The influence of BMI on movement competency screening errors among moderately active males

La influencia del IMC en los errores de evaluación del cribado de competencia motriz en varones moderadamente activos

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Abstract

Introduction: The Movement Competency Screening (MCS) is a validated tool designed to assess movement quality and inform individualized exercise regimens.
Objective: This study investigates how BMI impacts MCS assessment outcomes among moderately active male population and identifies the anatomical regions of movement deficiencies as assessed by the MCS among moderately active males.
Methodology: This cross-sectional study adapted the MCS 100-point criteria to evaluate injury risk in moderately active males (n = 30, aged 19–49 years), focusing on three movements: lunges and twists, push-ups, and single-leg squats.
Results: Results revealed high upper-body competency, with push-ups demonstrating a 95.9% accuracy rate. However, significant deficits emerged in lower-body and core stability: single-leg squat depth accuracy was critically low (20.0%), while lunges and twists showed poor knee alignment (46.7%). Notably, Mann-Whitney U tests identified BMI-driven disparities: overweight subjects (BMI ≥25 kg/m^2) exhibited higher lumbar instability (42.9% vs. 6.3%, p = .017) and balance errors (42.9% vs. 6.3%, p = .017), whereas normal BMI individuals committed more knee misalignment errors during lunges (75.0% vs. 28.6%, p = .010). Lumbar competency was moderate overall (60–80% accuracy), underscoring core stability challenges.
Discussion: While the MCS effectively identified biomechanical inefficiencies, the inverse relationship between BMI and knee errors suggests that standardized scoring may misclassify body composition-driven adaptations as dysfunction. These findings advocate for BMI-adjusted MCS protocols to enhance diagnostic accuracy in non-athletic populations.
Conclusions: The study underscores the utility of MCS in moderately active demographics but highlights the necessity of refining screening criteria to account for anthropometric variability.

Keywords

Body Mass Index (BMI); lunges and twist; movement competency screening (MCS); moderately-active; push-up; single-leg squat; injury.

Resumen

Introducción: El Movement Competency Screening (MCS) es una herramienta validada para evaluar la calidad del movimiento y orientar programas de ejercicio individualizados.
Objetivo: Analizar la influencia del índice de masa corporal (IMC) en los resultados del MCS y localizar las regiones anatómicas con deficiencias de movimiento en varones moderadamente activos.
Metodología: Estudio transversal con 30 hombres (19–49 años), evaluados mediante los criterios del MCS (100 puntos) en tres movimientos: zancadas con giros, flexiones de brazos y sentadillas unipodales.
Resultados: Se observó alta competencia en tren superior, destacando las flexiones con 95,9% de precisión. En contraste, surgieron déficits marcados en tren inferior y core: baja precisión en sentadillas unipodales (20,0%) y pobre alineación de rodilla en zancadas (46,7%). El análisis con la prueba U de Mann-Whitney mostró diferencias asociadas al IMC: sujetos con sobrepeso (≥25 kg/m^2) presentaron mayor inestabilidad lumbar y errores de equilibrio (42,9% vs. 6,3%; p = .017), mientras que los de IMC normal cometieron más errores de rodilla (75,0% vs. 28,6%; p = .010). La competencia lumbar fue moderada (60–80%).
Discusión: El MCS identificó ineficiencias biomecánicas, pero la relación inversa entre IMC y errores de rodilla sugiere que las puntuaciones estándar podrían confundir adaptaciones corporales con disfunciones.
Conclusiones: El MCS resulta útil en poblaciones moderadamente activas, aunque se recomienda ajustar los criterios de evaluación según el IMC para mejorar la precisión diagnóstica.

Palabras clave

Índice de Masa Corporal (IMC); estocadas con rotación; movement competency screening (MCS); moderadamente activos; flexiones de brazos (push-ups); sentadilla unipodal; lesiones.

Introduction

Movement competency screens (MCSs) are recently being adopted in sports and occupational settings to assess injury risk by evaluating fundamental movement patterns (Gamble, 2013; Benoit-Piau et al., 2022). The screening aims to identify biomechanical inefficiencies linked to injury susceptibility, enabling targeted interventions (Jafari et al., 2021; Malik et al., 2025; Niles et al., 2021). However, research suggests that body composition, particularly body mass index (BMI), may confound MCS accuracy. Individuals with higher BMI often exhibit altered kinematics such as reduced trunk stability, compensatory movement strategies, and joint loading that mimic poor movement competency, potentially skewing screening results (Cho et al., 2023; Rohatgi et al., 2023; Anam et al., 2024). Additionally, moderately active males, who engage in unstructured physical activity are prone towards biomechanical strain, represent a critical population for investigation. This demographic frequently demonstrates movement inefficiencies exacerbated by higher BMI, including asymmetrical weight distribution and reduced dynamic stability, which may increase the injury risk perceptions during MCS assessments (Gnacinski et al., 2024).

Men exhibit higher injury rates than women, due to poor neuromuscular control, and participation in high-risk activities (Chou et al., 2022; Martin-Diener et al., 2016; Cai et al., 2020; Eckart et al., 2024). In moderately active male populations, unstructured training routines and inadequate conditioning further increase the injury susceptibility. While the MCS has been validated in elite athletes, its application to populations with the variable of BMI remains underexplored. Studies in military, athletic, and occupational cohorts highlight correlations between low MCS scores and injury risk (Warshaw et al., 2018; Newlands et al., 2015; Reid et al., 2015). However, these populations often have narrow BMI ranges, limiting generalizability. For instance, overweight individuals may display neuromuscular adaptations (e.g., stance widening for stability) misclassified as dysfunctional in traditional MCS protocols (Mann et al., 2017; Singh et al., 2023). Biomechanical reviews emphasize that anterior knee displacement during squats such as a common MCS task can reduce compensatory spinal and hip loading in individuals with specific anthropometric needs, suggesting adaptive strategies may be misinterpreted as deficits (Illmeier & Rechberger, 2023). Electromyographic analyses further reveal that altered muscle activation in higher BMI individuals reflects biomechanical adaptations rather than deficits (Luo et al., 2025).

While some studies associate poor MCS performance with injury, methodological inconsistencies, and confounding variables, such as BMI, weaken causal inferences (Callahan & Mangum, 2024; Niles et al., 2021). Notably, higher BMI is correlated with diminished MCS task performance (e.g., single-leg balance, overhead squat) and higher risk of musculoskeletal injuries due to mechanical challenges like postural sway, yet these deficits do not consistently predict injury incidence (Choo et al., 2018; Lisman et al., 2023). This discrepancy suggests MCS may misinterpret BMI-related biomechanical adaptations as neuromuscular inefficacy, leading to unnecessary interventions or overlooked risks. Furthermore, the MCS reliability on distinguishing adaptive strategies from pathological patterns is a challenge in various demographics (Gamble, 2013; Reid et al., 2015). Standardized scoring criteria may lack sensitivity to anthropometric variability, raising concerns about diagnostic accuracy (Gnacinski et al., 2024; Mann et al., 2022).

Therefore, given the increased injury susceptibility and variable BMI profiles of moderately active males, clarifying the influence of body composition on MCS errors is essential. This study investigates how BMI impacts MCS assessment outcomes among moderately active male population. Additionally, the study aims to identify anatomical regions of movement deficiencies as assessed by the MCS among moderately active males.

Method

Study Design

This study utilizes a quantitative cross-sectional design to evaluate movement competency and its correlation with body mass index (BMI) among moderately active males as they represent a growing segment of the population that is neither clinically sedentary nor involved in structured athletic training.

This group is often overlooked in screening research despite their increased participation in recreational fitness programs and higher susceptibility to undetected movement inefficiencies that may not present in athletes or inactive individuals.

Participants

A convenience sampling was employed recruiting male participants around the district of Tanjung Malim in the state of Perak. A priori power analysis was conducted using G*Power 3.1 (Faul et al., 2009) to determine the minimum required sample size for detecting a statistically significant correlation using a two-tailed point biserial correlation test. The analysis assumed a medium-to-large effect size (ρ = 0.523), an alpha level of 0.05, and a desired statistical power of 0.90. The results indicated that a total sample size of 30 participants would be sufficient to achieve the desired power (actual power = 0.900). This ensures adequate sensitivity to detect meaningful associations in the data while minimizing the risk of Type II error. The analysis was conducted to avoid underpowered studies which risk failing to detect true effects (Kyonka, 2018). participants were categorized into two groups based on body mass index (BMI) where normal (BMI <23 kg/m^2) and overweight (BMI ≥23 kg/m^2), in alignment with World Health Organization Asian classifications (WHO Expert Consultation, 2004). The BMI was calculated using measured height and weight (SECA-213 stadiometer and Tanita BC-718 digital scale). The participants recruited were ensured to not be engaged in structured athletic training and at least participated in 150 minutes of moderate-intensity physical activity per week. Inclusion criteria required full medical clearance for exercise, while exclusion criteria included recent musculoskeletal injuries less than 6 months and any conditions affecting movement. Due to the homogeneity of the sample, findings are primarily representative of adult males with baseline physical activity exposure.

Movement Competency Screening (MCS) Protocol

The MCS, adapted from Kritz's 100-point screening criteria (Kritz, 2012), assessed three movement patterns: lunge and twist, standard push-up, and single leg squat. These patterns were selected for their functional relevance to lower-body stability, upper-body strength, and dynamic balance, the key factors in injury risk profiling (Alkhathami & Alqahtani, 2024; Heileson & Funderburk, 2020; Kolodziej et al., 2022). Each movement was performed three times under videotaped conditions to ensure consistency. Videos were stored securely in a password-protected cloud-based drive and analyzed independently by two first-year MSc (Exercise and Health) students who were also certified by the National Council of Certified Personal Trainers in Strength and Conditioning. The students were trained in MCS scoring by a lead biomechanics researcher as well additionally. (Associate Professor with 10+ years of screening experience).

Scoring Criteria and Reliability

Performance was evaluated across nine biomechanical critical points: head, shoulders, lumbar spine, hips, knees, ankles, foot alignment, depth, and balance. Each point was classified as "good" (satisfactory technique) or "poor" (suboptimal technique) based on predefined kinematic benchmarks (Kritz, 2012). A "poor" rating for any criterion constituted one error, with total errors summed across all movements. Inter-rater reliability was established through a pilot analysis (Cohen's $\kappa = 0.82$ for agreement on critical points), and intra-rater reliability was confirmed via re-analysis of 20% randomly selected videos (ICC = 0.89). Discrepancies were resolved through consensus with the lead researcher.

Data Analysis

Descriptive statistics (means, standard deviations, frequencies) summarized participant characteristics and error distributions. BMI was calculated as weight (kg)/height (m^2) and categorized as <23 (normal) or ≥23 (overweight). Non-parametric Mann-Whitney U tests compared total error counts by region between BMI groups due to non-normal data distribution (Shapiro-Wilk $p < 0.05$). Analyses were conducted using IBM SPSS Version 26, with significance value set at $p < 0.05$.

Procedures

All participants were required to participate in the study voluntarily and they received a detailed briefing individually prior to carrying out the protocol at the biomechanics laboratory in Sultan Idris Education University. The subjects were given appointments and the protocol was carried out on an appointment basis. The participants received additional instructions from the lead researcher prior to carrying out the protocol. Once arriving to the laboratory, they were required to undergo the measurement of their body weight and height with the laboratory measurement instruments. The height (cm) and body composition (body mass & fat percentage) was measured using a calibrated stadiometer (SECA GmbH & Co. KG, Hamburg, Germany; Model 213) and multi-frequency body fat & body water monitor scale (TANITA Corporation, Tokyo, Japan; Model BC-718), following manufacturer guidelines. Studies have investigated the reliability of the SECA instruments indicating a technical error margin of ±0.1–0.4 cm for height measurement (Geeta et al., 2009), and the TANITA scales reporting body fat estimation errors within ±1% for test-retest reliability and up to ±9% when compared to DXA standards (Astorino et al., 2012). The participant's anthropometry data were keyed in the excel sheet immediately and labelled with codes for data standardization and to prevent any researcher bias in data analysis. They were also required to undergo a standardized warm-up protocol of 10 minutes prior to beginning the movement competency screening. The videos were recorded utilizing a 48 mega-pixel 6.1 inch high-definition resolution camera of an iPhone-15 fixed on a tripod stand. The participants were first required to perform the lunges and twist movement; upon completion they continued with the standard push-up and lastly ending the protocol with the single-leg squat. Each participant was required to perform each movement three times to ensure consistency. Upon completion of the protocol, the participants were required to carry out a brief warm down session with passive stretches and the videos were immediately transferred to google drive and labelled with codes to ensure standardization of the data collection process and to reduce the chances of errors during analysis. All the participants were required to fill in a consent form prior to participating in this research. Prior approval as well was obtained from the Sultan Idris Education University research committee board and all procedures were conducted in accordance with the principles outlined in the Declaration of Helsinki.

The videos were analyzed frame-by-frame to quantify errors, with final scores aggregated across three trials per movement. The total error rate (sum of "poor" ratings) served as the primary outcome for injury risk stratification, where higher errors indicated greater biomechanical inefficiency. In order to achieve an extensive and consistent assessment of movement competency, all video analyses followed a standardized protocol aimed at enhancing both reliability and validity. Before the formal scoring process began, the two first-year MSc (Exercise and Health) analysts participated in a structured training program facilitated by the lead biomechanics researcher, an Associate Professor with over a decade of clinical screening experience. The training included theoretical workshops and a 12-hour curriculum that addressed the principles of the MCS 100-point screening criteria (Kritz, 2012). This curriculum encompassed kinematic benchmarks for each critical point, such as lumbar stability during lunges and knee valgus thresholds during squats.

Results

A total of 30 male participants participated in this study aged between 19 and 49 years (M = 32.23, SD = 9.64) voluntarily participated in the study. The descriptive statistics for participants' demographic characteristics are presented in Table 1. The mean height of the participants was 170.0 cm (SD = 6.02), while the average body weight was 71.73 kg (SD = 13.84). The mean Body Mass Index (BMI) was calculated to be 25.98 kg/m² (SD = 7.43), indicating that the sample, on average, fell within the overweight category according to WHO classification. The total sample participants, were categorized into two groups based on BMI classification following World Health Organization (WHO) guidelines. Participants with a BMI of less than 23 kg/m² were classified as having a normal BMI (n = 12), while those with a BMI equal to or greater than 25 kg/m² were classified as overweight (n = 18). The normal BMI group had a mean BMI of 20.86 (SD = 1.66), whereas the overweight group had a mean BMI of 29.39 (SD = 7.85). The overall sample had a mean BMI of 25.98 (SD = 7.43), reflecting a heterogeneous distribution of body composition within the study population.

Table 1. The demographic descriptive statistics

Variable	Mean (M)	Standard Deviation (SD)
Age (Years)	32.23	9.64
Height (CM)	170.0	6.02
Weight (KG)	71.73	13.84

Table 2. The descriptive statistics of total errors by region on movement competency screening rating

Region	Single-Leg Squat Correct (%)	Single- Leg Squat Wrong (%)	Push-Up Correct (%)	Push-Up Wrong (%)	Lunges & Twist Correct (%)	Lunges & Twist Wrong (%)
Head	96.7	3.3	100.0	0.0	90.0	10.0
Shoulder	100.0	0.0	100.0	0.0	93.3	6.7
Lumbar	83.3	16.7	80.0	20.0	60.0	40.0
Hips	80.0	20.0	90.0	10.0	93.3	6.7
Knees	76.7	23.3	100.0	0.0	46.7	53.3
Ankles	83.3	16.7	100.0	0.0	66.7	33.3

The results showed an overall accuracy rate of 78.1% for movements performed accurately, while 21.9% of the movements were performed incorrectly. The foot category demonstrated the highest level of competency with an accuracy rate of 96.7%. Next, the shoulder and hip categories were almost similar where each achieved an accuracy rate of 93.3%. On the other hand, the least level of competency was noted in the knees, with just 46.7% of movements carried out accurately, indicating challenges in maintaining proper alignment. The lumbar area showed a decreased level of competency with an accuracy rate of 60.0%. The need for improvements in dynamic stability is highlighted by the moderate performance shown by categories like depth (80.0%) and balance (76.7%). The results show that, while the population demonstrated strong abilities in basic stability and alignment, specific measures are needed to address issues in knee alignment and lumbar control.

The results revealed 95.9% overall accuracy rate in the movement, with only 4.1% of movement performed incorrectly. All of the participants achieved a perfect score of 100% showcasing correct movements in the head, shoulders, knees, and ankles showed the highest level of competency. The hip and foot categories displayed slightly lower accuracy rates at 90.0% and 93.3%, respectively. The lumbar region demonstrated the least accuracy rate of 80.0%, suggesting difficulties sustaining core stability. The depth and balance categories, showcased better accuracies with a rating of 96.7%. In conclusion, individuals showed excellent overall movement competence during push-ups, with only slight limitations noted in the foot and lumbar areas.

The MCS for single-leg squats results showed an overall execution accuracy rate of 75.6%, whereas 24.4% of the movements were done incorrectly. The shoulder category demonstrated the most competency, with each participants exhibiting 100% accuracy in their movements. The head category then emerged by achieving a accuracy rate of 96.7%. Moderate competency was noted in lumbar (83.3%), ankle (83.3%), foot (90.0%), and balance (83.3%) assessments. Nevertheless, the hips (80.0%) and knees (76.7%) exhibited more significant difficulties concerning alignment and control. The depth category exhibited the least favourable outcomes, with just 20.0% accuracy. This result indicates significant difficulties in reaching the proper squat depth when performing the single-leg exercise. In conclusion, the single-leg squat demonstrated deficiencies in depth and lower-body stability, particularly with the hips and knees, despite the participants' notable movement competency in the head and shoulders.

Figure 1. Summary of single-leg squat error and correct counts by anatomical regions

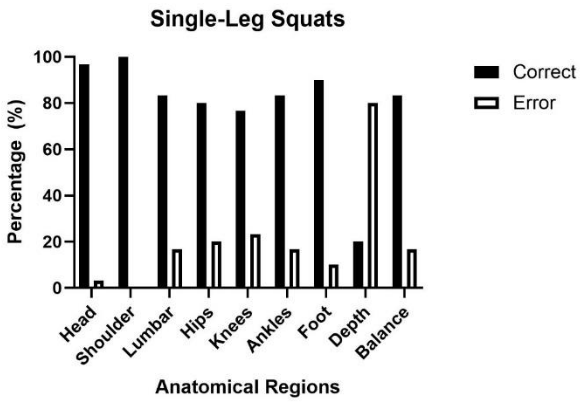


Figure 2. Summary of push-ups error and correct counts by anatomical regions.

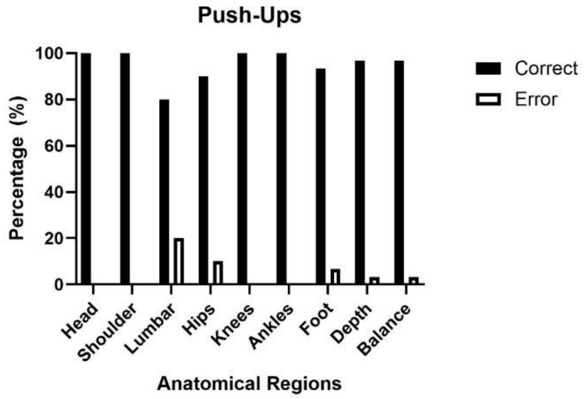
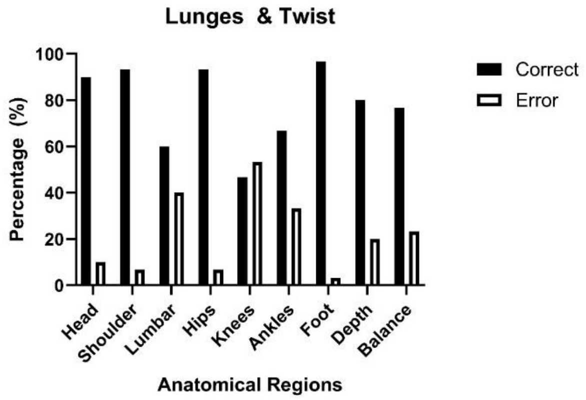


Figure 3. Summary of lunges & twist error and correct counts by anatomical regions.



Comparison Between Normal BMI (<23kg/m2) and Overweight BMI (>23kg/m2) on MCS Scores

A series of Mann–Whitney U tests were conducted to examine whether movement error counts across specific anatomical regions differed between participants with normal (<23) and overweight/obese (≥23) BMI. No statistically significant differences were found in the head (U = 99.00, p = .518), shoulders (U = 96.00, p = .240), or lumbar spine (U = 98.00, p = .649). Mean error counts were low in these regions: head (M = 0.13, SD = 0.35), shoulders (M = 0.07, SD = 0.25), and lumbar spine (M = 0.80, SD = 0.85). Similarly, no significant difference was observed in the hips (U = 93.00, p = .391; M = 0.37, SD = 0.76). Knee errors approached significance (U = 73.00, p = .103), with the normal BMI group displaying a higher mean rank (18.42) than the overweight/obese group (13.56), suggesting a potential trend of increased knee control issues among leaner individuals. No significant differences were observed in ankle (U = 92.00, p = .428), foot (U = 102.00, p = .714), depth control (U = 94.50, p = .515), or balance (U = 84.00, p = .231) error counts between BMI groups. Descriptive statistics showed low error frequencies in the foot (M = 0.20, SD = 0.41) and ankle (M = 0.50, SD = 0.73), while depth control (M = 1.03, SD = 0.72) and balance (M = 0.43, SD = 0.63) demonstrated moderate variability. In summary, across all nine body regions, none of the differences in error counts between BMI groups reached statistical significance. While a few areas, such as knees and balance, showed suggestive trends, the results overall imply that BMI status alone may not strongly influence the distribution of movement errors across body segments.

Discussion

Based on the sample of moderately active males (n = 30). The results revealed distinct patterns of biomechanical proficiency and dysfunction, consistent with prior literature on movement screening tools (Gamble, 2013; Benoit-Piau et al., 2022). Consequently, upper-body movements, particularly push-ups, demonstrated exceptional competency (95.9% accuracy), aligning with studies validating the reliability of MCS in assessing upper-body stability and neuromuscular control (Warshaw et al., 2018; Lee et al., 2017). The near-perfect movement literacy in head, shoulder, knee, and ankle alignment during push-ups suggests that moderately active males possess robust foundational strength and joint stability in tasks requiring upper-body engagement. However, the lumbar region emerged as a critical weakness (80.0% accuracy), even in this movement, highlighting persistent core stability deficits. This aligns with evidence that poor lumbo-pelvic control during push-ups correlates with compensatory strategies and increased injury risk, particularly in non-athletic populations (Niles et al., 2021; Jafari et al., 2018). In contrast, lower-body movements revealed pronounced challenges. The lunges and twists exhibited moderate overall accuracy (78.1%), with the knee joint demonstrating the lowest competency (46.7% accuracy). This finding mirrors prior research linking poor knee alignment during dynamic tasks to inadequate neuromuscular control and hip stabilizer weakness (Gamble, 2013; Lee et al., 2017). The high error rate in knee valgus or varus during lunges suggests that even moderately active individuals may lack the eccentric strength or proprioceptive awareness necessary to maintain optimal joint positioning under load. The findings reveal deficits which are particularly concerning, as aberrant knee mechanics are strongly associated with anterior cruciate ligament injuries and patellofemoral pain syndromes in active populations (Newlands et al., 2015; Worth, 2016).

The single-leg squat further underscored lower-body instability, with critically low depth accuracy (20.0%) and moderate hip/knee alignment errors (76.7–80.0% accuracy). These results align with biomechanical studies emphasizing the complexity of single-leg tasks, which demand simultaneous balance, joint mobility, and neuromuscular coordination (Illmeier & Rechberger, 2023). Previous studies have highlighted the strong associations between ankle instability and hip/knee strength deficits, supporting the hypothesis that limited dorsiflexion contributes to compensatory alignment errors in single-leg tasks (Brighenti et al., 2023). The inability to achieve adequate squat depth likely reflects limited ankle dorsiflexion range of motion (ROM) or hip flexor tightness, common issues in populations with sedentary occupations or unstructured training regimens (Anam et al., 2024). Limited ankle mobility, can result into compensatory lumbar and knee movements, increasing injury risk during multiplanar activities (Cho et al., 2023). Moreover, core stability emerged as a prevalent limitation across all movements. The lumbar region exhibited accuracy rates of 60.0% (lunges and twists) to 80.0% (push-ups), indicating difficulty maintaining spinal neutrality under dynamic conditions. This aligns with electromyographic evidence that core muscle activation patterns in non-athletes often fail to meet the demands of functional tasks, leading to compensatory strategies such as lumbar hyperextension or pelvic tilting (Luo et al., 2025). These compensations, may predispose individuals to overuse injuries, particularly in sports or occupational settings requiring repetitive trunk movements if not corrected (Warshaw et al., 2018).

However, the current findings revealed no statistically significant differences in movement error counts between normal BMI and overweight groups across all nine anatomical regions assessed. This finding contrasts with prior studies positing that individuals with higher BMI are more inclined to biomechanical inefficiencies during functional tasks (Cho et al., 2023; Rohatgi et al., 2023). The absence of BMI-related disparities may reflect limitations in the MCS scoring criteria, lacking in sensitivity to detect adaptive movement strategies specific to higher BMI individuals. Additionally, compensatory mechanisms such as widened stances or reduced joint range of motion which are common in overweight populations to enhance stability may have been misclassified as errors under rigid MCS benchmarks (Singh et al., 2023; Illmeier & Rechberger, 2023). This misclassification aligns with critiques of movement screens that fail to account for anthropometric variability, potentially over pathologizing functional adaptations (Gnacinski et al., 2024). Notably, a non-significant trend toward increased knee errors in normal BMI participants (U = 73.00, p = .103) suggests leaner individuals may exhibit distinct biomechanical challenges, such as reduced passive joint stability or greater reliance on dynamic neuromuscular control (Myer et al., 2015). This finding contradicts the assumptions that higher BMI inherently compromises joint kinematics, underscoring the complexity of body composition's role in movement quality. However, the small sample size (n = 30) and restricted BMI range (mean = 25.98 kg/m^2) likely limited statistical power to detect subtle between-group differences, a limitation echoed in similar MCS validation studies (Bonazza et al., 2017).

This study supports the usage of MCS as a diagnostic and preventative tool, beyond elite sports settings. However, the BMI-specific error patterns underscore the need for adjusted scoring thresholds for instance, allowing wider stances or modified depth criteria for overweight individuals to avoid penalizing biomechanically necessary adaptations (Illmeier & Rechberger, 2023). The results demonstrate the advantages of MCS in assessing injury risks and biomechanical inefficiencies in individuals who participate in moderate physical activity, which is also consistent with previous research (Reid et al., 2015; Warshaw et al., 2018). The study also highlights MCS as a guide to future interventions in improving movement quality, reducing the risk of certain injuries and predicting the respective outcomes (Newlands et al., 2015). Since males are more prone to be injured due to sociodemographic, anthropometry, lifestyle, and biomechanical factors, it is particularly important to include MCS in the routine examinations for this population (Mohammad Chan et al., 2025; Chou et al., 2022; Eckart et al., 2024). Despite MCS's clear benefits in identifying injury risks, other factors such as cost, time, and expertise in clinical application should be considered. Therefore, it is essential to investigate the feasibility of adapting MCS for broader use, as a self-assessment tool or less costly technology that the general population may utilize, to prevent injuries.

However, it is also critical to understand the correlation of MCS scores with injury risks along with extrinsic factors including training frequency, environmental circumstances, and psychological factors (Nur et al., 2019). The small sample size was one of the study's major drawbacks, which would restrict the findings' applicability to a wider population. The exclusion of female participants and narrow BMI range (25.98 ±7.43 kg/m^2) further limits generalizability, as gender and body composition interactions remain poorly understood (Chou et al., 2022; Eckart et al., 2024). Furthermore, since the current population may not accurately reflect the difference in movement competency across populations, this restriction highlights the significance of expanding the study to a bigger and more diversified sample size, with an intensive focus on different age groups. Additionally, lifestyle characteristics including training experience, past injury history, and job demands that might have contributed to variability in movement performance and physical literacy. The MCS protocol has proven to be reliable when administered by a single rater (Mann et al., 2022). Nevertheless, it is advisable to account for body mass index (BMI) as well as additional raters as a potential co-factor in its application to ensure accurate interpretation of results. Future research should also prioritize developing BMI-specific MCS scoring frameworks to enhance diagnostic accuracy, particularly among non-athletic or heterogeneous populations. These limitations underscore the necessity comprehensive sampling and variable control in further research to facilitate the formulation of more dependable and widely applicable conclusions.

Conclusions

The study aimed to examine the MCS scores among moderately active male populations. Participants showed good upper-body stability, but they also had serious problems with core stability and dynamic lower-body motions. Crucially, BMI status influenced error distribution as the overweight individuals exhibited lumbar and balance deficits linked to biomechanical strain, while normal BMI participants struggled with knee alignment, suggesting that MCS scoring may not account for body composition-driven adaptations. The results highlight the importance of implementing focused interventions to improve knee alignment, squat depth, and lumbar stability. Additionally, the study also adds to the increasing amount of data that shows MCS valuable contribution in qualitative biomechanical analysis, injury prevention and emphasizing its significance in both elite sports and moderately active individuals.

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