



The Impact of Creatine Supplementation on Speed, Power and Agility in Netball Players: A Controlled Study

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Abstract

This study examined whether short-term creatine monohydrate supplementation enhances important netball-related performance attributes in female competitors. Four female netball players (age 22.0 ± 3.2 years; range 18–25 years; ≥ 2 years of competitive experience) completed two 7-day supplementation phases (creatine monohydrate $20 \text{ g} \cdot \text{day}^{-1}$ in four 5 g doses; matched maltodextrin placebo), separated by a four-week washout, using a randomised, double-blind, placebo-controlled crossover design. Each of the four athletes participated in the matched crossover analysis after completing all testing dates. Performance testing assessed linear speed (20 m sprint), lower-body power (standing broad jump), upper-body power (seated 6 kg medicine ball throw), and change of direction (505 test). Paired-samples t-tests found no statistically significant differences between creatine and placebo for medicine ball throw (mean difference 0.033 m, $p = .473$), standing broad jump (0.034 m, $p = .587$), 20 m sprint (0.090 s, $p = .198$), or agility (0.005 s, $p = .973$). The two distance measures were descriptively better with creatine, the sprint time was better with a placebo, and the increases in agility were almost the same. The sample of four complete cases and the manual timing used in some sessions restrict interpretation.

Introduction

Netball is a high-intensity intermittent court sport in which players repeatedly accelerate, decelerate, jump, land, pass and change direction within a restricted playing area (Brooks *et al.*, 2021; Mackay *et al.*, 2025). Speed, strength, and the ability to change direction are important performance attributes for competitive players because of these repetitive explosive motions. However, broad match averages do not accurately reflect the movement demands placed on individual athletes since the physical demands of netball vary by position and level of play (Brooks *et al.*, 2021; Mackay *et al.*, 2025). The 20m sprint speed, standing broad-

jump distance, sitting medicine-ball throw distance, and 505 change-of-direction time are the field-based metrics that are the focus of this study.

Creatine monohydrate may be relevant to these outcomes because high-intensity actions rely partly on rapid ATP resynthesis through the phosphagen system (Kreider *et al.*, 2017). Increasing total muscle creatine through supplementation may enhance phosphocreatine availability and support repeated explosive efforts (Kreider *et al.*, 2017; Antonio *et al.*, 2021). However, the size and consistency of this effect in applied, sport-specific field tests remain uncertain (Glaister and Rhodes, 2022).

Although creatine is widely studied in strength, power and intermittent-sport settings, findings are not always directly transferable to female netball players (Antonio *et al.*, 2021; Tam, Mitchell and Forsyth, 2025). Netball performance requires athletes to accelerate, decelerate and change direction while carrying their own body mass, so any potential supplementation benefit must be considered alongside movement efficiency, body-mass change, test reliability and individual responsiveness (Glaister and Rhodes, 2022; Atkinson and Nevill, 1998; Hopkins, 2000). Existing evidence suggests that creatine is more likely to support repeated high-intensity work than to improve every isolated maximal action (Kreider *et al.*, 2017; Glaister and Rhodes, 2022). This distinction is important for netball because sprinting, jumping, throwing and change-of-direction tasks may respond differently to supplementation. A controlled, sport-specific study is therefore needed to test whether short-term creatine loading produces measurable changes in performance outcomes that are relevant to netball players.

The gap in the literature is particularly important because netball is predominantly played by women, yet female-specific and netball-specific supplementation evidence remains limited (Tam, Mitchell and Forsyth, 2025). Findings from male, mixed-sex or laboratory-based samples should therefore be applied cautiously. This study addresses this issue by examining creatine supplementation in competitive female netball players using practical performance tests that align with the sport's demands (Brooks *et al.*, 2021; Mackay *et al.*, 2025).

Therefore, this study investigates whether short-term creatine monohydrate supplementation produces measurable improvements in speed, power and agility in competitive female netball players. The findings from this study contributes to the applied sport-nutrition literature by examining whether creatine's established physiological rationale translates into practical

field-based outcomes in a female netball population. This is important because coaches and athletes require evidence based research on sport-relevant tests rather than assumptions drawn from male, laboratory-based or samples relating to other sports.

Aim and Objectives

The primary aim of this study was to determine the effect of seven days of creatine monohydrate loading, compared with a maltodextrin placebo, on selected measures of speed, upper- and lower-body power, and agility performance in competitive female netball players. The objectives were to quantify pre-to-post changes in 20 m sprint time, standing broad-jump distance, seated 6 kg medicine-ball throw distance and 505 change-of-direction time under each condition; compare matched within-participant changes between creatine and placebo; report the direction, magnitude and uncertainty of condition differences; conduct a clearly labelled secondary descriptive analysis of incomplete observations; and describe self-reported side effects following each condition.

Literature Review

The Mechanism of Creatine Monohydrate

Creatine monohydrate is among the most widely researched ergogenic aids in the field of sport nutrition and is consistently associated with improvements in short-duration, high-intensity performance (Kreider *et al.*, 2017; Antonio *et al.*, 2021). Its well-defined physiological mechanism—creatine enhances intramuscular creatine and phosphocreatine availability, which improves the quick resynthesis of adenosine triphosphate during repeated maximal efforts—is the basis for its widespread use (Kreider *et al.*, 2017). This is particularly relevant for short-duration actions, such as sprinting, jumping, and explosive changes of direction. Contemporary reviews continue to stipulate that creatine is most effective where performance depends on repeated bursts of power rather than prolonged steady-state endurance, although the size of the effect varies according to training status, exercise type, dosage strategy, and the characteristics of the athlete (Antonio *et al.*, 2021; Forbes *et al.*, 2023). In team and court-based sports such as netball, where repeated accelerations and decelerations are frequent, this mechanism provides a strong theoretical basis for the use of creatine supplementation.

Creatine is synthesised from the amino acids arginine, glycine and methionine, while additional creatine is obtained through dietary sources such as meat and fish. Around 95% of the body's creatine is stored in skeletal muscle, where it exists as free creatine or phosphocreatine (Kreider *et al.*, 2017), supplementation expands this intramuscular store beyond that normally achieved through dietary sources alone. However, individual responses vary because baseline creatine stores differ; athletes with lower initial muscle creatine, including some individuals who consume little or no animal-derived food, may experience a greater increase than those whose stores are already comparatively high to begin with (Burke *et al.*, 2003; Ribeiro *et al.*, 2020). This variability explains why group-level findings can conceal meaningful responders and non-responders, and suggests that dietary assessment is important, because habitual intake could moderate both physiological uptake and the subsequent performance response.

During high intensity activity, the body relies on stored phosphocreatine to donate a phosphate group for the rapid regeneration of ATP, allowing muscle contraction to continue at high power outputs (Kreider *et al.*, 2017). When phosphocreatine availability is increased through supplementation, athletes may be able to sustain force production for slightly longer, recover more efficiently between repeated efforts, and maintain performance. Earlier research demonstrated that short-term loading protocols can substantially elevate muscle creatine stores, while more recent studies have reinforced that these effects translate most reliably into performance benefits in repeated sprint, strength, and power exercises (Antonio *et al.*, 2021; Glaister and Rhodes, 2022). This is particularly important in sports requiring intermittent maximal actions with brief recovery periods, as even marginal improvements in phosphocreatine restoration may influence the quality of repeated efforts across a training session or competitive performance, including netball training and matches.

Supplementation protocols influence both the rate and extent of creatine saturation; a conventional loading strategy typically provides approximately 20g per day, divided into smaller doses such as four lots of five grams daily, for five to seven days before a lower maintenance dose is adopted. An alternative is to consume a smaller daily amount over several weeks, producing a slower but similar increase in muscle creatine (Kreider *et al.*, 2017; Antonio *et al.*, 2021). The distinction is relevant when interpreting acute studies, because a brief intervention without an adequate loading dose may fail to elevate stores sufficiently before testing. Conversely, loading can produce a rapid increase in body mass

that may affect blinding and movement performance, particularly exercises requiring extensive movement such as jumping, sprinting. Co-ingestion of creatine with carbohydrate or protein may support creatine retention through insulin-mediated uptake, although total adherence remains more important in applied settings (Steenge, Simpson and Greenhaff, 2000). For a controlled netball study such as this one, the protocol must therefore balance physiological efficacy with participant tolerance, compliance, and the timing of post-supplementation testing.

Creatine Supplementation and High-Intensity Exercise Performance

The broader literature generally supports creatine's performance-enhancing role but also indicates that outcomes are not uniform across the field of research. Reviews published in recent years suggest that creatine is especially effective for repeated sprint ability, peak power, total work output, and resistance-training adaptations, while effects on purely aerobic performance are less consistent in the literature (Antonio *et al.*, 2021; Glaister and Rhodes, 2022; Forbes *et al.*, 2023). Meta-analytic work has also shown creatine supplementation to produce meaningful improvements in upper- and lower-body strength and power, especially when paired with training. On the other hand, some mixed-sport and field-based studies report equivocal results, which may reflect differences in supplementation duration, performance tests, participant calibre, or the ecological validity of laboratory protocols (Wax *et al.*, 2021; Glaister and Rhodes, 2022; Fernández-Landa *et al.*, 2023). This inconsistency is important for this study because a supplement that appears effective in controlled cycling or resistance-based tasks may not necessarily confer the same benefit during sport-specific movements such as multidirectional acceleration, braking, and reactive agility (Sweeting *et al.*, 2017; Sheppard and Young, 2006). The practical value of creatine in a sport such as netball must be assessed in relation to the unique physical profile rather than assumed from generic sport-nutrition findings, due the variability in existing research.

Glaister and Rhodes (2022) reviewed 14 double-blind, randomised, placebo-controlled studies of short-term creatine loading and repeated-sprint performance. These findings are relevant to this study because they show that creatine may improve the ability to maintain work output across repeated high-intensity efforts but does not necessarily improve peak performance in a single sprint. This may be relevant as this study assessed isolated field-based outcomes, including one 20m sprint, one best standing broad jump, one best medicine

ball throw and one 505 change-of-direction test, rather than repeated bouts of sprinting or jumping. The meta-analysis also reported a small increase in body mass after creatine loading, which may be more relevant to running and change-of-direction tasks than to cycle-ergometer tests, because netball players must repeatedly accelerate, decelerate and redirect their own body mass (Glaister and Rhodes, 2022; Sweeting *et al.*, 2017; Sheppard and Young, 2006). As such, even if creatine improves phosphocreatine availability, this may not necessarily translate into faster sprint or agility times in a short field test, particularly if any small energetic benefit is offset by body-mass change, technical variation or measurement error. For this reason, this study should be interpreted as testing whether a short loading protocol improves selected netball-related performance tests, rather than as a direct test of creatine's effect on repeated-sprint ability.

Creatine Supplementation in Female Athletes

A key limitation in the existing creatine literature is that many studies focus on male participants, despite the widespread use of creatine by female athletes. Recent systematic reviews in active females suggest that the ergogenic benefit of creatine is promising but not yet conclusive across all outcomes (Tam, Mitchell and Forsyth, 2025). Some studies demonstrate improvements in strength, power, or anaerobic performance, while many others report no significant difference compared with placebo. This inconsistency may reflect a relatively small and heterogeneous evidence base, along with insufficient attention to female-specific methodological factors such as the menstrual cycle, hormonal contraceptive use, dietary intake, and training background. This gap in the literature is highly relevant to this study because netball is predominantly played by women, and applying conclusions drawn largely from male or mixed-sex populations may reduce the specificity and external validity of the research rationale. Consequently, there is a clear need for more sport-specific and female-specific investigations into creatine supplementation.

Physical Demands of Competitive Netball

Netball is a high-intensity intermittent team sport characterised by repeated accelerations, decelerations, jumps, landings, changes of direction and short sprints interspersed with lower-intensity movement and tactical pauses (Mackay *et al.*, 2025). Netball performance therefore depends on both explosive movement qualities and the ability to reproduce them throughout match play, sometimes under fatigue. Positional demands vary substantially: midcourt players generally cover greater distance and perform frequent directional changes, whereas shooters and defenders rely more heavily on jumping, contesting, landing control and

explosive short movements (Brooks *et al.*, 2021; Hackett *et al.*, 2024; Mackay *et al.*, 2025). These characteristics make netball a plausible context in which creatine supplementation may be relevant, but they also mean that supplementation effects should be interpreted in relation to position, playing level and the specific movement task assessed.

Speed, power and agility are key performance variables in netball and align with the physiological domains most often associated with creatine supplementation. Speed supports attacking leads, defensive recoveries and transitions; power underpins jumping, first-step acceleration and physical contests; and agility requires efficient deceleration, re-orientation and re-acceleration within restricted court spaces (Hewit, 2011). Because creatine may support repeated high-intensity efforts and power output, it is useful to investigate whether it influences these attributes in netball, while recognising that technical skill, perception and decision-making also shape match performance.

Short linear sprint tests may capture acceleration ability, but distances must reflect the restricted spaces and brief leads common in netball, hence the 20m distance used in this study. Lower-body power can be assessed through countermovement or squat jumps, although jump height alone does not reveal landing control or the ability to repeat jumps. Pre-planned change-of-direction tests primarily measure physical execution, whereas true agility includes perception and decision-making in response to an external stimulus (Hewit, 2011). Creatine may plausibly influence the energetic and muscular components of these tasks, but it is less likely to alter anticipatory skill or tactical decision-making over a short intervention. Therefore, improvements in a planned agility test should not be interpreted as proof of enhanced match agility without acknowledging this distinction.

Evidence for Creatine in Team and Court Sports

Direct evidence on creatine supplementation in netball players is limited, so much of the applied rationale must be inferred from related team sports such as football, rugby and basketball. These sports share repeated characteristics such as sprinting, jumping and explosive movement demands, but transfer to netball should be made cautiously because netball includes distinctive positional restrictions, landing demands, pivoting and rapid spatial adjustment (Hewit, 2011; Mackay *et al.*, 2025). Accordingly, creatine should be evaluated through clearly defined outcomes such as sprint speed, explosive power and planned change-

of-direction performance rather than broad assumptions about match performance, as in this study.

Given that netball requires sustained attention, rapid information processing, decision-making and adaptation to changing game conditions, creatine may also have cognitive relevance for performance however the literature around this is in its early stages. Creatine contributes to cerebral energy metabolism, and supplementation may increase brain creatine availability, potentially supporting ATP regeneration when cognitive demand is high (McMorris *et al.*, 2024). Although the evidence for general cognitive performance and executive function remains mixed, a comprehensive review and meta-analysis reported possible benefits for memory, attention and information-processing speed (Xu *et al.*, 2024). Previous studies have also suggested that creatine supplementation may improve memory, particularly in people with lower dietary creatine intake (Avgerinos *et al.*, 2018). However, more recent evidence remains inconclusive, and any cognitive effects may be more apparent under stressors such as sleep deprivation than under rested conditions (McMorris *et al.*, 2024). Cognitive benefits in netball should therefore be treated as a theoretical possibility rather than an assumed outcome and would need to be assessed directly through appropriate cognitive tests which have not been included in this study.

Evidence from football provides a clear team-sport comparison because the game combines brief accelerations, repeated sprints, jumping, and longer periods of submaximal activity, as does netball. Mujika *et al.* (2000) randomly assigned 17 highly trained male football players to creatine or placebo after baseline testing. Following six days of 20 g creatine per day, the creatine group improved average 5 m repeated-sprint time and showed a near-significant improvement over 15 m, while countermovement-jump and intermittent-endurance performance did not improve. Creatine also appeared to limit the decline in jumping after the endurance test. The study therefore supports a selective effect on repeated explosive actions rather than a general enhancement of every physical quality. Although its small male sample limits generalisation to female netball players, the short sprint distances and incomplete recovery periods resemble the energetic pattern of leads, defensive recoveries, and transitions in netball.

Cox *et al.* (2002) found that short-term creatine loading was beneficial in elite female football players during a field-based protocol designed to simulate match-play activity. This contrasts

the findings of this study, and this difference may suggest that creatine benefits are more detectable when performance tasks involve repeated high-intensity efforts rather than single sprint, jump or throw attempts. In addition to this, McKenna *et al.* (1999) investigated whether creatine supplementation increased muscle total creatine and whether that translated into improved maximal intermittent exercise performance. This study found that creatine supplementation increased muscle total creatine, but this did not automatically improve maximal intermittent exercise performance.

More directly relevant female evidence comes from Ramírez-Campillo *et al.* (2016), who studied 30 young female football players during a six-week in-season plyometric programme. Players completed plyometric training with either creatine or placebo, while a control group received placebo without the programme. Before and after the intervention, the researchers assessed vertical-jump performance using countermovement and drop-jump tests, maximal linear sprinting over short distances, change-of-direction speed using a pre-planned course, and repeated-sprint ability using a series of short maximal running sprints separated by brief recovery periods; endurance was assessed separately with an intermittent running test. Both plyometric groups improved jump performance (effect sizes 0.25–0.49), sprint performance (0.35–0.41), repeated-sprint performance (0.48–0.55), endurance (0.32–0.34), and change-of-direction speed (0.46–0.55), whereas the control group did not change. The creatine group improved significantly more than both the placebo-plus-plyometric and control groups for jump and repeated-sprint outcomes ($p < 0.05$), while no additional creatine advantage was reported for linear sprinting, endurance, or change-of-direction speed. The study is particularly informative for netball because it used female athletes and running-based repeated sprints; however, the simultaneous training intervention makes it difficult to isolate the supplement's precise contribution, and football movement patterns still differ from netball's frequent landing, pivoting, and restricted positional movement.

Rugby findings and creatine are less consistent and illustrate how exercise mode and body-mass support can affect results. Ahmun, Tong and Grimshaw (2005) used a randomised, double-blind crossover design in highly trained rugby players who completed five days of 20g per day creatine and placebo conditions. Performance was assessed through repeated Wingate cycling and repeated 40m running sprints. No significant treatment effects were found for peak or minimum power, running velocity, or fatigue index, although small performance improvements were observed. For netball, where efforts are usually shorter and

more multidirectional, tests based on repeated short accelerations may be more sensitive than repeated 40 m sprints; this study implemented a 20m sprint for this reason.

Basketball studies offer a useful court-sport comparison because repeated jumping, short sprinting, and rapid changes of direction are central to both sports. Vargas-Molina *et al.* (2022) examined 23 male under-16 basketball players during eight weeks of resistance and plyometric training. The creatine group consumed 0.1g per kg of body mass per day and displayed a greater improvement in Abalakov jump performance than the non-supplemented control group; a group-by-time interaction was also reported for points scored per game. However, no additional group effect appeared for squat jump, drop jump, or countermovement jump. The open-label design, adolescent male sample, and absence of placebo blinding weaken causal certainty, while scoring is influenced by playing time, tactics, and skill. Nevertheless, the findings reinforce the possibility that creatine may enhance selected explosive adaptations when combined with structured training, rather than producing uniform improvements across all jump tests. This information is useful for this current study as structured training was not implemented and tests were completed in isolation, which may have altered the findings.

Across the team sports of football, rugby and basketball, the evidence suggests conditional rather than universal benefits of creatine supplementation. Positive findings are most common for repeated short sprints, maintenance of explosive output, certain jump outcomes or adaptations to combined strength and plyometric training, whereas null findings are more common when outcomes emphasise endurance, isolated peak performance or mass-dependent running over longer distances (Mujika *et al.*, 2000; Ahmun, Tong and Grimshaw, 2005; Ramírez-Campillo *et al.*, 2016; Glaister and Rhodes, 2022; Vargas-Molina *et al.*, 2022). For netball, the strongest expectation is therefore a modest effect on repeated explosive actions or training quality rather than a broad improvement in aerobic capacity, technical skill or match success.

An additional pathway is the capacity of creatine to enhance the quality and volume of training. Acute increases in phosphocreatine availability may allow athletes to complete slightly more high-intensity work during sprint, plyometric, or resistance sessions. Over several weeks, this accumulated training stimulus could contribute to larger improvements in strength and power than supplementation alone (Antonio *et al.*, 2021). This distinction

between an immediate ergogenic effect and a training-mediated adaptation is important, particularly for this study which implemented a short term loading dose. A short loading study may detect altered repeated-effort performance but is less likely to capture changes in muscle mass or neuromuscular qualities, whereas a longer intervention period confounds supplementation with the design and adherence of the training programme.

Body Mass and Practical Considerations of Creatine Supplementation

Creatine-related body-mass gain is an important practical consideration for netball because players repeatedly accelerate, decelerate, jump and change direction while carrying their full body mass. Short-term loading commonly produces small increases in body mass, with Glaister and Rhodes (2022) reporting a pooled increase of approximately 0.79 kg and Cox *et al.* (2002) observing an increase of around 0.8 kg in elite female football players after six days of loading. Such changes do not necessarily impair performance, as some studies still report improvements in repeated-sprint or agility-related outcomes, but additional mass could reduce relative power or movement efficiency if force production does not also improve. This study should therefore interpret sprint, jump and agility outcomes alongside any changes in body mass rather than treating mass gain only as a side effect (Chwalbińska-Moneta, 2003; Antonio *et al.*, 2021).

Creatine monohydrate is generally considered safe and well tolerated in healthy individuals when evidence-based doses are used (Kreider *et al.*, 2017; Antonio *et al.*, 2021). Common practical concerns include gastrointestinal discomfort, transient water retention, and the misconception that supplementation necessarily causes dehydration or renal damage.

Reviews do not support these claims in healthy users, although participants with relevant medical conditions including renal issues require appropriate screening and clinical guidance (Kreider *et al.*, 2017; Antonio *et al.*, 2021). Dividing a loading dose and consuming it with meals may reduce gastrointestinal symptoms (Kreider *et al.*, 2017). From a research perspective, adverse events, hydration practices, and adherence should be recorded systematically rather than inferred from returned supplement containers alone.

Familiarisation with any body-mass change is also important because athletes' expectations may influence self-reported performance or reveal group allocation, conflicting the double-blinded protocol.

Randomised, double-blind, placebo-controlled designs as displayed in this study, reduce allocation and expectancy bias, although blinding may be threatened if participants notice rapid body-mass change or gastrointestinal symptoms (Glaister and Rhodes, 2022; Hopewell *et al.*, 2025). Placebos should therefore match the active supplement in appearance, dosing schedule and administration.

Maltodextrin is frequently used as the placebo in creatine trials because it is an inexpensive, readily soluble carbohydrate powder that can be prepared to look and taste broadly similar to creatine monohydrate. For example, Dinan *et al.* (2022) used a randomised, double-blind, placebo-controlled design in resistance-trained male and female college athletes, with maltodextrin incorporated into the supplementation protocol to support blinding. This approach is relevant to this netball study because expectations about receiving an ergogenic aid could influence effort during sprint, jump, or agility testing. However, it is useful to note that maltodextrin is not completely physiologically inert as it supplies rapidly available carbohydrate and energy, which could affect training quality, glycogen availability, or recovery if the dose is substantial (Wilburn *et al.*, 2020). The placebo and creatine conditions should therefore be matched carefully for powder mass, appearance, flavour, administration schedule, and any additional carbohydrate, while participants' wider dietary intake is controlled or recorded where possible.

Taken together, the literature provides a strong physiological rationale for creatine supplementation in strength, power and repeated high-intensity performance (Kreider *et al.*, 2017; Antonio *et al.*, 2021; Glaister and Rhodes, 2022). These effects are most relevant to sports characterised by brief explosive movements and incomplete recovery, which broadly reflects the physical demands of netball (Mackay *et al.*, 2025). However, important gaps remain as evidence in female athletes is less comprehensive than in males, methodological quality varies across studies, and direct research in netball populations is sparse (Tam, Mitchell and Forsyth, 2025). The extent to which laboratory-based performance gains transfer to sport-specific outcomes such as agility and positionally relevant movement quality also remains uncertain. Further controlled research is therefore needed to determine whether creatine supplementation can meaningfully enhance speed, power and agility in netball players. A study focused on these outcomes could add to the applied sport-nutrition literature by addressing a female-dominant, under-researched sport and testing whether the established

ergogenic effects of creatine extend to the key netball performance variables outlined in this study.

Overall, the literature supports creatine as an ergogenic aid for repeated high-intensity exercise, strength and power-based tasks, but the evidence is limited and less consistent for isolated field-based sprint, jump and change-of-direction tests. The evidence base is also limited by the underrepresentation of female athletes and the scarcity of research in netball-specific populations. It therefore remains unclear whether short-term creatine loading produces measurable benefits in performance tests that reflect the demands of competitive female netball. This study addresses that gap by applying a controlled crossover design and assessing speed, upper-body power, lower-body power and planned change-of-direction performance in female netball players.

Methodology

Study Design

This study used a randomised, double-blind, placebo-controlled crossover design to investigate the effects of short-term creatine supplementation on speed, upper-body power, lower-body power, and agility in competitive female netball players. The crossover design allowed each participant to complete both conditions and act as her own control, reducing the influence of between-participant differences in training status and performance, which was particularly advantageous given the modest sample size (Capili and Anastasi, 2024).

Participants were randomly assigned to one of two counterbalanced orders, creatine followed by placebo or placebo followed by creatine, to reduce order effects. Both participants and the primary researcher remained unaware of the allocation during data collection, limiting the potential influence of participant expectations and researcher judgement on performance testing (David and Khandhar, 2023). Double-blind study designs are fundamental to high-quality research, particularly within medical and exercise science contexts, as they minimise bias by ensuring that neither participants nor researchers are aware of treatment allocation. By concealing whether individuals receive the active intervention or a placebo, double-blinding reduces the influence of placebo effects, researcher expectancy, and subjective outcome interpretation. This methodological approach enhances the internal validity of findings and supports the collection of more reliable, objective, and reproducible data (David and Khandhar, 2023).

The study consisted of two 7-day supplementation phases separated by a four-week washout period. Creatine loading can rapidly increase intramuscular creatine and phosphocreatine stores, and concentrations may remain elevated for several weeks after supplementation ends (Kreider *et al.*, 2017). The four-week washout was therefore used to reduce the likelihood of carryover between the two conditions. Performance testing was conducted before and after each supplementation phase.

Participants

Twelve competitive female netball players aged 18 and over enrolled in the study. Three withdrew before data collection, five missed one or more testing sessions, and four completed both supplementation conditions and all four testing sessions. Accordingly, the primary matched crossover analysis included four participants (those who completed all testing dates). Eligibility criteria required at least two years of competitive playing experience. Exclusion criteria included creatine use within the previous eight weeks, renal, metabolic or cardiovascular disorders, musculoskeletal injury affecting performance. Ethical approval was obtained from the UWTSD institutional research ethics committee before data collection, and all participants provided written informed consent in accordance with the Declaration of Helsinki (World Medical Association, 2013). Although the final matched sample was small, the use of complete crossover cases preserved the within-participant comparison between creatine and placebo. This was important because each participant acted as their own control, reducing some influence of between-participant variation in fitness, training status and playing experience.

Procedures

Following recruitment and eligibility screening, participants completed a baseline testing session before supplementation began. The study then involved two 7-day supplementation phases (creatine and placebo) separated by a four-week washout period, in accordance with a randomised, double-blind crossover design (Capili and Anastasi, 2024). Performance testing was conducted at four time points: baseline, after the first supplementation phase, before the second supplementation phase and after the second supplementation phase. The overall sequence was therefore baseline testing, phase-one supplementation, post-phase-one testing, four-week washout, pre-phase-two testing, phase-two supplementation and final post-

intervention testing. The washout period was included to reduce carryover effects, as intramuscular creatine concentrations may remain elevated for several weeks after supplementation ceases (Kreider *et al.*, 2017; Salem *et al.*, 2025).

Supplementation Procedures

Participants completed two supplementation phases, each lasting seven consecutive days. During the creatine condition, participants consumed creatine monohydrate at a dose of 20g/day, divided into four 5g doses consumed throughout the day, consistent with established creatine loading protocols shown to rapidly increase intramuscular creatine stores (Kreider *et al.*, 2017). During the placebo condition, participants consumed 20g/day of a visually and texturally matched maltodextrin powder, administered using the same dosing schedule to maintain blinding and control for expectancy effects (David and Khandhar, 2023). Supplements were pre-packaged into individual daily sachets and coded by an independent third party to preserve the double-blind study design. Participants were instructed to dissolve each dose in water and consume it with meals to enhance gastrointestinal tolerance and standardise ingestion conditions, as co-ingestion with food has been shown to improve supplement tolerance and uptake (Kreider *et al.*, 2017). Participants were instructed to maintain their habitual diet and training routines throughout the study to minimise confounding influences on performance outcomes.

Randomisation and Blinding Procedures

Participants were randomly allocated to one of two counterbalanced supplementation orders (creatine–placebo or placebo–creatine) in accordance with best practice for crossover trial designs (Capili and Anastasi, 2024). Both participants and the primary researcher responsible for data collection remained blinded to supplementation allocation throughout the study to reduce performance bias and observer expectancy effects (David and Khandhar, 2023). Supplement allocation codes were generated and securely stored by an independent third party and were not disclosed until completion of data collection and preliminary data screening, thereby preserving the integrity of the double-blind design.

Testing Session Procedures

All performance testing sessions took place on a netball court at the same local leisure centre to ensure environmental consistency and reduce external variability. Participants completed a standardised dynamic warm-up consisting of light aerobic activity and dynamic stretching, as dynamic warm-ups have been shown to enhance neuromuscular readiness and performance

while reducing injury risk (McCrary *et al.*, 2015). Performance tests were administered in the same order during each session, progressing from speed-based assessments to power and agility tests, to minimise the influence of cumulative fatigue on subsequent performance outcomes (Hopkins, 2000). Standardised rest periods were provided between trials and tests to allow adequate recovery and improve measurement reliability. All testing was conducted using the same equipment and was assessed by the same researcher at each time point to reduce variation between testing sessions (Atkinson and Nevill, 1998).

Washout Period Procedures

A four-week washout period was implemented between supplementation phases to allow intramuscular creatine concentrations to return to baseline and to minimise potential carryover effects. This duration was considered appropriate given evidence that elevated muscle creatine stores may persist for several weeks following supplementation cessation (Kreider *et al.*, 2017; Salem *et al.*, 2025). During the washout period, participants were instructed to refrain from all creatine supplementation. The inclusion of a washout period was critical for preserving the internal validity of the crossover design, as residual supplementation effects could otherwise confound treatment comparisons (Capili and Anastasi, 2024).

Adverse Effects and Withdrawal Procedures

Participant safety was prioritised throughout the study. Participants were instructed to report any adverse effects or discomfort experienced during supplementation or performance testing, and appropriate action was taken where necessary. Participation was entirely voluntary, and participants were free to withdraw from the study at any time without penalty or adverse consequences.

Data Recording

Data were stored in password-protected electronic files accessible only to the researcher. The same researcher collected the measurements at each time point, and the equipment and procedures were kept consistent across sessions where possible (Atkinson and Nevill, 1998). These data management procedures were used to ensure participant confidentiality, data security, and ethical handling of personal information, in accordance with ethical and data protection guidelines (British Psychological Society, 2021, World Medical Association, 2013).

Measurements and Instruments

Performance outcomes were assessed using a selection of field-based tests selected for their established validity, reliability, and relevance to the physical demands of competitive netball.

Speed

Linear speed performance was assessed using a 20m sprint test, which reflects the short-distance acceleration demands frequently observed in netball match play. Electronic timing gates (Brower) were intended to be used to record sprint times to improve reliability and minimise human error (Hopkins, 2000; Atkinson and Nevill, 1998) however, due to technical issues during data collection, a handheld stopwatch was used instead. To minimise measurement error, timing was performed by the same researcher across all trials and sessions, and participants followed the same start procedures and trial structure. Participants began from a stationary standing start with the front foot positioned just behind the court line to prevent premature triggering. Three trials were completed and the fastest time was retained for analysis. The 20m sprint test was selected as it primarily assesses acceleration ability, which is a key physical quality in netball match play. Time-motion and tracking analyses have shown that netball players most frequently perform short, high-intensity sprints typically ranging between 10–20 m, rather than longer maximal-velocity runs (Davidson and Trewartha, 2008; Brooks *et al.*, 2021). As such, a 20m distance closely reflects the movement demands and spatial constraints of the netball court, enhancing the validity of the assessment.

In team-sport athletes, most sprint efforts occur over distances of ≤ 20 –25 m, with performance outcomes largely determined by rapid acceleration rather than the attainment of maximal sprint velocity (Sweeting *et al.*, 2017). The 20m sprint therefore provides a more relevant measure of sport-specific speed than longer sprint distances (e.g. 30–40 m), which are less representative of netball match play. Although electronic timing gates typically demonstrate superior test–retest reliability and reduced measurement error compared with manual timing (Hopkins, 2000; Atkinson and Nevill, 1998; McMahon *et al.*, 2017), the use of a handheld stopwatch in this study was standardised by employing a consistent assessor and consistent start and trial procedures across all sessions. This approach aimed to improve the consistency of sprint timing and support the detection of meaningful changes in performance following short-term ergogenic interventions, such as creatine supplementation, in competitive netball players.

Lower-Body Power

Lower-body explosive power was evaluated using the standing broad jump, a valid and reliable field-based measure of horizontal power that has strong associations with sprint acceleration and change-of-direction ability in court-based sports (Hopkins, 2000). Jump distance was measured using a standardised tape measure, with the greatest distance from three attempts retained for analysis to improve test–retest reliability. The standing broad jump was selected as a field-based measure of lower-body explosive power, as it assesses horizontal force production, which is highly relevant to the acceleration, sprinting, and change-of-direction demands of netball. Horizontal power has been shown to be strongly associated with short-distance sprint performance and agility in court-based team sports, making the standing broad jump a functionally relevant assessment (Hopkins, 2000). Participants began with their toes positioned behind a marked take-off line and performed a maximal horizontal jump using a self-selected countermovement and arm swing. Jump distance was measured to the nearest centimetre from the take-off line to the rearmost point of contact on landing using a standardised tape measure. Participants completed three trials, with the longest jump distance retained for analysis. Adequate rest was provided between attempts.

This test has demonstrated acceptable to excellent test–retest reliability in athletic populations and is widely used in applied sport performance research due to its simplicity, low equipment requirements, and sensitivity to changes in neuromuscular performance (Atkinson and Nevill, 1998; Hopkins, 2000). Retaining the best distance from multiple trials further enhances measurement reliability by reducing random error. Additionally, the standing broad jump is particularly suitable for intervention studies, such as creatine supplementation research, as it is sensitive to changes in explosive lower-body performance without inducing excessive fatigue or requiring complex laboratory equipment.

Upper-Body Power

Upper-body explosive power was assessed using the seated medicine ball throw (6 kg medicine ball), a commonly used and reliable assessment of upper-body power in athletic populations. The seated position and standardised medicine ball mass were employed to minimise lower-body contribution and isolate upper-body force production, enhancing measurement validity (McGuigan *et al.*, 2012). Throw distance was measured to the nearest centimetre, with the best of three trials recorded for analysis. A 6 kg medicine ball is

commonly used in the seated medicine ball throw when assessing upper-body explosive power in trained athletes because it provides sufficient external resistance to require high force production while still allowing the movement to be performed explosively. Lighter loads may lack sensitivity in trained populations, whereas heavier loads can reduce movement velocity and compromise the assessment of power rather than strength (McGuigan *et al.*, 2012). The use of a standardised ball mass also enhances test–retest reliability and allows comparison with existing sport science literature, as the 6 kg load has been widely employed and validated in athletic cohorts (McGuigan *et al.*, 2012). Furthermore, when performed from a seated position, the 6kg medicine ball throw effectively isolates upper-body musculature by minimising lower-body contribution, thereby improving construct validity (Atkinson and Nevill, 1998).

Participants performed the test in a standardised seated position with their back against a wall, legs fully extended, and feet flat on the floor to minimise lower-body contribution and isolate upper-body power output. A medicine ball of standardised mass was used for all participants. From the seated position, participants threw the ball forward as forcefully as possible using a two-handed chest pass action. Throw distance was measured to the nearest centimetre from the wall to the point of first contact with the floor. Three trials were completed, with the greatest distance recorded for analysis.

Agility

Agility performance was assessed using the 505 change-of-direction (COD) test, which evaluates an athlete’s ability to decelerate, perform a rapid 180° turn, and re-accelerate over a short distance. The test is designed to isolate braking and re-acceleration capacity while minimising the influence of maximal linear sprint speed. The 505 test has demonstrated high test–retest reliability in team-sport athletes and is widely used in applied sport science research due to its simplicity, reproducibility, and relevance to sports requiring frequent deceleration and directional changes, such as netball (Sheppard and Young, 2006).

Participants accelerated from a standing start toward a turning line positioned 5 m beyond the timing point. Upon reaching the turning line, the participant planted the designated foot, executed a 180° change of direction, and sprinted back 5 m through the timing point. Timing began when the participant passed the timing point on the initial approach and stopped when they re-crossed it following the turn. Turning leg dominance was standardised across trials to

control for asymmetry, and three trials were performed with sufficient recovery, with the fastest time retained for analysis.

Electronic timing gates were intended to be used to improve measurement precision; however, due to technical issues during data collection, 505 COD times were recorded using a handheld stopwatch. All instruments and equipment were otherwise consistent across testing sessions, and all measurements were conducted by the same researcher to reduce inter-rater variability and enhance data reliability (Atkinson and Nevill, 1998).

Collectively, these tests have demonstrated acceptable to excellent test-retest reliability in athletic populations and are widely used in applied sport performance research, supporting their suitability for detecting potential performance changes following short-term creatine supplementation.

Performance testing was administered in a fixed order to minimise fatigue effects and preserve measurement validity. Participants first completed the 20m sprint test to assess speed, followed by the standing broad jump to evaluate lower-body power and the seated medicine ball throw to assess upper-body power. The 505 change-of-direction test was performed last, as it places the greatest demands on deceleration, braking forces, and neuromuscular control. This sequence progresses from the least fatiguing to the most fatiguing assessments and aligns with best practice in applied sport science testing, supporting valid, reliable, and repeatable performance measurements.

Statistical Analysis

Before analysis, the data was screened for missing values and potential outliers. For each dependent variable, a change score was calculated for each condition as post-supplementation minus the phase-specific pre-supplementation value. Microsoft Excel was then used to calculate descriptive statistics and compare creatine and placebo change scores using two-tailed paired-samples *t*-tests, because the observations were obtained from the same participants under both conditions. Each row represented one participant, with separate columns for the creatine and placebo change scores. Statistical significance was set a priori at $p < .05$. For each outcome, the mean change for each condition, mean paired difference, standard deviation of the difference scores, 95% confidence interval, *t* statistic, degrees of freedom, two-tailed *p* value and Cohen's d_z for paired samples were reported. Cohen's d_z was

calculated by dividing the mean of the participant-level difference scores by the standard deviation of those difference scores. Excel formulas were also used to summarise sample size, means, standard deviations, standard errors and percentage changes. Because only four participants completed both conditions, the degrees of freedom were 3 for each paired comparison, and inferential results, effect sizes and p values were interpreted cautiously alongside the direction and practical magnitude of the observed changes. Given the small sample size, statistical significance was not interpreted in isolation; effect sizes and confidence intervals were used to support interpretation to provide additional information about the magnitude, direction and uncertainty of the observed differences. This approach was important because a non-significant result in a small sample does not necessarily indicate that no meaningful effect occurred.

Data Collection

All performance data were collected during scheduled testing sessions conducted under standardised conditions. Performance outcomes for speed, lower-body power, upper-body power, and agility were recorded using validated field-based tests administered in a consistent order to minimise fatigue effects (Hopkins, 2000). Each participant completed multiple trials for each test, with the best performance retained for analysis to enhance measurement reliability and reduce random error (Atkinson and Nevill, 1998).

All testing equipment and procedures were consistent across sessions, and the same researcher conducted all measurements at each time point to reduce inter-rater variability and improve data reliability (Atkinson and Nevill, 1998). Performance data were recorded immediately following each trial using anonymised participant identification codes and subsequently transferred to secure electronic data files for analysis. The standardisation of testing conditions, equipment, and data recording procedures was implemented to ensure the collection of reliable, objective, and reproducible performance data suitable for detecting changes following short-term creatine supplementation (Hopkins, 2000).

Some participants were unable to attend post-testing sessions due to illness or other unforeseen circumstances. In these cases, a brief questionnaire assessing perceived changes in performance (e.g., power, strength, speed, and agility) was distributed to capture subjective outcomes and minimise data loss however unfortunately, this was not completed by

participants. To maintain adequate participant numbers across pre- and post-supplementation testing for the second supplementation phase, additional eligible athletes were recruited for the second round of testing. Participants who attended the final testing session were also provided with a questionnaire to record any symptoms experienced whilst taking Supplement A and Supplement B. For the research purposes, only the participants that completed all testing sessions were included in the primary analysis (n=4).

Ethics and Risk

Ethical approval for this study was obtained from the institutional research ethics committee (UWTSD) prior to commencement. All participants received a detailed participant information sheet outlining the study aims, procedures, potential risks, and benefits. Written informed consent was obtained before participation, and participants were informed that their involvement was voluntary and that they could withdraw from the study at any time without penalty or adverse consequences, in accordance with the Declaration of Helsinki (World Medical Association, 2013).

Participant confidentiality was maintained and all electronic data was stored on password-protected devices accessible only to the researcher. Data was handled in accordance with institutional data protection policies and recognised ethical guidelines (British Psychological Society, 2021).

The risks associated with participation were considered minimal. Creatine monohydrate supplementation at a dose of 20 g·day⁻¹ for short-term loading is widely supported in the literature as safe for healthy adults, with mild gastrointestinal discomfort being the most reported side effect (Kreider *et al.*, 2017). To mitigate risk, participants with known renal, metabolic, diabetes or cardiovascular conditions were excluded, and supplements were consumed in divided doses with meals to improve tolerance (Kreider *et al.*, 2017).

Performance testing involved maximal or near-maximal physical effort; however, all tests were commonly used in athletic populations and were preceded by a standardised warm-up to reduce injury risk (McCrary *et al.*, 2015). Participants were instructed to report any adverse events or discomfort experienced during supplementation or testing, and appropriate action was taken where necessary to protect participant welfare (World Medical Association, 2013).

Overall, the study was designed to prioritise participant safety while adhering to established ethical standards for human research.

Results

As this study used a crossover design, the primary analysis included only participants who completed both the creatine and placebo conditions. This ensured that comparisons between supplements were made using matched data from the same participants. Participants with incomplete crossover data were excluded from the primary paired analysis. Twelve participants were enrolled to complete the study however three withdrew before the data collection commenced due to inability to attend the testing dates. Five participants withdrew for one or more testing sessions due to illness or unforeseen circumstances; therefore, only partially completed the testing. Four participants completed all four testing sessions.

Primary Paired Crossover Analysis

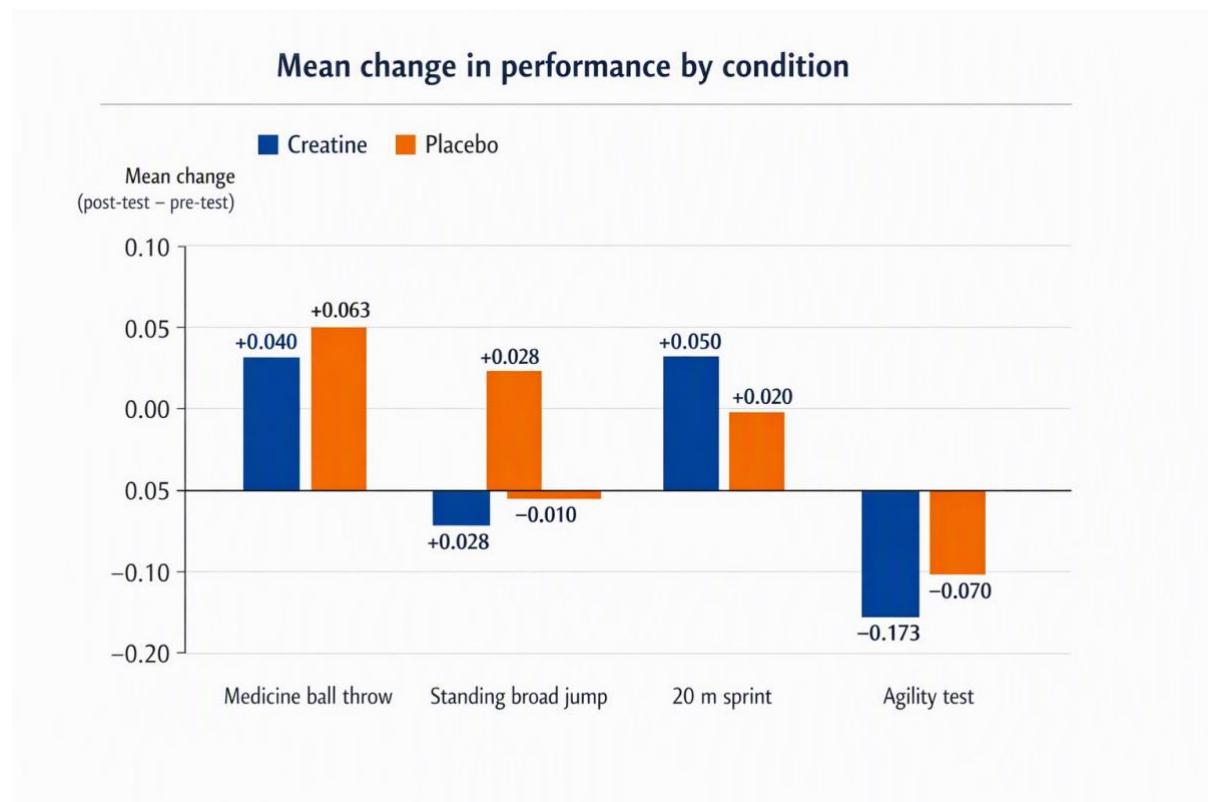
The primary analysis was based on the four participants who completed both supplementation conditions. Mean changes and standard deviations were calculated for each performance measure under creatine and placebo conditions. Because the same participants contributed data to both conditions, paired-samples t-tests were used to compare creatine and placebo responses.

Table 1. Primary paired crossover analysis for matched creatine and placebo conditions

Measure	Condition	Pre-test mean ± SD	Post-test mean ± SD	Change mean ± SD	N
Medicine ball throw (m)	Creatine	2.710 ± 0.263	2.795 ± 0.463	0.085 ± 0.226	4
	Placebo	2.730 ± 0.258	2.783 ± 0.460	0.053 ± 0.224	4
Standing broad jump (m)	Creatine	1.894 ± 0.188	1.919 ± 0.239	0.025 ± 0.056	4
	Placebo	1.880 ± 0.182	1.871 ± 0.188	-0.009 ± 0.096	4
20 m sprint (s)	Creatine	3.603 ± 0.230	3.673 ± 0.301	0.070 ± 0.112	4
	Placebo	3.555 ± 0.285	3.535 ± 0.246	-0.020 ± 0.069	4
Agility test (s)	Creatine	8.418 ± 0.440	8.298 ± 0.705	-0.120 ± 0.281	4
	Placebo	8.538 ± 0.464	8.413 ± 0.503	-0.125 ± 0.132	4

Note. Values are mean ± SD. The analysis includes the four participants who completed all four testing sessions. Supplement A was treated as creatine and Supplement B as placebo.

Change was calculated as post-test minus the phase-specific pre-test value; therefore, negative changes indicate improvement for sprint and agility time. Separate pre-test values



were collected before each supplementation phase.

Figure 1. Mean change in performance from pre-test to post-test under creatine and placebo conditions for the four participants who completed both supplementation periods. Change was calculated as post-test minus pre-test. Positive values indicate an increase in throwing or jumping distance but a slower sprint time, whereas negative values indicate a decrease in distance or a faster sprint or agility time. Bars show condition means only; variability is reported in Table 1.

Across the matched crossover sample, creatine produced a larger mean improvement than placebo in medicine ball throw (mean difference 0.033 m) and standing broad jump (0.034 m). For 20 m sprint, the positive mean difference of 0.090 s indicated a less favourable change under creatine because lower times represent better performance. Agility changes were almost identical between conditions (mean difference 0.005 s). Given the sample of four participants, all estimates should be interpreted cautiously. Paired-samples t-tests found no statistically significant creatine-placebo difference for medicine ball throw, $t(3) = 0.82, p =$

.473, $d_z = 0.41$; standing broad jump, $t(3) = 0.61$, $p = .587$, $d_z = 0.30$; 20 m sprint, $t(3) = 1.65$, $p = .198$, $d_z = 0.83$; or agility, $t(3) = 0.04$, $p = .973$, $d_z = 0.02$. The direction of each effect must be interpreted according to whether higher or lower values represent better performance.

Table 2. Paired-samples t-test results for matched creatine and placebo conditions

Performance measure	Mean difference	95% CI	Cohen's d_z	t	df	p	Result
Medicine ball throw (m)	0.033	−0.095 to 0.160	0.41	0.82	3	0.473	Not significant
Standing broad jump (m)	0.034	−0.144 to 0.212	0.30	0.61	3	0.587	Not significant
20 m sprint (s)	0.090	−0.083 to 0.263	0.83	1.65	3	0.198	Not significant
Agility test (s)	0.005	−0.382 to 0.392	0.02	0.04	3	0.973	Not significant

Note. Mean difference was calculated as the creatine change score minus the placebo change score. The 95% confidence intervals were calculated from the four participant-level paired differences using the t distribution with 3 degrees of freedom. Cohen's d_z was calculated by dividing the mean participant-level paired difference by the standard deviation of those paired differences. For throwing and jumping distance, positive values favour creatine; for sprint and agility time, negative values favour creatine. The confidence intervals were wide for each outcome, indicating considerable uncertainty around the estimated creatine-placebo differences. For each measure, the interval included values that could favour either creatine or placebo, meaning the true effect could range from beneficial to unfavourable. Therefore, the results should be interpreted as inconclusive rather than as evidence that creatine and placebo were equivalent.

As shown in Table 2, none of the paired-samples t-tests reached statistical significance. The two-tailed p values exceeded .05 for medicine ball throw, standing broad jump, 20 m sprint and agility. The mean differences favoured creatine descriptively for both distance measures, favoured placebo for sprint time, and indicated virtually no difference for agility. Given the four matched participants, the Microsoft Excel paired-samples t-test analysis did not provide clear evidence of a creatine-related performance benefit.

Secondary Descriptive Analysis Including Incomplete Cases

A secondary descriptive analysis was also conducted using all available observations, including participants who did not complete both supplementation conditions. This analysis was included only to explore whether the overall pattern of mean responses changed when incomplete cases were added. No inferential statistics were performed on this expanded dataset because the observations were not fully paired.

Table 3. Secondary descriptive analysis including all available observations

Measure	Creatine mean $\pm$ SD	Placebo mean $\pm$ SD	Cohen's d	N per condition
Medicine ball throw (m)	0.037 $\pm$ 0.193	0.047 $\pm$ 0.161	-0.06	6
Standing broad jump (m)	-0.103 $\pm$ 0.156	0.018 $\pm$ 0.088	-0.96	6
20 m sprint (s)	0.117 $\pm$ 0.163	0.045 $\pm$ 0.092	0.54	6
Agility test (s)	-0.038 $\pm$ 0.333	0.177 $\pm$ 0.413	-0.57	6

Note. Cohen's d was calculated as the creatine-minus-placebo mean difference divided by the pooled standard deviation. These effect sizes are descriptive only because the expanded dataset contains incomplete crossover cases and is not fully paired. The sign indicates the direction of the creatine-minus-placebo contrast.

Post-Study Questionnaire – Side effects following supplementation:

Five participants completed the post-study symptom questionnaire. Of these, four reported side effects during Supplement A (creatine), whereas no adverse effects were reported during Supplement B (placebo). The most frequently reported side effects during creatine supplementation were gastrointestinal symptoms, with three participants reporting stomach upset or nausea; symptom severity was described as mild in one case and moderate in two cases. Reported onset ranged from approximately 30 minutes after the first dose to 1–2 days after supplementation commenced. One participant reported symptoms lasting approximately three days and had initially consumed 20 g across the day before being advised to follow the prescribed loading protocol of 5 g taken four times daily. Additional symptoms reported during creatine supplementation included diarrhoea on day 1, mild muscle cramps after 1 day, and vivid dreams that reportedly persisted for 1 week after discontinuation. No participant reported missing a dose because of side effects. Four participants indicated that side effects did not negatively affect training or match performance, whereas one participant reported feeling tired and weak in the gym after cessation of creatine supplementation.

Figure 4. Post-study questionnaire side effects following supplementation

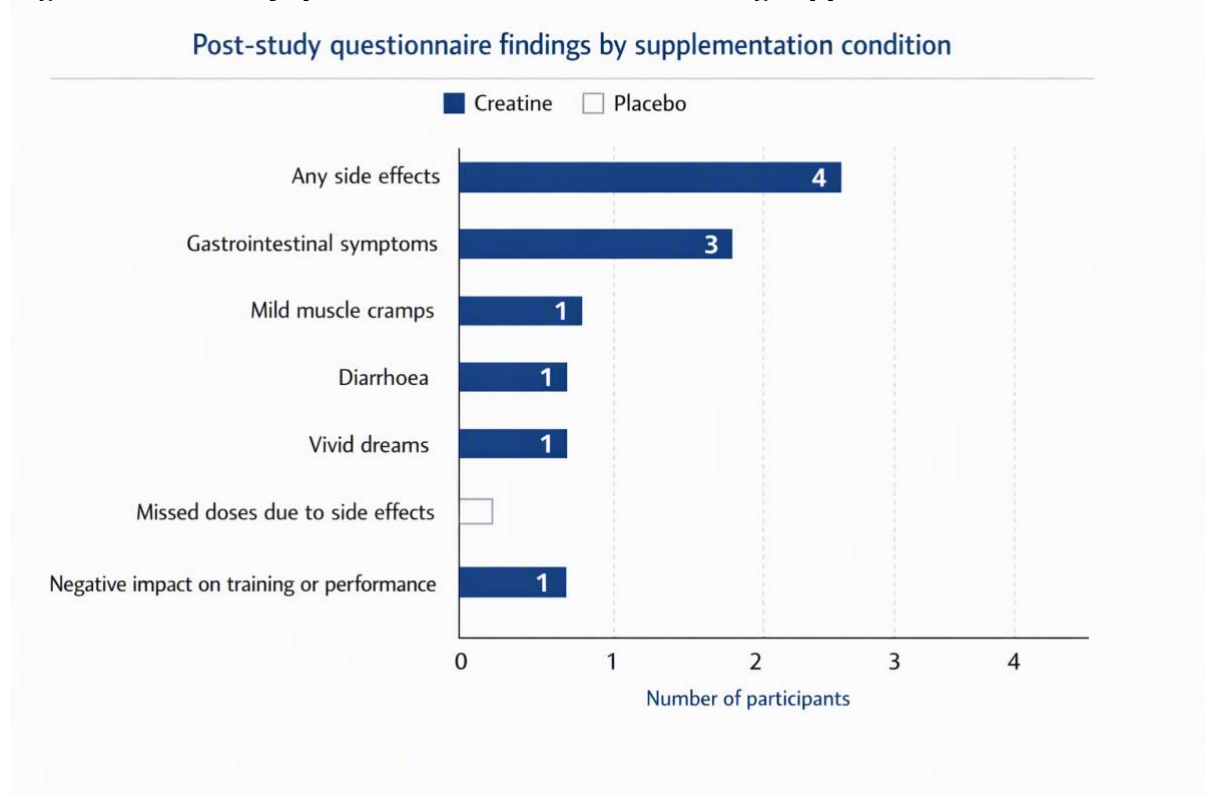


Figure 4. Number of participants reporting questionnaire findings under creatine and placebo conditions. Four of five participants reported at least one side effect during creatine supplementation, whereas none reported side effects during placebo supplementation. Gastrointestinal symptoms were the most common creatine-related finding. Creatine and placebo are both included for every outcome; zero-value labels and zero-length bars are not displayed.

Summary

The results show only small differences between creatine and placebo across the performance measures assessed. In line with the crossover design, the primary analysis was restricted to the four participants who completed both supplementation conditions, so paired comparisons were based on matched data. Paired-samples t-tests found no statistically significant differences between creatine and placebo for medicine ball throw, standing broad jump, 20 m sprint or agility performance. The secondary descriptive analysis including incomplete cases showed broadly similar small and variable changes, but no inferential statistics were performed because the expanded dataset was not fully paired. Within this small sample, creatine supplementation did not produce clear performance benefits over placebo.

Discussion

Overview of Findings

The main finding of this study was that short-term creatine loading did not produce a statistically significant advantage over maltodextrin for any of the four performance tests. Creatine was associated with slightly greater improvements in medicine ball throw and standing broad jump, while sprint performance favoured placebo and agility responses were almost identical. This pattern is consistent with the literature review's conclusion that creatine supplementation produces conditional rather than universal performance benefits (Kreider *et al.*, 2017; Antonio *et al.*, 2021; Glaister and Rhodes, 2022). However, with only four complete crossover cases, the present study cannot determine whether the mixed results reflect the intervention, individual variation or the testing conditions. The strongest evidence for creatine relates to repeated high-intensity exercise, resistance-training adaptation and maintenance of explosive output, whereas this study assessed isolated field-based outcomes after a short loading period (Glaister and Rhodes, 2022; Wax *et al.*, 2021). This may explain why no clear positive effect was observed for 20m sprint, standing broad jump, medicine ball

throw or 505 change-of-direction performance after a period of creatine supplementation. The results are also consistent with limited female-specific evidence showing mixed and outcome-dependent responses to creatine supplementation (Smith-Ryan *et al.*, 2021; Tam, Mitchell and Forsyth, 2025). Therefore, rather than contradicting the wider literature, this study suggests that any creatine benefit in female netball players may depend on the type of task, repeated-effort demand, training context, individual responsiveness and quality of experimental control (Kreider *et al.*, 2017; Tam, Mitchell and Forsyth, 2025).

The absence of clear performance improvements does not necessarily contradict creatine's physiological mechanism. As outlined in the literature review, McKenna *et al.* (1999) showed that creatine supplementation can increase muscle total creatine without improving maximal intermittent exercise performance. This supports the idea that increased creatine availability does not always translate directly into measurable field-test improvements. In addition to this, Snow and Murphy (2003) reviewed factors that influence creatine loading into skeletal muscle, suggesting that creatine loading varies between individuals. This study did not measure muscle creatine uptake, so it cannot confirm whether participants achieved meaningful increases in intramuscular creatine. Therefore, a null finding may reflect differences in biological uptake as well as the possibility that increased stores did not translate into improved field-test performance.

In the four participants who completed both conditions, creatine did not produce a clear advantage over placebo for power, speed or agility. None of the paired comparisons reached statistical significance: medicine ball throw, $t(3) = 0.82, p = .473$; standing broad jump, $t(3) = 0.61, p = .587$; 20 m sprint, $t(3) = 1.65, p = .198$; and agility, $t(3) = 0.04, p = .973$.

Descriptively, creatine was slightly more favourable for medicine ball throw and standing broad jump, placebo was more favourable for 20 m sprint, and agility changed by almost the same amount in both conditions. The maltodextrin placebo also complicates interpretation because it is a rapidly available carbohydrate rather than a completely inert comparator (Jeukendrup, 2014; Almutairi *et al.*, 2022). Depending on dose, timing, previous carbohydrate intake and exercise demand, it may have influenced carbohydrate availability or other physiological responses and reduced the apparent contrast with creatine; however, any performance effect in these brief tests remains uncertain (Jeukendrup, 2014; Almutairi *et al.*, 2022; Wilburn *et al.*, 2020). Due to the modest sample size, the findings point more to uncertainty than to evidence that creatine is ineffective.

The non-significant results do not show that creatine and placebo were equivalent.

With only four complete crossover cases, the estimates were imprecise and highly sensitive to individual responses. Effect sizes were moderate for medicine ball throw ($d_z = 0.41$), small for standing broad jump ($d_z = 0.30$), large for sprint ($d_z = 0.83$), and negligible for agility ($d_z = 0.02$). The sprint favoured placebo because a positive creatine-minus-placebo difference represents a slower sprint time under creatine, whereas positive distance differences favoured creatine. Because each estimate came from only four paired observations, one different individual response could have changed the interpretation substantially. Overall, the results indicate substantial uncertainty rather than demonstrating either the presence or absence of a meaningful effect.

The secondary analysis adds context but should remain subordinate to the paired analysis as these subjects did not complete all testing conditions. Including incomplete cases increased the dataset to six observations per condition. Mean changes were still small for medicine ball throw (creatine 0.037 ± 0.193 m; placebo 0.047 ± 0.161 m), but the pattern shifted more noticeably for standing broad jump (-0.103 ± 0.156 m versus 0.018 ± 0.088 m), sprint (0.117 ± 0.163 s versus 0.045 ± 0.092 s) and agility (-0.038 ± 0.333 s versus 0.177 ± 0.413 s). The corresponding descriptive effect sizes were -0.06 , -0.96 , 0.54 and -0.57 . In this expanded dataset, standing broad jump and sprint favoured placebo, whereas agility favoured creatine. This contrast with the complete-case findings shows how strongly the estimates depended on which participants were included and how individual results can significantly impact findings. Because these observations were not fully paired, condition differences may reflect participant inclusion as much as supplementation. These values are therefore best used to illustrate variability, not to support firm treatment conclusions (Hopkins, 2000).

Interpretation in Relation to Creatine and Female Performance

The results fit with the physiological argument developed earlier, but they also show the limits of applying that mechanism to isolated field tests. Creatine increases phosphocreatine availability for rapid adenosine triphosphate resynthesis, so the clearest expected benefit is during repeated brief, high-intensity work or during training programmes where extra high-quality work can accumulate into adaptation (Kreider *et al.*, 2017; Smith-Ryan *et al.*, 2021). A single medicine ball throw, standing broad jump, sprint or 505 test may not stress this system enough to reveal a clear effect. Test performance also depends on technical execution,

motivation, warm-up, neuromuscular readiness and measurement error, not energy availability alone (Mănescu *et al.*, 2026). It is therefore possible for creatine stores to increase without producing a measurable improvement in every isolated task, especially after a short intervention. This distinction is important because it separates creatine's established biochemical action from its less consistent translation into sport-specific performance outcomes (Kreider *et al.*, 2017).

Females have historically been underrepresented in creatine research, and variables such as hormonal status, habitual diet and baseline creatine availability may influence responsiveness (Smith-Ryan *et al.*, 2021). Tam *et al.* (2025) reviewed 27 studies and reported improvements over placebo in only 3 of 11 strength or power studies, 4 of 17 anaerobic studies and 1 of 5 aerobic studies. The review also highlighted considerable variation in participants, tests, dosage strategies and intervention length, as well as limited reporting of female-specific methodological factors. The present findings sit within that pattern; creatine may benefit some women or some performance tasks, but improvement is not consistent across all outcomes. The physiological rationale remains valid, but the size and detectability of any benefit appear to depend on the athlete, protocol, test and quality of experimental control (Smith-Ryan *et al.*, 2021; Tam *et al.*, 2025).

The medicine ball throw showed a small descriptive advantage for creatine, but this should be interpreted cautiously. The mean creatine-minus-placebo difference was 0.033 m and the effect size was moderate ($d_z = 0.41$), but the comparison was not statistically significant, $t(3) = 0.82$, $p = .473$. Throw distance improved by 0.085 ± 0.226 m under creatine and by 0.053 ± 0.224 m under placebo. Because seated medicine ball throw performance is technique-dependent, small differences in posture, release angle, warm-up or instructions could alter the outcome. The maltodextrin comparator also prevents a clean comparison with an inert placebo, although the study did not measure blood glucose, glycogen availability or any direct physiological response to maltodextrin (Jeukendrup, 2014; Almutairi *et al.*, 2022). The finding is therefore best described as a small, non-significant descriptive advantage rather than evidence of a supplement-specific effect.

Standing broad jump was particularly unstable across analyses; in the four complete cases, the mean creatine-minus-placebo difference was 0.034 m, representing a small descriptive effect in favour of creatine ($d_z = 0.30$), but the paired comparison was not significant, $t(3) = 0.61$, $p = .587$. Mean change was 0.025 ± 0.056 m under creatine and -0.009 ± 0.096 m under

placebo. Once incomplete cases were included, however, the descriptive pattern shifted strongly towards placebo. This reversal makes it difficult to treat the paired estimate as a stable treatment signal. Broad jump performance is affected by countermovement strategy, arm swing, take-off angle, landing technique, surface and fatigue, so a few inconsistent or unfamiliar trials alter the group mean considerably in a small sample.

Sprint performance was descriptively poorer following creatine. In the matched sample, the mean creatine-minus-placebo difference was 0.090 s, which favoured placebo because lower times indicate better sprint performance ($d_z = 0.83$); however, the comparison was not significant, $t(3) = 1.65$, $p = .198$. Sprint time increased by 0.070 ± 0.112 s under creatine but decreased by 0.020 ± 0.069 s under placebo. The all-observations analysis also showed slower times in both conditions, with a larger deterioration under creatine. This pattern should not be interpreted as evidence that creatine impaired sprinting as four paired cases provide little precision, and sprint time is affected by starting technique, timing method, surface, footwear, warm-up and recent high-intensity activity. Creatine-related increases in intracellular water and body mass could theoretically make acceleration less efficient if force production does not also improve, but as body mass was not measured, this explanation remains speculative (Kreider *et al.*, 2017). Maltodextrin may also have contributed to the placebo-favouring direction, although evidence for a reliable acute benefit in very short anaerobic tasks is limited (Wilburn *et al.*, 2020). The most cautious interpretation is a non-significant unfavourable trend that needs replication under tighter control.

Agility changed by almost the same amount in the two conditions. In the matched sample, the mean creatine-minus-placebo difference was 0.005 s, giving a negligible effect ($d_z = 0.02$), and the comparison was not significant, $t(3) = 0.04$, $p = .973$. Mean change was -0.120 ± 0.281 s under creatine and -0.125 ± 0.132 s under placebo, so the placebo condition improved by only 0.005 s more than creatine. The expanded analysis favoured creatine descriptively, but variability increased and the observations were not fully paired. Because the 505 test combines acceleration, braking and reacceleration, it is theoretically relevant to the phosphocreatine mechanism (Kreider *et al.*, 2017). Even so, the matched data do not show a meaningful condition difference. A more informative design would use electronic timing, repeated agility bouts and reliability data so that small changes can be separated from measurement inaccuracies. This cautious interpretation is consistent with Tam *et al.*'s (2025)

conclusion that creatine responses in active females are outcome-specific and currently inconclusive.

Methodological Interpretation

Pre-test values were collected separately before each supplementation phase, allowing phase-specific change scores to be calculated for both creatine and placebo. This approach strengthened the crossover analysis by accounting for possible changes in performance between phases due to training adaptation, competitive load, injury, seasonal progression or repeated exposure to the tests (Mujika and Padilla, 2000). Nevertheless, period and carryover effects remained important considerations because muscle creatine stores decline gradually after supplementation rather than immediately (Kreider *et al.*, 2017). The four-week washout period was intended to minimise residual effects from the first supplementation phase, while randomisation and counterbalancing helped reduce the influence of treatment order. Future crossover research should continue to collect a distinct pre-test value before each condition, justify the washout duration, and assess sequence, period and carryover effects explicitly (Kreider *et al.*, 2017).

The timing of testing also weakened interpretation; week 3 creatine testing took place after some participants had played netball, creating an acute fatigue exposure immediately before sprinting, jumping and change-of-direction tests. Neuromuscular fatigue can reduce force production and impair subsequent physical performance (Alba-Jiménez, Moreno-Doutres and Peña, 2022). Netball-specific training has also been shown to increase fatigue and soreness and reduce jump height and relative peak power during the following 24 hours, which supports the need to account for residual fatigue when scheduling performance tests (Birdsey *et al.*, 2022). Other influential variables, including sleep, hydration, carbohydrate intake, caffeine use, muscle soreness, menstrual symptoms and recent training load, were not reported as standardised or monitored. In a sample this small, one fatigued session can have a disproportionate effect on the mean and therefore, the mitigation of these variables limits confidence that the observed differences were caused by supplementation rather than day-to-day variation in readiness (Hopkins, 2000).

Twelve participants enrolled in the study; three withdrew before data collection, five missed one or more sessions, and only four completed all four tests. The complete-case analysis preserved the paired crossover comparison, but it may have introduced selection bias if

completers differed from non-completers in training status, availability, health or supplement tolerance. The all-observations analysis used more data but lost comparability between conditions. Future studies should allow for attrition when calculating sample size, report reasons for withdrawal by condition, record adherence prospectively and use an analysis plan that can handle repeated measures and incomplete observations, such as a mixed-effects model (Hopkins, 2000).

The side-effect findings from the post-study questionnaire add an important, applied dimension to the study. Four of five questionnaire respondents reported at least one symptom during creatine, while no symptoms were reported during placebo. Gastrointestinal complaints were most common, including stomach upset, nausea and diarrhoea, alongside cramps and vivid dreams. Although this data is descriptive and based on few respondents, the complete separation between conditions is evident. Tolerability can influence adherence, expectancy, training quality and willingness to continue supplementation (Kreider *et al.*, 2017; Longobardi *et al.*, 2025). Symptoms could also indirectly affect performance if participants eat less, sleep poorly or approach testing while uncomfortable. Consequently, adverse-event reporting should not be treated as separate from efficacy; it is part of evaluating whether a protocol is practically useful (Kreider *et al.*, 2017; Longobardi *et al.*, 2025).

The loading procedure may partly explain the symptom burden as one participant initially consumed 20 g across the day before clarification that the intended regimen was 5 g four times daily. As described in the literature review, larger single servings may increase the amount of unabsorbed creatine in the gastrointestinal tract and contribute to osmotic discomfort leading to gastrointestinal discomfort and loose stools (Ostojic and Ahmetovic, 2008). Reviews generally conclude that creatine monohydrate is safe for healthy people when used appropriately, while recognising that gastrointestinal distress can occur and appears more likely with high or poorly divided doses (Kreider *et al.*, 2017; Longobardi *et al.*, 2025). A loading phase is not essential for eventual muscle saturation; approximately 3–5 g per day over a longer period can reach a similar endpoint more gradually (Kreider *et al.*, 2017). The present symptom pattern therefore reinforces the literature review's emphasis on dose distribution and tolerability rather than indicating that creatine is inherently unsafe. Blinding may also have been compromised by the marked difference in symptom experience. If participants associated gastrointestinal effects with creatine, they may have inferred their

condition, changing expectations or effort during testing. Such expectancy effects can operate in either direction: belief in receiving creatine might enhance motivation, whereas discomfort or concern might reduce it (Kreider *et al.*, 2017; Longobardi *et al.*, 2025). A formal blinding check would help determine whether subjective cues threatened the placebo comparison (Kreider *et al.*, 2017; Longobardi *et al.*, 2025).

Strengths, Limitations and Recommendations for Future Research

The main strength of the study was its placebo-controlled crossover design, which allowed participants to act as their own comparator and reduced confounding from stable individual differences. The inclusion of several sport-relevant outcomes, effect sizes and a symptom questionnaire also broadened the interpretation beyond statistical significance alone (Caldwell and Vigotsky, 2020). The findings were separated into primary matched analysis and secondary incomplete-case description, avoiding a single inferential comparison based on non-equivalent observations (Ross, Breskin and Westreich, 2020). There were however many limitations including the small sample size, leaving estimates imprecise and highly sensitive to individual responses. Attrition and incomplete crossover data may have introduced selection bias. Although separate pre-test values were collected before each supplementation phase, the small sample and lack of a full analysis of period, sequence and carryover effects limited the separation of treatment effects from learning, training and time-related influences. Maltodextrin as the placebo was another limitation because it is metabolically available carbohydrate rather than a guaranteed inert comparator; systematic review evidence indicates that orally consumed maltodextrin can produce physiological effects, although whether the study dose influenced these specific tests is unknown (Almutairi *et al.*, 2022). Manual or technique-sensitive tests, absent reliability data, and unmonitored diet, hydration, sleep, body mass, menstrual factors and training load further restrict causal interpretation.

In this study, participants consumed 20 g/day⁻¹ of maltodextrin during the placebo condition, matching the total daily powder dose used in the creatine condition. Maltodextrin is a rapidly digestible carbohydrate, and carbohydrate intake can support exercise performance under some conditions by increasing exogenous carbohydrate availability; however, the effect depends strongly on dose, timing, nutritional status, exercise duration and intensity (Jeukendrup, 2014). A systematic review also found that orally consumed maltodextrin frequently produced physiological or gut-related effects, challenging its universal treatment

as an inactive placebo (Almutairi *et al.*, 2022). In contrast, direct evidence for a reliable ergogenic effect during short anaerobic tasks is limited: Wilburn *et al.*, (2020) reported altered glucose, insulin and epinephrine responses after pre-exercise maltodextrin but no improvement in resistance-exercise performance. Thus, the 20 g·day⁻¹ maltodextrin dose may have contributed to some placebo-favouring observations or attenuated the creatine–placebo contrast, but this study cannot establish that it enhanced medicine ball throw, jump, sprint or agility performance. Interpretation should therefore be framed as a comparison between creatine and a potentially active carbohydrate comparator, and future studies should justify the placebo dose and timing or include an additional non-caloric control.

With four outcome tests, reliance on a conventional .05 threshold raises concern, although no result approached significance in the paired analysis (Hopewell *et al.*, 2025). Confidence intervals may have been more informative as they would show the range of plausible effects and make the imprecision visible (Caldwell and Vigotsky, 2020; Hopewell *et al.*, 2025). The reported individual-response figure is therefore useful, but future reporting should identify whether apparent responders show consistent benefits across outcomes or only isolated changes. Test-retest reliability should also be reported so that observed differences can be judged against measurement inaccuracies and practical relevance (Atkinson and Nevill, 1998; Hopkins, 2000).

From a practical perspective, the present data does not justify recommending this specific short-term loading protocol as a reliable means of improving medicine ball throw, standing broad jump, 20m sprint or agility in a similar group however, this does not translate to creatine being ineffective in athletes. Consistent with the literature review, the wider evidence supports creatine most strongly for repeated high-intensity exercise and training adaptation, whereas findings in active females remain mixed across isolated strength, power, anaerobic and aerobic tests (Kreider *et al.*, 2017; Wax *et al.*, 2021; Tam *et al.*, 2025). Practitioners should therefore tailor supplementation decisions to the athlete's goals. If the aim is to improve a single sprint or jump immediately, expectations should remain modest. If the aim is to support repeated training quality, strength development or repeated-sprint capacity over time, a longer intervention and outcome measures matched to those demands are more appropriate (Wax *et al.*, 2021).

Future research should recruit a substantially larger sample based on an a priori power calculation using a prespecified primary outcome (Cook *et al.*, 2018). One primary performance measure would reduce multiplicity and sharpen the study's purpose, while secondary outcomes could explore mechanism and transfer. Participants should complete multiple familiarisation sessions, and test reliability should be established before randomisation. The same equipment, tester, warm-up, surface, footwear guidance and time of day should be used throughout. Electronic timing should replace manual timing where possible, and several valid attempts should be averaged or selected according to a preregistered rule (Marković and Rakić, 2025).

Daily creatine intake, dose timing, gastrointestinal symptoms, body mass, hydration, diet, sleep, menstrual cycle characteristics, training load and match exposure should be recorded throughout (Bourdon *et al.*, 2017; Smith-Ryan *et al.*, 2021). These variables need not all be used as statistical covariates in a small trial but documenting them would help explain anomalous sessions and assess protocol fidelity. A lower-dose non-loading strategy could be compared with loading to determine whether improved tolerability changes adherence or performance (Kreider *et al.*, 2017; Longobardi *et al.*, 2025). Where feasible, muscle creatine or a validated proxy would confirm that supplementation achieved the intended biological exposure; without such verification, a null performance result cannot distinguish lack of physiological uptake from lack of translation to performance (Snow and Murphy, 2003).

Overall, creatine did not produce statistically significant improvements over the maltodextrin placebo in the four-person matched crossover analysis. Descriptively, creatine was more favourable for medicine ball throw and standing broad jump, placebo was more favourable for 20 m sprint, and agility changed by almost the same amount in both conditions. Because maltodextrin is a rapidly available carbohydrate and may not be biologically inert, a small placebo-related physiological or performance effect could have reduced the apparent creatine-placebo difference; however, this was not directly measured and should not be assumed (Jeukendrup, 2014, Almutairi *et al.*, 2022, Wilburn *et al.*, 2020). The incomplete-case analysis produced similarly mixed and unstable patterns; its apparent agility advantage for creatine was not reproduced in the matched analysis. The findings should therefore be treated as preliminary and specific to the conditions of this study; any performance benefit in this cohort was neither consistent or statistically reliable.

The principal limitation is the extremely small and incomplete sample size; although 12 participants enrolled, only four completed both supplementation conditions and all testing sessions. This significantly reduced statistical power, widened uncertainty and made effect-size estimates sensitive to the influence of a single participant (Cook *et al.*, 2018; Caldwell and Vigotsky, 2020). Attrition may also have introduced selection bias if those who completed every session differed systematically from those who withdrew or missed testing in motivation, health, availability, training status or supplement tolerance (Hopewell *et al.*, 2025; Ross, Breskin and Westreich, 2020). Although the secondary analysis increased the number of observations to six per condition, it did not restore the matched structure of the crossover design. Its reversal of the broad-jump pattern illustrates why those exploratory estimates should not be treated as equivalent to the primary paired analysis (Ross, Breskin and Westreich, 2020).

Another limitation is that testing conditions were not sufficiently standardised. The Week 3 creatine assessment followed netball participation, creating an acute fatigue exposure before tests of sprinting, jumping and change of direction. In addition, badminton players using the sports hall asked the research team to relocate testing to a different area of the hall. This meant that participants were not assessed in an identical location across sessions and may have encountered differences in floor surface, available run-up space, court markings, lighting, surrounding activity and distraction. Even relatively small environmental and procedural changes can reduce the reproducibility and precision of repeated performance measurements; reliability depends on controlling systematic influences such as learning, motivation and fatigue as well as random measurement variation (Hopkins, 2000). Sleep, hydration, carbohydrate intake, caffeine, muscle soreness, recent training load, footwear, surface and time of day were also not reported as controlled. These variables can change short-duration performance by amounts like, or larger than, the differences observed between supplements (Birdsey *et al.*, 2022; Bourdon *et al.*, 2017; Jeukendrup, 2014). Menstrual-cycle characteristics and symptoms were not monitored either, this would be useful for future research due to their relevance to the interpretation of female athlete research (Smith-Ryan *et al.*, 2021; Tam *et al.*, 2025). These factors do not necessarily explain the results, but their absence prevents confident separation of supplementation effects from normal day-to-day and environmental variation.

The supplementation protocol and adherence procedures also require caution as one participant initially misunderstood the loading instructions. Muscle creatine was not measured, so the study cannot confirm that supplementation increased intramuscular stores or distinguish a biological non-response from a performance test that was insensitive to change. The marked difference in reported symptoms between creatine and placebo may also have weakened blinding. Participants who experienced gastrointestinal discomfort could have inferred their allocation, potentially altering confidence, motivation or effort during testing. The side-effect assessment itself was based on five respondents and retrospective self-report. It provides valuable, applied information but cannot estimate incidence precisely or establish that every symptom was caused by creatine. Vivid dreams and post-supplement fatigue, for example, may have alternative explanations. Conversely, the absence of missed doses does not mean symptoms were unimportant, because discomfort could still affect food intake, hydration, sleep or willingness to use the supplement. The most appropriate interpretation is that tolerability was a notable concern in this protocol and deserves prospective investigation, not that creatine is inherently unsafe.

Recommendations for Applied Practice

The findings of this study do not support an immediate improvement in a single sprint, jump, throw or agility test from this short creatine loading protocol. As established in the literature review, the strongest rationale for creatine concerns repeated high-intensity work and training adaptation, while responses and tolerability vary between individuals (Kreider *et al.*, 2017; Smith-Ryan *et al.*, 2021). Supplementation should be aligned with the athlete's goals, monitored rather than assumed effective and trialled away from important competition where possible. Clear divided-dose instructions or a lower daily dose may help users who experience gastrointestinal discomfort (Longobardi *et al.*, 2025). Decisions should also account for changes in body mass, dietary pattern and the relevance of repeated-effort capacity to the athlete's sport.

A non-significant result in four complete cases does not overturn the wider evidence base, just as established physiological plausibility does not guarantee that every athlete will improve every performance measure (Kreider *et al.*, 2017; Caldwell and Vigotsky, 2020). An individual trial should therefore use consistent training and testing indicators, monitor symptoms and review whether the supplement supports the intended outcome over a meaningful period (Bourdon *et al.*, 2017; Longobardi *et al.*, 2025).

Conclusion

The aim of this study was to examine whether short-term creatine supplementation produced measurable improvements in selected performance outcomes when compared with a placebo condition. Using a crossover design, performance changes were assessed across medicine ball throw, standing broad jump, 20 m sprint and agility performance. Overall, the findings did not demonstrate a statistically significant performance benefit of creatine supplementation compared with placebo within the matched sample. Although some descriptive differences were observed across individual measures, these changes were small, inconsistent and should be interpreted with caution.

The primary paired crossover analysis included only the four participants who completed both supplementation conditions. This approach strengthened the internal comparison by ensuring that creatine and placebo responses were assessed within the same individuals. However, the paired-samples t-tests showed no significant differences between conditions for any of the performance measures. Therefore, the results suggest that creatine did not produce clear improvements in upper-body power, lower-body power, sprint speed or agility in this sample.

The secondary descriptive analysis, which included all available observations, supported the interpretation that performance responses were variable and generally small. Because this analysis included incomplete crossover cases, it was not appropriate to apply inferential statistical testing (Ross, Breskin and Westreich, 2020). Nevertheless, the descriptive pattern did not indicate a consistent advantage for creatine over placebo. The post-study questionnaire also showed that several participants reported side effects during creatine supplementation, particularly gastrointestinal symptoms, whereas no side effects were reported during placebo. This pattern is consistent with evidence that gastrointestinal discomfort can occur during creatine loading, particularly when larger or poorly divided doses are consumed (Ostojic and Ahmetovic, 2008; Kreider *et al.*, 2017; Longobardi *et al.*, 2025). This suggests that tolerability should be considered when evaluating the practical use of creatine supplementation in applied sport settings.

A key limitation of this study was the very small sample size, particularly in the primary paired analysis. With only four matched participants, the study had limited statistical power

to detect small or moderate effects, and the resulting effect estimates were highly sensitive to individual responses (Cook *et al.*, 2018; Caldwell and Vigotsky, 2020). Individual variability and incomplete data may also have influenced the findings and introduced selection bias if participants who completed all sessions differed systematically from those with missing observations (Ross, Breskin and Westreich, 2020; Hopewell *et al.*, 2025). The short supplementation period may have further limited the opportunity to detect training-mediated adaptations, which are more likely to emerge over longer interventions than after an acute loading phase (Kreider *et al.*, 2017; Wax *et al.*, 2021). As a result, the absence of statistically significant results should not be interpreted as definitive evidence that creatine has no effect on performance. Instead, the findings indicate that this study was unable to demonstrate a clear ergogenic effect under the conditions tested (Caldwell and Vigotsky, 2020; Tam *et al.*, 2025).

In conclusion, this study found no statistically significant evidence that short-term creatine supplementation improved performance compared with placebo across the selected tests. Although creatine produced some favourable descriptive changes in certain outcomes, these were inconsistent and limited by the small sample size. The findings contribute to an underdeveloped area of sport-nutrition research because women have historically been underrepresented in creatine studies, and evidence in active female populations remains smaller and more heterogeneous than evidence in males (Smith-Ryan *et al.*, 2021; Tam *et al.*, 2025). Future studies should recruit larger female samples and report menstrual-cycle characteristics, hormonal contraceptive use, dietary creatine intake, training status and body-mass changes, as these factors may influence supplementation responses and the interpretation of performance outcomes (Smith-Ryan *et al.*, 2021; Tam *et al.*, 2025). Netball-specific research is particularly valuable because findings from male, mixed-sex or laboratory-based samples may not transfer directly to the repeated acceleration, jumping and change-of-direction demands of competitive female netball. These findings support cautious interpretation and reinforce the need for adequately powered, female-focused and sport-specific research before firm conclusions are drawn about creatine's effects on these performance measures.

Despite its limitations, this study provides useful preliminary evidence by applying a controlled crossover design to a female netball-specific supplementation question that remains underrepresented in the current literature. The findings highlight the need for larger,

better-controlled studies before firm conclusions can be made about creatine's effect on speed, power and agility in competitive female netball players.

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AI tool (with url)	Date used	How this tool was used	Example prompt(s)
Grammarly https://www.grammarly.com/	01/09/2026	Check my work	Please check grammar
Microsoft copilot https://copilot.microsoft.com/	13/03/2026	Suggestions for structure and presentation Data presentation	Please suggest a structure for the literature review Please present this data in a readable table

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Appendix

Appendix A: Participant Information Sheet

Bria Rees
2314624@student.uwtsd.ac.uk

Participant Information Sheet

Effects of Creatine Supplementation on Speed, Power, and Agility in Netball Players

Dear Participant,

You are invited to take part in a research study investigating how creatine supplementation may affect speed, power, upper-body power, lower-body power and agility in netball players. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please read the following information carefully and ask if anything is unclear or if you would like more details.

What is the purpose of the study?

The purpose of this study is to assess whether creatine supplementation can improve performance measures such as speed, power, and agility in netball players.

Why have I been invited?

I am recruiting approximately 15–20 netball players to participate in this study. Participants will be divided equally into two groups.

What will happen if I take part?

If you agree to participate, you will complete the following:

- **Baseline Testing:**
You will complete a series of performance tests to assess speed, upper-body power,

lower-body power, and agility. These include a sprint test, seated medicine ball throw, standing broad jump, and an agility test. No supplementation will be taken during this phase.

- **Intervention Phase 1 (7 days):**

You will receive either creatine supplementation (20 g per day) or a placebo supplement (20 g maltodextrin powder). After 7 days, you will repeat the performance tests.

- **Washout Period:**

A four-week washout period will follow, during which no supplements will be taken.

- **Intervention Phase 2 (7 days):**

You will switch to the opposite supplement and repeat the performance tests at the end of this phase.

Each testing session will last approximately 60–90 minutes. The total study duration, including the washout period, will be approximately six weeks.

- **Data Collection:**

Your performance metrics (speed, power, agility) will be measured at each stage.

Location of the study:

The study will take place in Pentre Awel Leisure Centre Sports Hall in Llanelli.

Investigator:

The lead investigator is Bria Rees.

Who is funding the research?

The research is not being funded, this is being conducted as part of an MSc Sport and Exercise Nutrition course at UWTSD Carmarthen.

Are there any risks or benefits?

Creatine supplementation is widely considered safe for healthy adults when taken at recommended doses. Some individuals may experience mild side effects such as stomach discomfort or muscle cramping. Performance testing involves maximal physical effort, but all tests are commonly used in athletic populations and will be preceded by a warm-up to reduce injury risk. If you feel unwell at any point, testing will stop immediately.

While there may be no direct benefit to you, the findings may help improve understanding of creatine use in netball players.

The study will help us understand whether creatine can enhance athletic performance in netball players. Due to the use of maltodextrin powder, individuals with diabetes, following a ketogenic diet or any other issues related to carbohydrates, will be excluded from the study.

Eligibility Criteria

Participants must meet all the following criteria to be eligible to take part in the study:

- Female netball players aged 18–40 years
- Currently participating in competitive netball
- Minimum of two years' competitive playing experience
- Free from injury and able to complete maximal sprinting, jumping, and agility tasks
- Generally healthy, with no known medical conditions that would contraindicate creatine supplementation or high-intensity exercise
- Willing to maintain habitual training and dietary patterns throughout the study
- Willing to abstain from caffeine for 24 hours prior to each testing session
- Able to provide written informed consent

Exclusion Criteria

Participants will be excluded from the study if they meet any of the following criteria:

- Current or recent (within the previous 8 weeks) use of creatine supplementation
- Presence of renal (kidney), metabolic, or cardiovascular disorders
- Diagnosis of diabetes mellitus or other medical conditions requiring strict carbohydrate management
- Following a ketogenic or very low-carbohydrate diet, due to the use of maltodextrin as a placebo
- Use of other ergogenic aids or supplements known to influence neuromuscular performance (e.g. beta-alanine, caffeine loading, pre-workout supplements)
- Current musculoskeletal injury or condition that may impair performance or increase injury risk
- Pregnancy or breastfeeding
- Known intolerance or adverse reaction to creatine or maltodextrin
- Inability to comply with supplementation, testing, or washout requirements

Do I have to take part?

Participation is voluntary. If you decide to take part, you will be given this information sheet to keep and asked to sign a consent form. You are free to withdraw at any time without giving a reason.

Confidentiality

All information collected about you during the study will be kept strictly confidential.

Contact for Further Information

If you have any questions or would like more information about the study, please contact the researcher.

What do I do next?

If you are happy to participate having read this information sheet, please sign the informed consent form.

Warm-Up

- **0–2 minutes: Light aerobic activation**
Perform light jogging or skipping to gradually increase heart rate and body temperature.
- **2–4 minutes: Dynamic mobility and activation**
Complete the following dynamic exercises as demonstrated:
 - 10 × forward and backward leg swings (each leg)
 - 10 × walking lunges
 - 10 × body-weight squats
 - 10 × arm circles (forward and backward)

Performance Test Instructions

1. 20 m Sprint Test (Speed)

- Start from a stationary standing position behind the start line.
- Begin the sprint when instructed and run **maximally** in a straight line through the finish gate.
- Continue running past the finish line and do not slow down before completing the sprint.
- You will complete **three trials**, with adequate rest between each sprint.
- The **fastest time** will be used for analysis.

2. Standing Broad Jump (Lower-Body Power)

- Stand with both feet behind the take-off line.
- When ready, jump forward as far as possible using a two-footed take-off and arm swing.
- Land on both feet and maintain balance on landing.
- Jump distance will be measured from the take-off line to the **rearmost point of contact** on landing.
- You will complete **three trials**, with the **longest jump** recorded for analysis.

3. Seated Medicine Ball Throw (Upper-Body Power)

- Sit on the floor with your back against a wall, legs fully extended, and feet flat on the floor.
- Hold the medicine ball at chest height using both hands.
- When instructed, throw the ball forward **as forcefully as possible** using a chest-pass motion.
- Ensure your back remains in contact with the wall throughout the movement.
- You will complete **three trials**, with the **longest throw distance** recorded for analysis.

4. 505 Change-of-Direction Test (Agility)

- Start from a stationary standing position behind the start line.
- Sprint forward toward the turning line when instructed.
- Place your designated foot on or beyond the turning line, perform a **180° turn**, and sprint back through the timing gate as quickly as possible.
- Run maximally through the finish gate and do not slow down before completion.
- You will complete **multiple trials**, with adequate rest between efforts.
- The **fastest time** will be used for analysis.

Appendix B: Consent Form

Research Study Informed Consent

Study Title: The Impact of Creatine Supplementation on Speed, Power and Agility in Netball Players: A Controlled Study

This information is being collected as part of a research project conducted by Bria Rees at the University of Wales Trinity Saint David. The information which you supply and that which may be collected as part of the research project will be entered into a filing system or database and will only be accessed by authorised personnel involved in the project. The information will be retained by the University of Wales Trinity Saint David and will only be used for the purpose of research, and statistical and audit purposes. By supplying this information, you are consenting to the University storing your information for the purposes stated above. The information will be processed by the University in accordance with the provisions of the Data Protection Act 1998. No identifiable personal data will be published.

Statements of understanding/consent:

- I confirm that I have read and understand the participant information sheet for this study. I have had the opportunity to ask questions if necessary and have had these answered satisfactorily.

- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. If I withdraw my data will be removed from the study and will be destroyed.
- I understand that my personal data will be processed for the purposes detailed above, in accordance with the Data Protection Act 1998.

- Based upon the above, I agree to take part in this study.

Name of participant..... Date..... Signature.....

Name of researcher..... Date..... Signature.....

Appendix C: Ethics Approval

APPLICATION FOR ETHICAL APPROVAL

RESEARCH STUDENTS

This form is to be completed by the student within **SIX** months for full-time students and **TWELVE** months for part time students, after the commencement of the research degree or following progression to Part Two of your course.

Once complete, submit this form via the ***MyTSD Doctoral College Portal*** at (<https://mytsd.uwtsd.ac.uk>).

This document is also available in Welsh.

RESEARCH STAFF ONLY

All communications relating to this application during its processing must be in writing and emailed to pgresearch@uwtsd.ac.uk, with the title 'Ethical Approval' followed by your name.

STUDENTS ON UNDERGRADUATE OR TAUGHT MASTERS PROGRAMMES should submit this form (and receive the outcome) via systems explained to you by the supervisor/module leader.

In order for research to result in benefit and minimise risk of harm, it must be conducted ethically. A researcher may not be covered by the University's insurance if ethical approval has not been obtained prior to commencement.

The University follows the OECD Frascati manual definition of **research activity**: "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications". As such this covers activities undertaken by members of staff, postgraduate research students, and both taught postgraduate and undergraduate students working on dissertations/projects.

The individual undertaking the research activity is known as the "principal researcher".

Ethical approval is not required for routine audits, performance reviews, quality assurance studies, testing within normal educational requirements, and literary or artistic criticism.

Please read the notes for guidance before completing ALL sections of the form.
This form must be completed and approved prior to undertaking any research activity.
Please see Checklist for details of process for different categories of application.

SECTION A: About You (Principal Researcher)

1	Full Name:	Bria Mae Rees			
2	Tick all boxes that apply:	Member of staff:	☐	Honorary research fellow:	☐
	Undergraduate Student	☐	Taught Postgraduate Student	☒	Postgraduate Research Student
3	Institute/Academic Discipline/Centre:	Prifysgol Cymru Y Drindod Dewi Sant – Athrofa Iechyd a rheolaeth.			
4	Campus:	Caerfyrddin			
5	E-mail address:	2314624@student.uwstd.ac.uk			
6	Contact Telephone Number:	07368528112			
For students:					
7	Student Number:	234624			
8	Programme of Study:	MSc Sport & Exercise Nutrition			
9	Director of Studies/Supervisor:	Geraint Forster			

SECTION B: Approval for Research Activity

1	Has the research activity received approval in principle? (please check the Guidance Notes as to the appropriate approval process for different levels of research by different categories of individual)	YES	☐	NO	☒
					Date
2	If Yes, please indicate source of approval (and date where known): <i>Approval in principle must be obtained from the relevant source prior to seeking ethical approval</i>	Research Degrees Committee	☐		
Institute Research Committee		☐			
Other (write in)		☐			

SECTION C: Internal and External Ethical Guidance Materials

	Please list the core ethical guidance documents that have been referred to during the completion of this form (including any discipline-specific codes of research ethics, location-specific codes of
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	research ethics, and also any specific ethical guidance relating to the proposed methodology). Please tick to confirm that your research proposal adheres to these codes and guidelines. You may add rows to this table if needed.	
1	UWTSD Research Ethics & Integrity Code of Practice	☒
2	UWTSD Research Data Management Policy	☒
3	<i>SENr Code of Professional Conduct</i>	☒

SECTION D: External Collaborative Research Activity

If there are external collaborators then you should gain consent from the contact persons to share their personal data with the university. If there are no external collaborators then leave this section blank and continue to section E.

1	Institution					
2	Contact person name					
3	Contact person e-mail address					
4	Is your research externally funded?	YES	☐	NO	☐	
5	Are you in receipt of a KESS scholarship?	YES	☐	NO	☐	
6	Are you specifically employed to undertake this research in either a paid or voluntary capacity?	Voluntary	YES	☐	NO	☐
7		Employed	YES	☐	NO	☐
8	Is the research being undertaken within an existing UWTSD Athrofa Professional Learning Partnership (APLP)?	If YES then the permission question below does not need to be answered.	YES	☐	NO	☐
9	Has permission to undertake the research has been provided by the partner organisation?	(If YES attach copy) If NO the application cannot continue	YES	☐	NO	☐

Where research activity is carried out in collaboration with an external organisation

10	Does this organisation have its own ethics approval system?	YES	☐	NO	☐
	If Yes, please attach a copy of any final approval (or interim approval) from the organisation (this may be a copy of an email if appropriate).				

SECTION E: Details of Research Activity

1	Indicative title:	The Impact of Creatine Supplementation on Speed, Power and Agility in Netball Players: A Controlled Study		
2	Proposed start date:	15 th September 2025	Proposed end date:	March 2026

	Introduction to the Research (maximum 300 words per section) Ensure that you write for a <u>Non-Specialist Audience</u> when outlining your response to the points below: <i>Purpose of Research Activity</i> <i>Proposed Research Question</i> <i>Aims of Research Activity</i> <i>Objectives of Research Activity</i> Demonstrate, briefly, how <u>Existing Research</u> has informed the proposed activity and explain <i>What the research activity will add to the body of knowledge</i> <i>How it addresses an area of importance.</i>
3	Purpose of Research Activity The primary purpose of this dissertation is to assess whether creatine supplementation is effective in enhancing speed and power in netball players. The research aims to contribute to the understanding of how nutritional interventions, specifically creatine supplementation, can influence athletic performance in a sport-specific context (this box should expand as you type)
4	Research Question Does creatine supplementation significantly improve power and strength in competitive netball players compared to a control group? (this box should expand as you type)
5	Aims of Research Activity To determine if creatine supplementation improves speed and power in netball players. (this box should expand as you type)
6	Objectives of Research Activity ☐ To determine if creatine supplementation improves speed and power in netball players. ☐ To evaluate the impact of creatine supplementation on performance metrics such as speed, power, and agility. (this box should expand as you type)
	Proposed methods (maximum 600 words) Provide a brief summary of all the methods that may be used in the research activity, making it clear what specific techniques may be used. If methods other than those listed in this section are deemed appropriate later, additional ethical approval for those methods will be needed. You do not need to justify the methods here, but should instead describe how you intend to collect the data necessary for you to complete your project.

7	Proposed Methods: Two-Group Crossover Design Study Design: A controlled, crossover study will be conducted with two groups of netball players. The study will assess the effects of creatine supplementation on speed, power (upper and lower body) and agility. Participants: Approximately 15-20 netball players will be recruited, divided equally into two groups. Procedure: 1. Baseline Testing (No Creatine): ○ Both groups will undergo initial performance testing to establish baseline measures for speed, power, and agility (sprint, seated med ball throw, agility test, standing broad jump). No participants will receive creatine supplementation during this phase. 2. Intervention Phase 1: ○ Group A will receive creatine supplementation for a set period (7 days of creatine loading, 20g per day) while Group B will take maltodextrin powder (20g per day for 7 days) as a placebo group. ○ At the end of this period, both groups will be retested using the same performance measures. 3. Intervention Phase 2: ○ The groups will switch: Group B will now receive creatine supplementation, and Group A will receive maltodextrin powder. ○ After the supplementation period, both groups will be retested again. Data Collection: • Performance metrics (speed, power, agility) will be measured at each stage. Analysis: • Results will be compared within and between groups to determine the effect of creatine supplementation on performance outcomes. This will be a double-blinded study and the researcher will not be aware of which participants had the creatine or maltodextrin, until after the data collection. (this box should expand as you type)
	Location of research activity

	Identify all locations where research activity will take place.
8	Pentre Awel Sports Hall (this box should expand as you type)
	Research activity outside of the UK If research activity will take place overseas, you are responsible for ensuring that local ethical considerations are complied with and that the relevant permissions are sought. Specify any local guidelines (e.g. from local professional associations/learned societies/universities) that exist and whether these involve any ethical stipulations beyond those usual in the UK (provide details of any licenses or permissions required). Also specify whether there are any specific ethical issues raised by the local context in which the research activity is taking place, for example, particular cultural and/or legal sensitivities or vulnerabilities of participants. If you live in the country where you will do the research then please state this.
9	N/A (this box should expand as you type)

10	Use of documentation not in the public domain: Are any documents NOT publicly available?	NO	☒
		YES	☐
11	If Yes, please provide details here of how you will gain access to specific documentation that is not in the public domain and that this is in accordance with the current data protection law of the country in question and that of England and Wales. (this box should expand as you type)		

	Does your research relate to one or more of the seven aims of the Well-being of Future Generations (Wales) Act 2015?	YES	NO
12	A prosperous Wales	☐	☒
13	A resilient Wales	☐	☒
14	A healthier Wales	☐	☒
15	A more equal Wales	☐	☒
16	A Wales of cohesive communities	☐	☒
17	A Wales of vibrant culture and thriving Welsh language	☐	☒
18	A globally responsible Wales	☐	☒
19	If YES to any of the above, please give details:		

	(this box should expand as you type)
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SECTION F: Scope of Research Activity

	Will the research activity include:	YES	NO
1	Use of a questionnaire or similar research instrument?	☐	☒
2	Use of interviews?	☐	☒
3	Use of focus groups?	☐	☒
4	Use of participant diaries?	☐	☒
5	Use of video or audio recording?	☐	☒
6	Use of computer-generated log files?	☐	☒
7	Participant observation with their knowledge?	☒	☐
8	Participant observation without their knowledge?	☐	☒
9	Access to personal or confidential information without the participants' specific consent?	☐	☒
10	Administration of any questions, test stimuli, presentation that may be experienced as physically, mentally or emotionally harmful / offensive?	☐	☒
11	Performance of any acts which may cause embarrassment or affect self-esteem?	☐	☒
12	Investigation of participants involved in illegal activities?	☐	☒
13	Use of procedures that involve deception?	☐	☒
14	Administration of any substance, agent or placebo?	☒	☐
15	Working with live vertebrate animals?	☐	☒
16	Procedures that may have a negative impact on the environment?	☐	☒
17	Other primary data collection methods. Please indicate the type of data collection method(s) below.	☐	☒
	Details of any other primary data collection method: (this box should expand as you type)		

If NO to every question, then the research activity is (ethically) low risk and **may** be exempt from **some** of the following sections (please refer to Guidance Notes).

If YES to any question, then no research activity should be undertaken until full ethical approval has been obtained.

SECTION G: Intended Participants

If there are no participants then do not complete this section, but go directly to section H.

Who are the intended participants:		YES	NO
1	Students or staff at the University?	☐	☒
2	Adults (over the age of 18 and competent to give consent)?	☒	☐
3	Vulnerable adults?	☐	☒
4	Children and Young People under the age of 18? (Consent from Parent, Carer or Guardian will be required)	☐	☒
5	Prisoners?	☐	☒
6	Young offenders?	☐	☒
7	Those who could be considered to have a particularly dependent relationship with the investigator or a gatekeeper?	☐	☒
8	People engaged in illegal activities?	☐	☒
9	Others. Please indicate the participants below, and specifically any group who may be unable to give consent.	☐	☒
	Details of any other participant groups: (this box should expand as you type)		

Participant numbers and source Provide an estimate of the expected number of participants. How will you identify participants and how will they be recruited?		
10	How many participants are expected?	Approximately 15-20 (this box should expand as you type)
11	Who will the participants be?	Netball players within lead researcher's netball club/league (this box should expand as you type)
12	How will you identify the participants?	Word of mouth followed by participant information sheet (this box should expand as you type)

Information for participants:		YES	NO	N/A
13	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	☒	☐	☐
14	Will you tell participants that their participation is voluntary?	☒	☐	☐

15	Will you obtain written consent for participation?	☒	☐	☐
16	Will you explain to participants that refusal to participate in the research will not affect their treatment or education (if relevant)?	☒	☐	☐
17	If the research is observational, will you ask participants for their consent to being observed?	☒	☐	☐
18	Will you tell participants that they may withdraw from the research at any time and for any reason?	☒	☐	☐
19	With questionnaires, will you give participants the option of omitting questions they do not want to answer?	☐	☐	☒
20	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	☒	☐	☐
21	Will you debrief participants at the end of their participation, in a way appropriate to the type of research undertaken?	☒	☐	☐
22	If NO to any of above questions, please give an explanation			
	<i>(this box should expand as you type)</i>			

	Information for participants:	YES	NO	N/A
24	Will participants be paid?	☐	☒	☐
25	Is specialist electrical or other equipment to be used with participants?	☒	☐	☐
26	Are there any financial or other interests to the investigator or University arising from this study?	☒	☐	☐
27	Will the research activity involve deliberately misleading participants in any way, or the partial or full concealment of the specific study aims?	☐	☒	☐
28	If YES to any question, please provide full details			
	Power, speed and agility testing equipment will be used with participants, along with the administration of Creatine. The University will fund and source the Creatine supplement. <i>(this box should expand as you type)</i>			

SECTION H: Anticipated Risks

	<u>Outline any anticipated risks that may adversely affect any of the participants, the researchers and/or the University, and the steps that will be taken to address them.</u> If you have completed a full risk assessment (for example as required by a laboratory, or external research collaborator) you may append that to this form.		
1	<u>Full risk assessment completed and appended?</u>	<u>Yes</u>	☐
		<u>No</u>	☒
2	Risks to participants For example: sector-specific health & safety, emotional distress, financial disclosure, physical harm, transfer of personal data, sensitive organisational information		
	Risk to participants: • Risk of injury during speed, agility, power testing. • Risk of creatine supplementation being contaminated. • Risk of adverse effects of creatine (bloating, water retention, gastrointestinal discomfort etc. • Risk of emotional distress due to weight gain/water retention • Risk of incorrect dose being administered • Participants with diabetes, following a ketogenic diet or any other concerns related to carbohydrate intake will be excluded from the study	<i>How you will mitigate the risk to participants:</i> • Ensure to encourage adequate warm up prior to testing. • Ensure the University source Creatine that has been rigorously tested. • Ensure participants are made aware of these risks in the information sheet provided • Ensure participants are made aware of these risks in the information sheet provided • Investigator and technician to weigh out and individually label doses for each participant	

		Participants will be excluded from the study if they have diabetes or any other issue related to carbohydrate intakes.
	<i>(this box should expand as you type)</i>	<i>(this box should expand as you type)</i>
3	If research activity may include sensitive, embarrassing or upsetting topics (e.g. sexual activity, drug use) or issues likely to disclose information requiring further action (e.g. criminal activity), give details of the procedures to deal with these issues, including any support/advice (e.g. helpline numbers) to be offered to participants. Note that where applicable, consent procedures should make it clear that if something potentially or actually illegal is discovered in the course of a project, it may need to be disclosed to the proper authorities	
	N/A <i>(this box should expand as you type)</i>	
4	Risks to the investigator For example: personal health & safety, physical harm, emotional distress, risk of accusation of harm/impropriety, conflict of interest	
	Risk to the investigator: Nil <i>(this box should expand as you type)</i>	<i>How you will mitigate the risk to the investigator:</i> <i>(this box should expand as you type)</i>
5	University/institutional risks For example: adverse publicity, financial loss, data protection	
	Risk to the University: - Financial as required to source Creatine and maltodextrin powder - Risk of accusation of improper conduct - Risk to professional reputation - Reputational risk - Risk of legal action by participant - Risk of data protection leak <i>(this box should expand as you type)</i>	<i>How you will mitigate the risk to the University:</i> - Discuss with Supervisor - Ensure behaviour is always in adherence with SENr code of professional conduct - Ensure all risk assessments and ethical regulations are adhered to - Ensure codes of practice are adhered to. Ensure creatine is purchased from reputable supplier and is batch tested. - Ensure study is risk assessed and ethically approved - Ensure study is GDPR compliant <i>(this box should expand as you type)</i>
6	Environmental risks For example: accidental spillage of pollutants, damage to local ecosystems	
	Risk to the environment: Nil <i>(this box should expand as you type)</i>	<i>How you will mitigate the risk to environment:</i> <i>(this box should expand as you type)</i>

Disclosure and Barring Service				
	If the research activity involves children or vulnerable adults, a Disclosure and Barring Service (DBS) certificate must be obtained before any contact with such participants.	YES	NO	N/A
7	Does your research require you to hold a current DBS Certificate?	☐	☒	☐
8	If YES, please give the certificate number. If the certificate number is not available please write "Pending"; in this case any ethical approval will be subject to providing the appropriate certificate number.			

SECTION I: Feedback, Consent and Confidentiality

1	Feedback What de-briefing and feedback will be provided to participants, how will this be done and when?
	Participants will be thanked for their participation, will have the option of providing feedback via a Microsoft teams evaluation form. Participants will be able to receive copies of the final results of the study if requested. <i>(this box should expand as you type)</i>
2	Informed consent Describe the arrangements to inform potential participants, before providing consent, of what is involved in participating. Describe the arrangements for participants to provide full consent before data collection begins. If gaining consent in this way is inappropriate, explain how consent will be obtained and recorded in accordance with prevailing data protection legislation.
	Participants will be provided with a participant information sheet and consent form prior to commencing the data collection. They will be informed on the purpose of the research, and the nature of their participation. They will also be informed of the data collection's results. <i>(this box should expand as you type)</i>
3	Confidentiality / Anonymity Set out how anonymity of participants and confidentiality will be ensured in any outputs. If anonymity is not being offered, explain why this is the case.
	Participants' data will be anonymised. <i>(this box should expand as you type)</i>

SECTION J: Data Protection and Storage

	Does the research activity involve personal data (as defined by the General Data Protection Regulation 2016 "GDPR" and the Data Protection Act 2018 "DPA")?	YES	NO
1	"Personal data" means any information relating to an identified or identifiable natural person ('data subject'). An identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier	☐	☒

	such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person. Any video or audio recordings of participants is considered to be personal data.		
	If YES, provide a description of the data and explain why this data needs to be collected:		
2	(this box should expand as you type)		
	Does it involve special category data (as defined by the GDPR)?	YES	NO
3	“Special category data” means sensitive personal data consisting of information as to the data subjects’ – (a) racial or ethnic origin, (b) political opinions, (c) religious beliefs or other beliefs of a similar nature, (d) membership of a trade union (within the meaning of the Trade Union and Labour Relations (Consolidation) Act 1992), (e) physical or mental health or condition, (f) sexual life,	☐	☒
	Will data from the research activity (collected data, drafts of the thesis, or materials for publication) be stored in any of the following ways?	YES	NO
5	Manual files (i.e. in paper form)?	☐	☒
6	University computers?	☐	☒
7	Private company computers?	☐	☒
8	Home or other personal computers?	☒	☐
9	Laptop computers/ CDs/ Portable disk-drives/ memory sticks?	☒	☐
10	“Cloud” storage or websites?	☒	☐
11	Other – specify:	☐	☒
12	For all stored data, explain the measures in place to ensure the security of the data collected, data confidentiality, including details of backup procedures, password protection, encryption, anonymisation and pseudonymisation:		
	All data will be kept in password protected cloud storage/Microsoft files which will not be shared. (this box should expand as you type)		

	Data Protection		
	Will the research activity involve any of the following activities:	YES	NO
13	Electronic transfer of data in any form?	☒	☐
14	Sharing of data with others at the University outside of the immediate research team?	☐	☒

15	Sharing of data with other organisations?	☐	☒
16	Export of data outside the UK or importing of data from outside the UK?	☐	☒
17	Use of personal addresses, postcodes, faxes, emails or telephone numbers?	☐	☒
18	Publication of data that might allow identification of individuals?	☐	☒
19	Use of data management system?	☐	☒
20	Data archiving?	☐	☒
21	If YES to any question, please provide full details, explaining how this will be conducted in accordance with the GDPR and Data Protection Act (2018) (and any international equivalents, where appropriate):		
	All data will be encrypted and kept in password protected cloud storage/Microsoft files which will not be shared. <i>(this box should expand as you type)</i>		
22	List all who will have access to the data generated by the research activity:		
	Researcher and supervisor. <i>(this box should expand as you type)</i>		
23	List who will have control of, and act as custodian(s) for, data generated by the research activity:		
	Researcher and supervisor. <i>(this box should expand as you type)</i>		
24	Give details of data storage arrangements, including security measures in place to protect the data, where data will be stored, how long for, and in what form. Will data be archived – if so how and if not why not.		
	All data will be encrypted and kept in password protected files. <i>(this box should expand as you type)</i>		
25	Please indicate if your data will be stored in the UWTSD Research Data Repository (see https://researchdata.uwtss.ac.uk/). If so please explain. <i>(Most relevant to academic staff)</i>		
	N/A <i>(this box should expand as you type)</i>		
26	Confirm that you have read the UWTSD guidance on data management (see https://www.uwtss.ac.uk/library/research-data-management/)	YES	☒
27	Confirm that you are aware that you need to keep all data until after your research has completed or the end of your funding	YES	☒

SECTION K: Declaration

	The information which I have provided is correct and complete to the best of my knowledge. I have attempted to identify any risks and issues related to the research activity and acknowledge my obligations and the rights of the participants. In submitting this application I hereby confirm that I undertake to ensure that the above named research activity will meet the University's Research Ethics and Integrity Code of Practice which is published on the website: https://www.uwtsd.ac.uk/research/research-ethics/	
1	Signature of applicant: Bria Rees	Date: 01/01/2026

For STUDENT Submissions:

2	Director of Studies/Supervisor:	Geraint Forster	Date: 28/01/2026
3	Signature:		

For STAFF Submissions:

4	Academic Director/ Assistant Dean:		Date:
5	Signature:		

Checklist: Please complete the checklist below to ensure that you have completed the form according to the guidelines and attached any required documentation:

☒	I have read the guidance notes supplied before completing the form.
☒	I have completed ALL RELEVANT sections of the form in full.
☒	I confirm that the research activity has received approval in principle
☐	I have attached a copy of final/interim approval from external organisation (where appropriate)
☐	I have attached a full risk assessment (where appropriate) <i>ONLY TICK IF YOU HAVE ATTACHED A FULL RISK ASSESSMENT</i>
☒	I understand that it is my responsibility to ensure that the above named research activity will meet the University's Research Ethics and Integrity Code of Practice.
☒	I understand that before commencing data collection all documents aimed at respondents (including information sheets, consent forms, questionnaires, interview schedules etc.) must be confirmed by the DoS/Supervisor, module tutor or Academic Director.

RESEARCH STUDENTS ONLY

Once complete, submit this form via the **MyTSD Doctoral College Portal** at (<https://mytsd.uwtsd.ac.uk>).

RESEARCH STAFF ONLY

All communications relating to this application during its processing must be in writing and emailed to pgresearch@uwtsd.ac.uk , with the title 'Ethical Approval' followed by your name.

STUDENTS ON UNDERGRADUATE OR TAUGHT MASTERS PROGRAMMES should submit this form (and receive the outcome) via systems explained to you by the supervisor/module leader.

Appendix D: Post-Study Questionnaire

Participant Questionnaire: Perceived Improvements Following Supplementation

Please complete the following questionnaire to help us understand your experiences with both Supplement A and Supplement B. Your feedback will assist in evaluating the perceived effects on power, strength, speed, and agility during games, training, and in your general daily life.

Section 1: Supplement Experience

1. Which supplement did you take first? (Please tick)
2. ☐ Supplement A
3. ☐ Supplement B

Section 3: Perceived Improvements

For each statement below, please indicate your level of agreement for **Supplement A** and **Supplement B** using the following scale:

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly Agree

Statement	Supplement A	Supplement B
I felt an improvement in power during games (e.g. jump height/take off, first-step acceleration, harder passes, stronger drives through contact, repeated explosive efforts)	1 2 3 4 5	1 2 3 4 5
I felt an improvement in strength during training (e.g. holding space in contact, stronger landing, more force on	1 2 3 4 5	1 2 3 4 5

drives, better repeated contacts, higher load tolerance in gym)		
I noticed greater speed in general life activities (e.g. walking pace, stairs, daily tasks, reaction/urgency)	1 2 3 4 5	1 2 3 4 5
My agility felt improved during training sessions (quicker deceleration, faster change of direction, better/quicker footwork)	1 2 3 4 5	1 2 3 4 5
I felt overall improvement in physical performance in general life.	1 2 3 4 5	1 2 3 4 5

Section 4: Additional Comments

Please provide any further thoughts on how Supplement A and Supplement B influenced your power, strength, speed, or agility, or any other observations relevant to your experience:

Appendix E: Anonymised Raw Performance Data

Supplement Allocation

Participant	Week 1	Week 3
1	A	B
2	—	A
3	A	B
4	B	A
5	A	B
8	B	A
9	A	B
10	B	A
11	B	A
12	A	B

Med Ball Throw (m)

Participant	B	Test 2	Test 3	Test 4
1	3.00	3.33	—	—

2	—	—	2.00	1.95
3	2.91	—	2.88	—
4	3.11	—	3.05	—
5	2.85	2.70	2.60	2.70
8	2.49	2.34	2.30	2.28
9	2.51	2.40	2.51	2.75
10	2.60	2.70	2.45	—
11	2.24	2.38	—	—
12	3.08	3.30	3.55	3.40

Standing Broad Jump (m)

Participant	B	Test 2	Test 3	Test 4
1	1.89	1.68	—	—
2	—	—	1.79	1.50
3	1.81	—	1.74	—
4	1.37	—	1.32	—
5	2.07	2.08	1.94	1.99
8	1.69	1.71	1.79	1.56
9	1.70	1.74	1.77	1.79
10	1.39	1.55	1.41	—
11	1.55	1.51	—	—
12	2.06	2.12	2.11	2.01

20 m Sprint (s)

Participant	B	Test 2	Test 3	Test 4
1	4.04	4.06	—	—
2	—	—	3.53	3.94
3	3.72	—	3.82	—
4	4.53	—	4.41	—
5	3.69	3.62	3.75	3.69

8	3.65	3.81	3.78	3.85
9	3.75	3.87	3.81	3.87
10	4.34	4.47	4.28	—
11	3.87	3.91	—	—
12	3.13	3.28	3.31	3.25

Agility Test (s)

Participant	B	Test 2	Test 3	Test 4
1	9.89	9.50	—	—
2	—	—	8.78	9.16
3	8.81	—	9.07	—
4	9.56	—	9.66	—
5	8.15	7.93	8.03	7.84
8	8.94	8.84	9.00	9.38
9	8.93	8.78	8.88	8.93
10	9.53	10.37	10.34	—
11	8.31	8.84	—	—
12	8.13	7.90	8.04	7.97

Appendix F: Statistical Calculations

Excel Paired-Samples Output

Outcome	n	Mean A–B	SD	SE	t	df	p	Cohen's dz	95% CI
Med ball throw	4	−0.025	0.335	0.167	−0.149	3	0.891	−0.075	−0.558 to 0.508
Standing broad jump	4	−0.027	0.170	0.085	−0.323	3	0.768	−0.161	−0.299 to 0.244
20 m sprint	4	0.043	0.127	0.064	0.667	3	0.552	0.334	−0.160 to 0.245

Agility test	4	0.022	0.314	0.157	0.144	3	0.895	0.072	-0.476 to 0.521
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Excel Analysis Formulas

For each participant, each phase change as post-test – pre-test was calculated. Then paired differences were calculated as creatine change – placebo change.

Calculation	Excel formula
Phase change	=PostCell-PreCell
Paired difference	=CreatineChangeCell-PlaceboChangeCell
Sample size	=COUNT(difference_range)
Mean paired difference	=AVERAGE(difference_range)
SD of paired differences	=STDEV.S(difference_range)
Standard error	=STDEV.S(difference_range)/SQRT(COUNT(difference_range))
t statistic	=AVERAGE(difference_range)/(STDEV.S(difference_range)/SQRT(COUNT(difference_range)))
Degrees of freedom	=COUNT(difference_range)-1
Two-tailed p-value	=T.DIST.2T(ABS(t_cell),df_cell)
Direct paired t-test	=T.TEST(creatine_change_range,placebo_change_range,2,1)
Cohen's dz	=AVERAGE(difference_range)/STDEV.S(difference_range)

95% CI lower	=mean_cell-T.INV.2T(0.05,df_cell)*SE_cell
95% CI upper	=mean_cell+T.INV.2T(0.05,df_cell)*SE_cell
Significance decision	=IF(p_cell<0.05,"Significant","Not significant")

Participant-Level Change Scores and Paired Differences

Change score = post-test – pre-test within each condition. Paired difference = creatine change (A) – placebo change (B). Positive values favour creatine for distance tests; negative values favour creatine for timed tests.

Participant	MB A	MB B	MB A–B	SBJ A	SBJ B	SBJ A–B
5	–0.150	0.100	–0.250	0.010	0.050	–0.040
8	–0.020	–0.150	0.130	–0.230	0.020	–0.250
9	–0.110	0.240	–0.350	0.040	0.020	0.020
12	0.220	–0.150	0.370	0.060	–0.100	0.160

Participant	Sprint A	Sprint B	Sprint A–B	Agility A	Agility B	Agility A–B
5	–0.070	–0.060	–0.010	–0.220	–0.190	–0.030
8	0.070	0.160	–0.090	0.380	–0.100	0.480
9	0.120	0.060	0.060	–0.150	0.050	–0.200
12	0.150	–0.060	0.210	–0.230	–0.070	–0.160

MB = med ball throw; SBJ = standing broad jump. Participant numbers are used to preserve anonymity.