


# Injuries in the emerging sport of roundnet (Spikeball): a cross-sectional study of 166 players

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## ABSTRACT

**Objectives** To describe injury frequency and characteristics in roundnet athletes and compare injury characteristics between elite and non-elite athletes.

**Methods** This cross-sectional study was performed by convenience sampling recreational and competitive roundnet athletes via a REDCap survey distributed through social media platforms. The custom survey evaluated athlete demographics, past sport participation, training workload and roundnet-related injuries throughout their whole playing career. Injury characteristics were reported for the full study cohort and compared between elite and non-elite athletes.

**Results** 166 athletes participated in the study, with 33.7% playing at the elite level. 279 injuries were reported, with 86.1% (n=143) of athletes reporting at least one injury throughout their playing career. Injuries most frequently involved the shoulder (20%), ankle (18%), knee (14%) and elbow (14%). 47% of reported injuries occurred due to overuse, and 67% resulted in missed competition time averaging 2.0 months. There were 10 injuries (3.6%) that required surgery. No differences were found in regards to injury frequency (1.9±1.5 vs 1.6±1.1 injuries per athlete, p=0.159) or any injury characteristics between elite and non-elite athletes.

**Conclusion** Roundnet athletes experienced a mean of 1.7±1.2 injuries while playing roundnet. Injuries most frequently involved the shoulder and ankle and often resulted in missed competition time. The level of competition does not significantly impact injury frequency or characteristics. Roundnet athletes may benefit from injury prevention programmes that include shoulder strengthening, maintaining shoulder range of motion and ankle stability.

## INTRODUCTION

Roundnet is a four-player ball sport where teams are composed of two players each positioned around a circular net. Similar to volleyball, once the ball is served to the opposing team, the two players on one team may touch the ball up to three times before having to hit the ball back onto the net, at which time it is conversely the other team's turn to return the ball to the net. The team that fails to return the ball back onto the net

## WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Roundnet (Spikeball) is a four-player sport where teams are composed of two players each positioned around a circular net, with each team able to touch the ball up to three times before having to hit the ball back onto the net—the team that fails to return the ball back onto the net within three touches loses the point, and games are played until one team reaches 21 points.
- ⇒ There have been no prior studies describing the workload involved in the sport of roundnet and the injuries experienced by roundball players.
- ⇒ Research regarding injury frequency and characteristics is robust in other sports, with fatigue and overuse being known contributors to injury.

## WHAT THIS STUDY ADDS

- ⇒ This study provides novel insights into the frequency of roundnet injuries in the elite (1.9 injuries per athlete) versus non-elite (1.6 injuries per non-elite athlete). Injuries most frequently affect the shoulder (20%), ankle (18%), knee (14%) and elbow (14%).

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ This study will spark and guide future research into injury prevention and treatment in roundnet athletes. The results can help clinicians better understand the injuries affecting the shoulder and ankle in the quickly growing international sport of roundnet. This research can be used by clinicians to guide athlete counselling and to optimise roundnet injury prevention.

within three touches loses the point, and games are played until one team reaches 21 points. Roundnet has recently gained popularity with over 4million competitive and recreational players worldwide. People often play the game casually; however, competitive tournaments started in the past decade, and many players train and compete across a 6-month competitive season currently known as the Spikeball Tour Series as well as other emerging leagues and tournaments. The first four levels of play (beginner, intermediate, advanced and contender) are open



**Figure 1** Roundnet athlete using both hands to serve, allowing the server to deceive and ace the serve receiver.

to any athlete, while the fifth level (premier) and sixth (professional) levels of competition are earned through tournament performance during the season. In 2022, the first roundnet world championship was held in Belgium, with over 30 countries competing in men's, women's and mixed (men+women) divisions.

With roundnet becoming more popular and increasingly competitive, serving and hitting velocities may have increased. Many competitive players can serve with both hands (figure 1), while others serve unilaterally (similar to a sidearm baseball pitch) to increase serve velocity. Additionally, diving is very common in roundnet, whether to bump/set the ball or to hit the ball onto the net (figure 2). Diving may lead to acute injuries in many regions of the body in roundnet athletes.



**Figure 2** Roundnet athlete diving to set the ball to his teammate.

While research on roundnet athletes is limited, the relationship between overhead workload and injury has been well established in other athletes such as baseball pitchers and volleyball players.<sup>1-4</sup> Studies have found that pitchers who continue to throw while fatigued were at a 36× increased risk of injury, and similarly, the incidence of non-traumatic shoulder pain in volleyball athletes was significantly associated with the number of years played competitively.<sup>4</sup> These findings describe how the chronic workloads experienced by overhead athletes contribute to injury. While the forces throughout the upper extremity are unclear in roundnet, these athletes experience high acute workloads as tournaments are very long (often >8 hours), and higher-level athletes may train often as well. The 6-month competitive season also suggests notably high chronic workloads in roundnet athletes. Because of this, roundnet athletes may be at risk for both acute and chronic injuries of the axial skeleton, upper extremity and lower extremity.

Despite the potential for both acute and overuse injuries, no study has described injuries in roundnet athletes or how they are clinically managed. Therefore, the primary purpose of this study was to describe injury frequency and characteristics in roundnet athletes and compare injury characteristics between elite and non-elite athletes. The authors hypothesised that elite roundnet athletes would report a higher rate of injuries compared with non-elite roundnet athletes.

## METHODS

### Design

This cross-sectional study was exempt from Institutional Review Board (Thomas Jefferson University study #22E.442) approval due to the minimal risk involved

with anonymous survey completion and the anonymity of survey completion. This study was conducted with the support and help of Spikeball Incorporated (Chicago, Illinois).

### Participants

Participants were recruited through convenience sampling by sharing the survey on various online roundnet groups and profiles such as Facebook, Discord and Instagram, with a message encouraging voluntary participation. To be included in this study, participants had to self-identify as a roundnet athlete and be able to complete online surveys. There were no requirements as to frequency or level of play in order to capture the full range of participant skill levels. Participants were excluded if they did not play roundnet and if they declined to participate, as well as if they did not complete the entirety of the distributed survey.

### Patient and public involvement

Patients and the public were not involved in the design or interpretation of this study.

### Equity, diversity and inclusion statement

Diversity in the patient population was pursued by providing the survey link on social media, instead of providing the survey in-person, in order to increase access to those who cannot afford to travel to attend tournaments. There was equal participant inclusion regardless of participant race, sex or gender. The study team also strove for diverse experience/input by incorporating researchers of various fields such as strength and conditioning, engineering and orthopaedic surgery, as well as a balance of male and female researchers.

### Data collection

A custom REDCap (Vanderbilt University, Nashville, Tennessee) survey evaluating athlete demographics, past sport participation, training workload and roundnet-related injury history was prepared by the first author and edited/approved by the study coauthors, including two premier roundnet athletes and two orthopaedic surgeons (online supplemental appendix figure A1).

The following demographic variables were collected: age, sex, height, weight, sport participation prior to roundnet, current level of roundnet competition (non-elite: beginner, intermediate, advanced and contender; elite: premier and professional), roundnet training workload and self-reported injuries throughout their whole playing career prior to roundnet. Athletes then completed a roundnet-related injury history related to three regions of the body: upper extremity, axial (head/neck/torso) and lower extremity. Athletes were asked how many injuries of each region they have experienced and then were asked to describe each injury, a more specific region of the injury, the mechanism of injury, time missed due to the injury, whether surgery was required and the surgical procedure. Any injuries that were described but did not mention an official diagnosis (eg, pain on the lateral side

of the elbow, as opposed to lateral epicondylitis) were interpreted by a sport medicine orthopaedic surgeon (MEB.), with any indistinguishable injuries described as an unspecified injury of that site. All injuries were also analysed to specify the joint/specific region of the body (hip, knee, ankle, etc) and the mode of onset of the injury based on the reported mechanism of injury. Specific question design can be viewed in the attached self reported survey (online supplemental appendix figure A1).

### Statistical analysis

Injuries across the full study cohort were summarised and reported. Athletes were separated into elite (premier and professional) and non-elite (beginner, intermediate, advanced and contender) for statistical analysis. Demographics and injury outcomes between elite and non-elite were compared using independent t-test and Mann-Whitney test for continuous variables depending on normality and  $\chi^2$  test for categorical variables. Injury characteristics were also compared between upper extremity, axial and lower extremity injuries using analysis of variance for continuous variables and  $\chi^2$  test for categorical variables.  $P < 0.05$  were deemed significant. All statistical analyses were done using R Studio (V.4.1.2, Vienna, Austria).

## RESULTS

### Population

Overall, 166 roundnet athletes participated in the study, including 144 males and 22 females with a mean age of  $22.9 \pm 4.1$  years (table 1). There were 119 (72%) roundnet athletes who played another sport prior to participating in roundnet, with most playing at the high school (58%) and collegiate (30%) levels. On average, roundnet athletes trained 9.1 months per year, 2.9 days per week, for 2.6 hours per training session. 25 athletes were excluded from allocation and subanalysis in elite and non-elite cohorts due to a lack of data regarding their level of competition.

### Injuries

86.1% (n=143) of athletes reported at least one injury throughout their playing career: 62 (37%) athletes reported 1 injury, 46 (28%) reported 2 injuries, 21 (13%) reported 3 injuries, 11 (7%) reported 4 injuries, 0 reported 5 injuries and 3 (2%) athletes reported 6 injuries. There were 279 injuries reported (135 upper extremity, 35 axial and 109 lower extremity) among the 166 included athletes. Lower extremity injuries (75%) were more likely than upper extremity (64%) and axial (54%) injuries to lead to time loss ( $p=0.038$ ) (online supplemental table A2). Mechanism of injury, time until return to play, rates of requiring surgery and time until returning to play from surgery did not differ based on region of injury (all  $p > 0.05$ ).

Roundnet athletes experienced a mean of  $1.7 \pm 1.2$  (range: 0–6) injuries while playing roundnet. Injuries



**Table 1** Demographics and training workload of included roundnet athletes

Variable	Total data* (n=166)	Elite (n=56)	Non-elite (n=85)	P value
Age	22.9 (4.1)	23.0 (3.3)	22.7 (4.3)	0.659
Male sex	144 (86.7%)	52 (92.9%)	73 (85.9%)	0.314
Height (cm)	179 (8.7)	180 (8)	179 (9)	0.504
Weight (kg)	74.8 (11.1)	76.0 (8.8)	75.0 (12.1)	0.611
BMI	23.3 (2.6)	23.4 (1.9)	23.3 (3.1)	0.780
Sport participation prior to roundnet	119 (71.7%)	44 (78.6%)	60 (70.6%)	0.390
Previous overhead athlete	33 (19.9%)			
Previous contact sport	73 (61.9%)			
Level of prior sport participation				0.984
Recreation	4 (3.4%)	2 (4.6%)	2 (3.4%)	
High school	68 (57.6%)	25 (56.8%)	32 (54.2%)	
College	35 (29.7%)	13 (29.5%)	18 (30.5%)	
Pro	11 (9.3%)	4 (9.1%)	7 (11.9%)	
Roundnet level of competition <sup>†</sup>				
Intermediate			6 (3.6%)	
Advanced			25 (15.1%)	
Contender			54 (32.5%)	
Premier		49 (29.5%)		
Professional		7 (4.2%)		
Unspecified	25 (15.1%)			
Years playing competitive roundnet	2.4 (1.7)	3.1 (2.1)	1.9 (1.2)	<0.001
Roundnet training (months per year)	9.1 (3.4)	9.9 (2.8)	8.7 (3.8)	0.025
Roundnet training (days per week)	2.9 (1.3)	3.1 (1.3)	3.0 (1.4)	0.732
Roundnet training (hours per session)	2.6 (0.9)	2.6 (0.8)	2.7 (1.0)	0.646
Surgery prior to roundnet:	21 (12.7%)	9 (16.1%)	11 (12.9%)	0.784
Region of prior surgery:				
Upper extremity	11 (52.4%)			
Torso	1 (4.8%)			
Lower extremity	9 (42.9%)			
Injury prior to roundnet:	53 (31.9%)	22 (39.3%)	28 (32.9%)	0.555
Region of injury prior to roundnet:				
Upper extremity	24 (44.4%)			
Torso	2 (3.7%)			
Lower extremity	28 (51.9%)			

Categorical data are presented as n (%), and continuous data are presented as mean (SD).

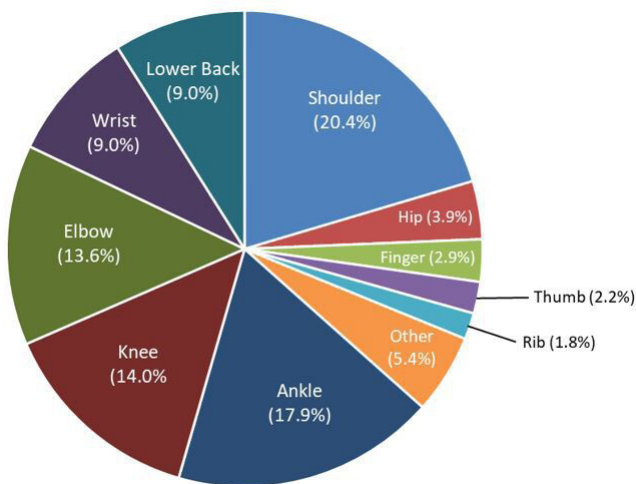
\*Total data include athletes with unspecified level of play in roundnet.

<sup>†</sup>Intermediate, advanced and contender levels of play are open to any athletes and are categorised as non-elite. Premier and professional status must be attained at regulated tournaments and are categorised as elite.

BMI, body mass index.

were most frequently of the shoulder (20%), ankle (18%), knee (14%) and elbow (14%) (figure 3). There were 131 (47.0%) injuries that occurred due to overuse, while 57 (20.4%) injuries occurred acutely from landing after diving and 84 (30.1%) injuries occurred acutely that were not related to diving. All 279 injuries are reported in online supplemental table A1.

Of the 279 injuries, 187 (67.0%) resulted in missed competition time due to the injury. Athletes missed an average of 2.0±2.2 months (range: 0–18 months) of play due to injury. 10 (3.6%) injuries required surgery, causing athletes to miss an average of 7.2±2.7 months (range: 4–12 months) of play (table 2).



**Figure 3** Frequency of injury to each joint/region in roundnet athletes.

### Differences in injury between competition levels

When comparing elite and non-elite roundnet athletes, elite athletes have played roundnet for more years (3.1 vs 1.9 years,  $p < 0.001$ ) and train more months per year (9.9 vs 8.7 months,  $p = 0.025$ ) than non-elite athletes (table 3). No other demographic or training workload differences were observed between groups (all  $p > 0.05$ ). The number of injuries and injury characteristics also did not differ between groups (all  $p > 0.05$ ).

### DISCUSSION

This study found that 86.1% of roundnet athletes experienced an injury throughout their playing careers, with each athlete experiencing more than one injury on average. Injuries in roundnet athletes most frequently involved the shoulder, ankle, knee and elbow, of which 67% result in missed competition time of about 2 months on average. Injuries from roundnet rarely require surgical intervention, and there was no difference in

**Table 3** Comparison of demographics, training workload, injury rates and injury characteristics between elite and non-elite roundnet athletes

Variable*	Elite (n=56)	Non-elite (n=85)	P value
Total injuries per player	1.9 (1.5)	1.6 (1.1)	0.159
Upper extremity injuries per player	0.9 (0.9)	0.7 (0.8)	0.264
Axial injuries per player	0.2 (0.5)	0.2 (0.4)	0.853
Lower extremity injuries per player	0.8 (0.8)	0.6 (0.7)	0.294
Injury characteristics	Elite (n=105)	Non-elite (n=132)	P value
Injury region			0.944
Upper	51 (48.6%)	63 (47.7%)	
Axial	12 (11.4%)	17 (12.9%)	
Lower	42 (40.0%)	52 (39.4%)	
Mechanism			0.916
Overuse	53 (50.5%)	64 (48.5%)	
Acute dive	22 (21.0%)	27 (20.5%)	
Acute other	30 (28.6%)	41 (31.1%)	
Missed time due to injury	67 (63.8%)	93 (70.5%)	0.344
Time until RTP from injury (days)	63 (81)	57 (57)	0.505
Underwent surgery for injury	3 (2.9%)	6 (4.6%)	0.735

Categorical data are presented as n (%), and continuous data are presented as mean (SD).  
 Statistically significant differences are in bold.  
 \*Values represent data for players who responded to participate in elite or non-elite levels of competition. Data from players who did not indicate the level of competition are excluded from this table.  
 RTP, return to play.

**Table 2** Description of 10 roundnet injuries that required surgery

Injury	Months until RTP after surgery
Two anterior shoulder dislocations	6
Posterior shoulder instability	4
Unspecified shoulder labral tear	6
Herniated intervertebral disc at L4-L5	9
Lower intervertebral disc rupture	4
Achilles tendon tear	10
Meniscal tear	6
Two anterior cruciate ligament tears	9, 12
RTP, return to play.	

injury frequency or characteristics between athletes at the elite and non-elite levels of competition in the sport.

The results of this study revealed that the highest percentage of overuse injuries in roundnet players occurred in the upper extremities, similar to other sports that involve throwing or hitting motions. Specifically, studies have reported that between 51% and 58% of baseball injuries affect the upper limb, most commonly in pitchers.<sup>5</sup> While the forces throughout the upper extremity during roundnet serving are unclear, findings from the current study suggest that some overuse injuries of the upper extremity are occurring, such as medial and lateral epicondylitis. Future biomechanical studies analysing upper extremity movements in roundnet will contribute to a better understanding of the stress experienced in the shoulders and elbows of players and the structures at risk of injury.

As the complexity of the roundnet serve is increasing, athletes' cognition of the increased strain on the upper extremity and of the importance of proper warmup is vital.

Studies have also linked repetitive throwing/pitching or swinging motions with increased mechanical motion and stress on the lumbar spine, with forces reaching up to six times the athlete's body weight.<sup>6</sup> Overuse injuries of the back in throwing/hitting sport range from vertebral stress reactions, insufficiency fractures, intervertebral disc degeneration, intervertebral disc herniation, sacroiliac joint pain, discogenic pain or facet joint pain. In roundnet, motion associated with serves, leaning over the net for hits and rapid rotation during play can be associated with similar mechanical stresses and the occurrence of lower back injuries found in this study.

However, differences exist in the injury patterns for acute diving injuries between roundnet and baseball players. Baseball studies have reported the knee and ankle to be most commonly affected due to leg to ground contact resulting primarily in contusions, haematomas, and rotation and pronation/supination of the ankle.<sup>7</sup> However, diving in baseball is often done foot first towards a plate. In roundnet, the mechanism of the dive differs, with players most frequently diving to set the ball and to avoid falling into the no-hit zone while hitting. The difference in diving mechanism may explain why roundnet dives more commonly result in axial and extremity injuries. This unique pattern of dive injuries discovered in this current study warrants further clinical assessment and kinetic analysis into the nature of dive injuries for roundnet athletes as well as preventative and treatment measures.

This study found no significant difference in the frequency or characteristics of injuries experienced at the elite and non-elite levels of competition in roundnet. Although there is no statistical significance, roundnet athletes at the elite level of competition experienced on average more injuries per player (1.9 vs 1.6) and less time missed due to injury (67 vs 93 days). Compared with other professional sport leagues, participation in the Spikeball Tour Series does not involve a salary; however, there is still financial compensation at the elite level of play through competition prizes and self-obtained sponsorships. It is thus possible that elite players return to play sooner than non-elite players since the elite players may feel greater pressure to return to play for monetary reasons as well as a chance to earn professional status. These financial resources may also influence training and competition at this level of sport. Further studies should be performed in association with roundnet athletes to gain insight into how roundnet athletes at the elite level of competition train and compete and to determine whether this may contribute to any differences in injury burden and lost time due to injury.

### Clinical recommendations

Since this is the first study to evaluate injuries in roundnet athletes, strong clinical recommendations cannot yet be made. However, clinicians may benefit from knowing that roundnet athletes can experience both acute and overuse injuries, and some of these injuries can be

serious enough to warrant surgical intervention. The general recommendation would be for clinicians to learn about the injuries experienced by roundnet players and the treatment and injury prevention options available. Clinicians can recommend full-body strengthening programmes, discuss the risks and proper mechanics of diving and promote effective warmups and postperformance stretching to minimise injury risk in roundnet athletes.<sup>6,8</sup>

Further research needs to differentiate whether roundnet players at the elite level of competition need any different or additional programmes to prevent and recover from injury when compared with non-elite levels of competition. Evaluating injuries in new sports is important for identifying common injury mechanisms and counselling patients, and future research should continue evaluating injury in roundnet and other newer sports.

### Limitations

There are several limitations to this study. First, the survey was administered via convenience sampling through social media platforms, which limits the availability of the survey to some roundnet athletes and makes the rate of follow-up unclear. Second, the results are limited based on the questions asked by the survey. Since this is a self-reported survey, we do not have validated medical diagnoses or treatments prescribed for players who experience injury. The definition of injury was determined by the player. The survey also lacks questions about training, competing and rehabilitation protocols which may influence the outcomes of injury frequency, characteristics and missed time due to injury. The survey was designed to avoid survey fatigue and the possibility of non-response bias; however, doing so limits the number of variables assessed in this study. Third, as a self-reported survey, study outcomes are solely based on patient recall and could potentially be affected by recall bias. Lastly, due to the cross-sectional study design, no causality for injury could be determined.

### CONCLUSION

Roundnet athletes experienced a mean of  $1.7 \pm 1.2$  injuries while playing roundnet. Injuries most frequently involved the shoulder and ankle and often resulted in missed competition time. The level of competition does not significantly impact injury frequency or characteristics. Roundnet athletes may benefit from injury prevention programmes that include shoulder strengthening, maintaining shoulder range of motion and ankle stability.

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**Contributors** RWP, SB, MEB and KBF were involved in developing the study purpose, study design and study logistics. RWP was responsible for IRB approval. RWP and RG prepared the study survey, with approval from SB, MEB and KBF. SB administered the study survey to the available population. RP performed data analysis. RP, RG and RM wrote the initial manuscript, and SB, MB and KF reviewed

and approved the final manuscript. The corresponding author KBF is the acting guarantor of this study.

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**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Ethics approval** This study involves human participants, but Thomas Jefferson University Study #22E.442 exempted this study. Participants gave informed consent to participate in the study before taking part.

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**Data availability statement** No data are available.

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