitations of binary decision criteria in physical assessments. Binary criteria may oversimplify assessment outcomes and fail to capture the spectrum of movement quality or performance, which could affect their utility in guiding interventions. For complex movements such as the squat, reliance on binary judgements may obscure observations in small differences in performance that could inform targeted interventions. Future studies might explore alternative scoring systems that provide a more graded evaluation of movement quality to address this limitation.

The 100-point scoring criteria of the SGMA required raters to observe multiple body segments during each exercise, leading to discrepancies, particularly in compound movements like the rotation over fixed foot, lunge, and overhead squat. These exercises rely on effective function of the kinetic chain which may lead to varied interpretations by the raters regarding what an "ideal" movement execution is. Poor intra- and inter-rater reliability was reported on the squat exercise in the SGMA, and, as a component of the FMS, had low levels of agreement between raters where difficulties in consistency have been reported due to the number of joints and segments involved in execution of the task (Gulgin & Hoogenboom, 2014; Minick et al., 2010; Schneiders et al., 2011). The FMS has a four-point scoring system for each individual exercise, theoretically allowing for greater inter-rater reliability due to less scope for differences in judgement and scoring. In contrast, some exercises in the SGMA have up to 20 criteria to observe (Table 1). This increased specificity in the SGMA could potentially lead to greater detail in assessment but also introduces a greater margin for error and potential for disagreements between raters. For instance, exercises like the lunge and seated thoracic rotation had more total points available to assess than other movements, with the lunge having 20 met/not met points, which could result in less consistent scoring between raters. Future work might consider reducing the complexity of the scoring and determining any changes this has on sensitivity of the SGMA.

The poor inter-rater reliability between individual exercises may also be explained by the experience of the rater. The FMS generally demonstrates good reliability regardless of the experience of the rater (Gulgin & Hoogenboom, 2014; Leeder et al., 2016). However, when examining the individual exercises, experienced raters may be more critical in interpreting scoring criteria on the FMS (Gulgin & Hoogenboom, 2014). Although the raters in the present study are experienced in movement assessment, they have varied experience with specific golf movement screening, particularly with the SGMA. This variability may be compounded by the more detailed criteria used in the SGMA compared to the simpler 0–3-point scale of the FMS. This highlights the need for clearer and more standardised grading criteria and additional rater training to ensure consistent and accurate assessments.

CONCLUSION

The Senior Golfers Movement Assessment (SGMA) demonstrates excellent reliability for the composite score, though variable reliability for the individual exercises. The SGMA shows promising potential as a tool for assessing movement competency in amateur senior golfers. By identifying movement deficits and guiding targeted interventions, the SGMA has the potential to inform strategies which may improve performance and reduce the risk of injury in this population.

Discrepancies in the intra- and inter-rater reliability when scoring the 100-point SGMA highlight the complexity of the exercises within the SGMA and the need for a revised, simpler, and less time-consuming grading criterion to improve consistency in the scoring, particularly when used by less experienced raters and under time constraints. However, it is important to note that a refined, simplified version of the tool, with enhanced reliability across all exercises, could provide a more practical and effective tool for both practitioners and senior golfers. Without improved reliability, the introduction of an additional screening tool could risk contributing to inconsistency within the field, thus undermining its potential value in practice.

Future research should aim to address these limitations by conducting larger-scale studies with diverse participant populations. Specific areas for future work include exploring the validity of the SGMA against performance and injury outcomes in senior golfers, revising scoring criteria to reduce conflicting interpretation of scores, and validating each exercise against performance metrics. Additionally, considering gender-specific normative data may enhance the precision and applicability of the SGMA, providing more tailored insights for intervention planning. Further work should also consider the applicability of the SGMA for specific populations, such as those with higher handicaps, and those recovering from common operations like total hip arthroplasty (THA) or knee replacement, or with osteoarthritis to expand its utility and relevance in various clinical and athletic settings.

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