UNIVERSIDADE ESTADUAL DE CAMPINAS

FACULDADE DE EDUCAÇÃO FÍSICA

SHIRKO AHMADI

PHYSICAL AND PSYCHOLOGICAL ASPECTS OF BRAZILIAN SITTING VOLLEYBALL PLAYERS

ASPECTOS FÍSICOS E PSICOLÓGICOS DE JOGADORES BRASILEIROS DE VOLEIBOL SENTADO

CAMPINAS

2019

SHIRKO AHMADI

PHYSICAL AND PSYCHOLOGICAL ASPECTS OF BRAZILIAN SITTING VOLLEYBALL PLAYERS

ASPECTOS FÍSICOS E PSICOLÓGICOS DE JOGADORES BRASILEIROS DE VOLEIBOL SENTADO

Thesis presented to the Physical Education Faculty of the University of Campinas, as part of the requirements for obtaining the title of Doctor in Physical Education, in the area of Adapted Physical Activity.

Tese de doutorado apresentada à Faculdade de Educação Física, da Universidade Estadual de Campinas, como parte dos requisitos exigidos para obtenção do título de Doutor em Educação Física, na Área de Atividade Física Adaptada.

Orientador: GUSTAVO LUIS GUTIERREZ
Coorientador: MARCO CARLOS UCHIDA

ESTE TRABALHO CORRESPONDE À VERSÃO FINAL DA TESE DEFENDIDA PELO ALUNO SHIRKO AHMADI, E ORIENTADA PELO PROF. DR. GUSTAVO LUIS GUTIERREZ

CAMPINAS
2019

Ficha catalográfica
Universidade Estadual de Campinas
Biblioteca da Faculdade de Educação Física
Andréia da Silva Manzato - CRB 8/7292

Ah51p Ahmadi, Shirko, 1985-
Physical and psychological aspects of Brazilian Sitting volleyball players / Shirko Ahmadi. – Campinas, SP : [s.n.], 2019.

Orientador: Gustavo Luis Gutierrez.
Coorientador: Marco Carlos Uchida.
Tese (doutorado) – Universidade Estadual de Campinas, Faculdade de Educação Física.

1. Esporte paralímpico. 2. Atividade física. 3. Composição corporal. 4. Psicologia. 5. Relações de gênero. I. Gutierrez, Gustavo Luis. II. Uchida, Marco Carlos. III. Universidade Estadual de Campinas. Faculdade de Educação Física. IV. Título.

Informações para Biblioteca Digital

Título em outro idioma: Aspectos físicos e psicológicos de jogadores brasileiros de voleibol sentado
Palavras-chave em inglês:
Paralympic sport
Physical fitness
Body composition
Psychology
Gender relations
Área de concentração: Atividade Física Adaptada
Titulação: Doutor em Educação Física
Banca examinadora:
Marco Carlos Uchida [Coorientador]
Mey de Abreu Van Munster
Edison Duarte
Maria Luiza Tanure Alves
Thiago Mattos Frota de Souza
Data de defesa: 26-11-2019
Programa de Pós-Graduação: Educação Física

Identificação e informações acadêmicas do(a) aluno(a)
- ORCID do autor: https://orcid.org/0000-0003-3627-7522
- Currículo Lattes do autor: http://lattes.cnpq.br/6253413740062658

COMISSÃO EXAMINADORA

Prof. Dr. Marco Carlos Uchida
(Presidente)

Prof. Dra. Mey de Abreu Van Munster
(Membro titular)

Prof. Dr. Edison Duarte
(Membro titular)

Profa. Dra. Maria Luiza Tanure Alves
(Membro titular)

Prof. Dr. Thiago Mattos Frota de Souza
(Membro titular)

A Ata da defesa com as respectivas assinaturas dos membros encontra-se no SIGA/Sistema de Fluxo de Dissertação/Tese e na Secretaria do Programa da Unidade.

“THE ART OF KNOWING IS KNOWING WHAT TO IGNORE”

Rumi (Mevlana)
(1207–1273)

DEDICATED TO

my mother and my father for their patient, kindness, and endless support. I have passed many years in abroad without thanking them worthy, but they have never passed even a moment without loving and supporting me continuously. They are the best parents ever.

ACKNOWLEDGEMENTS

Undertaking this PhD has been a truly life-changing experience for me and it would not have been possible to do without the support and guidance that I received from many people.

I would first like to express my sincere gratitude to my advisors, Dr. Gustavo Luis Gutierrez and Dr. Marco Carlos Uchida, for supporting me during these past three years. Without their guidance and constant feedbacks this PhD would not have been achievable. Gutierrez has been supportive and has given me the freedom to pursue various projects without objection. He has also provided insightful discussions about the research. I am also very grateful for his scientific advice and knowledge and many insightful discussions and suggestions. Uchida is someone you will instantly love and never forget once you meet him. He is my primary resource for getting my science questions answered and one of the smartest people I know. I hope that I could be as lively, enthusiastic, and energetic as Uchida and to someday be able to command an audience as well as he can.

I am deeply appreciated my friend Ronaldo Gonçalves de Oliveira (The father of Sitting volleyball in Brazil) for helping and advising me in every stage of this thesis. Also I would like to thank and the Brazilian Sitting volleyball national team players for taking the time to participate in this research.

I am using this opportunity to thank all professors in School of Physical Education, UNICAMP, for their patience, motivation, and immense knowledge.

My honest thanks also go to my colleagues in GEPEFAN, for helping and advising me in every stage of this thesis.

I would like to thank the examination board of my defense meeting for their participation and suggestions that enhanced the quality of thesis.

Last but not the least, I am really grateful my family for supporting me spiritually throughout not only my PhD program, but also my life.

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

RESUMO

O ponto de partida do Voleibol Sentado (VS) foi realizado na Holanda em 1956 e também foi aprovado como jogo paralímpico oficial em 1980. No Brasil, o VS é um esporte novo e foi lançado no final de 2002. Atualmente, o brasileiro masculino e o feminino As equipes VS no Ranking Mundial ParaVolley estão no segundo e terceiro lugares, respectivamente. O VS é uma grande simplicidade que mostra um exemplo real de adaptação e implementação de grandes esportes coletivos. Este trabalho está estruturado com base no formato de três capítulos, bem como nas seções de introdução e conclusão. No primeiro capítulo, "Aspectos do desempenho físico", apresentamos comparações entre agilidade, resistência, potência, velocidade e fatores de força de jogadores masculinos e femininos de elite brasileiros em VS. Houve valores estatisticamente mais altos para males em fatores de agilidade, velocidade, resistência e poder do que jogadores do sexo feminino, mas não houve diferença significativa entre os jogadores no desempenho da preensão manual (força). Além disso, de acordo com o teste do dinamômetro isocinético, os jogadores de VS masculinos e femininos apresentaram força rotacional assimétrica no ombro, preferência pelo lado dominante nos dois grupos. No segundo capítulo, "Antropometria e aspectos da composição corporal", descrevemos a composição corporal de jogadores brasileiros de VS, altamente treinados, masculinos e femininos, e também comparamos os valores obtidos com esses jogadores por Métodos de dobras cutâneas (DC) e pletismografia de deslocamento aéreo (PDA). Não houve diferenças significativas entre os valores médios dos jogadores que mediram por PDA e DC para porcentagem de gordura corporal (% GC) e densidade corporal (DC). A análise de% GC e DC para todos os jogadores comparando PDA a DC melhorou sem viés sistemático significativo. Também foi encontrado um alto grau de confiabilidade entre as medidas PDA e DC de% GC e DC. Houve correlações positivas estatisticamente significantes entre% GC e DC em todos os valores para ambos os métodos. No terceiro capítulo, "Aspectos psicológicos", analisamos os aspectos de qualidade de vida (QV), estilo de vida e humor de jogadores brasileiros de VS masculinos e femininos de elite. Os resultados deste estudo demonstraram que não houve diferenças significativas nos aspectos psicológicos entre jogadores masculinos e femininos. Esses capítulos forneceram uma visão geral dos jogadores brasileiros de elite de VS em aspectos físicos e psicológicos, nos quais foram consideradas diferenças de gênero nessa população em todos os aspectos. Na perspectiva da implicação clínica, a presente pesquisa pode ser vista como um primeiro passo no estabelecimento de uma base de referência sobre aspectos físicos e psicológicos nessa população específica de para-atletas. Além disso, essa base de referência pode ajudar treinadores paraolímpicos, fisioterapeutas e médicos para-desportivos na avaliação de jogadores de VS.

Palavras-chave: esporte paralímpico, aptidão física, composição corporal, psicologia, gênero diferenças

ABSTRACT

Start point of the Sitting volleyball (SV) was in the Netherlands in 1956 and also approved as an official Paralympic game in 1980. In Brazil, SV is a new sport and it was launched at the end of 2002. Nowadays, male's and female's Brazilian SV teams in World ParaVolley Ranking are on the second and third place, respectively. SV is a big simplicity that shows a real example of adaptation and implementation of a major team sports. This work is structured on the basis of three-chapter format, as well as introduction and conclusion sections. In the first chapter, "Physical performance aspects", we presented comparisons among the agility, endurance, power, speed, and strength factors of male and female Brazilian elite SV players. There were statistically significant higher values for males in agility, speed, endurance, and power factors than female players, but there was no significant difference between players in handgrip performance (strength). In addition, according to isokinetic dynamometer test, the male and female SV players had an asymmetrical rotational strength in their shoulder, preference for the dominant side in both groups. In the second chapter, "Anthropometry and body composition aspects", we described the body composition of male and female highly-trained Brazilian SV players and also compared the values obtained of this players by Skinfolds (SF) and Air-displacement plethysmography (ADP) methods. There were no significant differences between the mean values of players which measured by ADP and SF for body fat percentage (BF%) and body density (BD). The analysis of BF% and BD for all players comparing ADP to SF resulted in no significant systematic bias. Also a high degree of reliability was found between ADP and SF measures of BF% and BD. There were statistically significant positive correlations between BF% and BD in all values for both methods. In the third chapter, "Psychological aspects", we analysed the quality of life (QOL), lifestyle, and mood aspects of male and female elite Brazilian SV players. The results of this study demonstrated there were not significant differences in the psychological aspects between the male and female players. These chapters provided an overview of the elite Brazilian SV players in physical, and psychological aspects, in which in all aspects gender differences of this population were considered. In clinical implication perspective, the present research can be seen as a first step in establishing a reference base concerning physical and psychological aspects in this specific para-athlete population. Also, this reference base could help Paralympic coaches, physiotherapists and Para-sports physicians in the evaluation of SV players.

Keywords: Paralympic Sport, Physical Fitness, Body Composition, Psychology, Gender Differences

LIST OF FIGURES

CHAPTER 1

CHAPTER 2

CHAPTER 3

LIST OF TABLES

CHAPTER 1

CHAPTER 2

CHAPTER 3

LIST OF ABBREVIATIONS

Ac	*Activity*
ADP	*Air-Displacement Plethysmography*
AG	*Anger*
Al	*Alcohol*
BD	*Body Density*
BF%	*Body Fat Percentage*
BMI	*Body Mass Index*
BSA	*Bilateral Strength Asymmetry*
Ca	*Career*
CF	*Confusion*
CV	*Coefficient of Variation*
d	*Cohen's Effect Size*
D	*Disabled*
DP	*Depression*
DSL	*Dominant Strongest Limb*
DXA	*Dual Energy X-Ray Absorptiometry*
EF	*Energy Fatigue*
ER	*External Rotation*
ERo	*Emotional Role*
EW	*Emotional Wellbeing*
Fa	*Family*
FT	*Fatigue*
GH	*General Health*
HG	*Handgrip*
IBM	*International Business Machines Corporation*
ICC	*Intraclass Correlation*
In	*Insight*
IR	*Internal Rotation*
MANOVA	*Multivariate Analysis Of Variance*
MAT	*Modified Agility T-Test*
MCS	*Mental Component Summary*
MD	*Minimally Disabled*
η^2	*Partial Eta-Squared*
NDSL	*Non-Dominant Strongest Limb*
Nu	*Nutrition*
P	*Pain*
PCS	*Physical Component Summary*
PF	*Physical Functioning*
POMS	*Profile of Mood State*
PR	*Physical Role*
PT	*Peak Torque*
QOL	*Quality of Life*
r	*Effect Size for The Mann-Whitney U-Test*

SAT	*Speed & Agility Test*
SCI	*Spinal Cord Injury*
SCP	*Seated Chest Pass*
SET	*Speed & Endurance Test*
SF	*Skinfolds*
SFu	*Social Functioning*
SF-36	*Short-Form 36 Items*
Sl	*Sleep*
SV	*Sitting Volleyball*
TMD	*Total Mood Disturbance*
TN	*Tension*
To	*Tobacco*
Tp	*Type of Personality*
VG	*Vigor*
WF	*Work Fatigue*

TABLE OF CONTENTS

INTRODUCTION

Sitting volleyball (SV) was started in the Netherlands in 1956 and approved as an official Paralympic game in 1980. The SV is a big simplicity that shows an original example of adaptation and implementation of a team sport.[1] According to the accessibility, approachability and adaptability of the SV court (lower net, smaller size) allows people without or with physical impairments (e.g. amputations, poliomielitis, cerebral palsy) play together, as they sit down and get on the court, they are all in the same position, regardless to age, gender or (dis)ability.[2] The athletes who play SV are disabled in their lower limbs and it is very important for them to have a good upper limb physical performance.[3] The SV is a popular Paralympic team sport with quick movements which require power, agility, stamina and physical fitness factors.[4] SV demands moving on the sport court by using upper limbs and fast reactions in order to stay in position early enough to play effectively.

SV, which is consisted of quick moves and stimuli-responsive reactions, has a dynamic character, and it is evaluated that the physical fitness of an athlete will be a major factor for success.[5] SV is a very fast and unpredictable game. Using simple performance tests is significant for experts and coaches because it shows the physical fitness level of players and is simultaneously applicable on the floor. According to literature review survey, few studies in the field of performance tests in SV have been conducted.[6] The SV is considered as an overhead sport, in which the players' shoulder is extremely loaded during the displacement, practice and competition, particularly in elite players.[7,8] Moreover, on a glenohumeral level, optimum muscle strength is essential for performance and injury prevention.[9] Taking the SV injuries into consideration, repetitive motions are the most common reasons of diversities of shoulder injuries, which are linked to the weakness and imbalance of shoulder muscles.[10]

However, among the fitness factors for evaluation physical performance of para-athletes, body composition is a fundamental component of physical fitness related to athletic performance.[11] There are many methods for measuring body composition, laboratory methods, such as air-displacement plethysmography (ADP), and dual-energy x-ray absorptiometry (DXA) methods or field methods, such as the anthropometric method, which uses the sum of the skinfolds (SF) to measure body density (BD).[12,13]

In addition, participation in the SV brings merits to the physical, psychological and social health to people with impairments.[4,7,14-16] However, many of sport psychologists have examined the psychology of elite athletes since the late 1970s,[17] they have begun to conduct sport psychology research on athletes with physical impairments in the last two decades. The participation of people with impairments in sport activities can improve their quality of life (QOL), especially in social domains.[18] Also people with spinal cord injury found that, participating in physical activities is an important factor to improve QOL of this population.[16] For most of the elite SV players, sport activities are a lifelong orientation and remains significant even after retirement from the national team.[19] The sporting lifestyle has its roots in early childhood, where parents, friends, teachers and later coaches create and direct it. Today it is a synonym for a healthy and sensible way of live.[19,20] The growth of SV in the recent years has led to improved competitiveness among the para-athletes and search for satisfying results. Several factors or feelings that make up the sports scene can support or prevent the player's performance, such as, mood[21] or depression.[22] In general, athletes tend to have more positive mood states than non-athletes or athletes which participating at lower levels of competition. Sport psychologists have suggested that participation in sports for people with impairments might be associated with positive moods states.[23]

In SV both genders of different ages can play together, except in the high levels and formal competitions.[24] However, gender is an important physiological and sociological concept for researchers who wish to contribute to an understanding of disability sports.[25] It is widely known that different structural and functional features exist between men and women, such as power, muscle strength, and endurance. It has been shown that men are able to have a better physical performance than women, and are better in upper limb than lower limb tasks.[26,27] Another study showed that men depended more on initializing movement and reaction speed, while women seemed to use strategies which depended more on precision;[28] Also Saucier et al.,[29] found that women were better than men at perceptual-cognitive skills like object location memory. Very few studies have focused particularly on gender differences in Paralympic sport contexts, although, needless to mention, the importance of this concept has been more recognized in the recent years.

Similar to Olympic competition, coaches are frequently looking for the best training methods in Paralympic sports.[30] Experts and coaches must be able to recognize fundamental elements of elite sport in order to recruit optimally and train future athletes. SV coaches need to take players' physical and psychological levels to a specific range when looking to develop the athlete's tactics and game management.

This thesis is structured based on three chapters. The first chapter refers to the "Physical functional aspects in elite SV players". In this chapter, we investigated the agility, endurance, power, speed, and strength profile of male and female high-trained Brazilian SV players. As the SV players use their upper limbs to move and slide across the playing court, their shoulders are overloaded continuously during play, and also muscular imbalance is a common injury pattern among overhead players, this chapter was done to find out them. Thus, comparisons between male and female SV players regarding physical performance aspects were presented; which included agility, speed, endurance, power, and strength factors of Brazilians national team SV players (n= Thirteen; 6 males and 7 females). The research was approved by the Ethics Committee of the University of Campinas (UNICAMP) (Appendix 1).

The second chapter evaluated the "Anthropometry and body composition aspects in elite SV players". In this chapter, we analysed the body composition of highly-trained SV players by SF and ADP methods (n= Thirteen; 5 males and 8 females). The research was approved by the Ethics Committee of the University of Campinas (UNICAMP) (Appendix 1).

The last chapter analysed the "Psychological aspects in elite SV players". In this chapter, we investigated the quality of life, lifestyle, and mood states of male and female high-trained Brazilian SV players. As psychological researches on elite SV players and gender differences are extremely rare, this chapter was done to find out them. Thus, comparisons between male and female SV players regarding quality of life, lifestyle, and mood aspects were presented (n= Fourteen; 6 males and 8 females). The research was approved by the Ethics Committee of the University of Campinas (UNICAMP) (Appendix 1).

CHAPTER 1

PHYSICAL PERFORMANCE ASPECTS

AGILITY, ENDURANCE, POWER, SPEED, AND STRENGTH IN ELITE SITTING VOLLEYBALL PLAYERS

Abstract

Sitting volleyball (SV) is a popular Paralympic team sport, in which players use their upper limbs to move and slide across the playing court. The shoulders of SV players are overloaded continuously during play. The objective of this chapter was to investigate the agility, endurance, power, speed, and strength profile of male and female elite SV players. Thirteen Brazilian SV national team players, (six males, age= 32.8±4.1 years, body mass= 83.2±19.4 kg, seated height= 1.47±0.04 m; seven females, age= 31.5±9.2 years, body mass= 80.1±17.9 kg, seated height= 1.36±0.05 m) with similar time and volume of training, participated in this study. As a physical performance evaluation, five test trials were conducted for each player which included (1) modified agility t-test (MAT), (2) speed & agility test (SAT), (3) speed & endurance test (SET), (4) seated chest pass (SCP) and (5) handgrip (HG). In addition, a Biodex dynamometer was used to measure internal rotation (IR) and external rotation (ER) of the glenohumeral muscle strength at 60°/s and 180°/s velocities in a concentric/concentric mode. There were statistically significant differences, between the men and women of the Brazilian SV players with higher values for men in MAT (27 %, P= 0.001), SAT (22 %, P= 0.008), SET (23 %, P= 0.008) and SCP (19 %, P= 0.03) scores. Also, it was observed that male SV players were stronger than the female players at both upper limbs. Concerning the side effects, significant differences were found for IR at 60°/s velocity (F= 7.55, p= 0.02) and ER at 180°/s velocity (F= 5.91, p= 0.03), with higher values on the dominant limb in comparison to the non-dominant limb for both the male and female players. There were significant gender differences for the IR inter-limb asymmetry at 180°/s velocity, with a greater asymmetry between both shoulders in the male players compared to the female players, preference for the dominant side in both groups. Results showed that male players had higher scores in the five performance tests, but according to the effect size calculations there was no significant difference between male players and female players in HG performance. The SV players have an asymmetrical rotational strength profile. As muscular imbalance is a common injury pattern among overhead players. The findings of this chapter may assist the SV coaches and physiotherapists for evaluation and training of strength of the ER and IR shoulders of these players.

Keywords: Paralympic Sport, Fitness Test, isokinetic shoulder strength, Gender Differences.

INTRODUCTION

The athletes who play sitting volleyball (SV) are disabled in their lower limbs and it is very important for them to have a good upper limb physical performance.[1] The SV is a popular Paralympic team sport with quick movements which require power, agility, stamina and physical fitness factors.[2] SV demands moving on the sport court by using upper limbs and fast reactions in order to stay in position early enough to play effectively. SV, which is consisted of quick moves and stimuli-responsive reactions, has a dynamic character, and it is evaluated that the physical fitness of an athlete will be a major factor for success.[3] SV is a very fast and unpredictable game. Using simple performance tests is significant for experts and coaches because it shows the physical fitness level of players and is simultaneously applicable on the floor. According to literature review survey, few studies in the field of performance tests in SV have been conducted.[4] The SV is considered as an overhead sport, in which the players' shoulder is extremely loaded during the displacement, practice and competition, particularly in elite players.[5,6] Moreover, on a glenohumeral level, optimum muscle strength is essential for performance and injury prevention.[7] Taking the SV injuries into consideration, repetitive motions are the most common reasons of diversities of shoulder injuries, which are linked to the weakness and imbalance of shoulder muscles.[8]

In SV both genders of different ages can play together, except in the high levels and formal competitions.[9] However, gender is an important physiological and sociological concept for researchers who wish to contribute to an understanding of disability sports.[10] It is widely known that different structural and functional features exist between men and women, such as power, muscle strength, and endurance. It has been shown that men are able to have a better physical performance than women, and are better in upper limb than lower limb tasks.[11,12] Another study showed that men depended more on initializing movement and reaction speed, while women seemed to use strategies which depended more on precision;[13] Also Saucier et al.,[14] found that women were better than men at perceptual-cognitive skills like object location memory. Very few studies have focused particularly on gender differences in Paralympic sport contexts, although, needless to mention, the importance of this concept has been more recognized in the recent years. On the other side, SV players are at a significant mechanical disadvantage compared to the wheelchair athletes.[6] For instance, the arms movement in propelling a wheelchair forward is opposite of that of the SV player's arm movements, except for the backward movement. The internal and external rotations in shoulders of SV players during playing (serve, spike, or block),[4] and moving (forward, backward, or sideward), are the most overused muscles. To the best of our knowledge, there is not any published study about shoulder movements of SV players, but it could be assumed that the upper limbs muscles would be the muscles to control the impact of locomotion and playing the game.

Similar to Olympic competition, coaches are frequently looking for the best training methods in Paralympic sports.[15] Experts and coaches must be able to recognize fundamental elements of elite sport in order to recruit optimally and train future athletes. One of the methods of identifying fundamental elements is examining differences in performance tests (e.g., fitness, skill) among athletes.[16] Strength and physical ability are commonly required for sports, particularly Paralympic sports, such as SV.[17] SV coaches need to take players' fitness levels to a specific range when looking to develop the athlete's tactics and game management. Nowadays, available physical performance tests (non-laboratory and laboratory tests) could be used to evaluate the fitness levels of SV athletes, but there have been few researches in the field of fitness factors that affect SV skills. It would be useful for SV coaches to assess the sport performance of players by using a field test which would evaluate the fitness levels of SV players. Additionally, one way of characterizing shoulder performance for SV players, is via muscle strength test on a glenohumeral level. Isokinetic dynamometry is the gold standard in strength measurement. It also is a reliable and valid instrument for the measurement of human joint function.[18-22] For elite athlete population, isokinetic testing is typically conducted in an injury prevention screening service, or within the preparation of the athlete to return back to sports after injury.[23-25]

To our best knowledge, the present study is the first research in SV which clearly compares men and women in terms of physical performance. Additionally, men's and women's Brazilian sitting volleyball teams are in the second and third place of World ParaVolley Ranking, respectively.[26] Up to the present, normal values for shoulder muscles strength have not been described in SV, notably absent in elite players. Therefore, the aim of this chapter was to present the profile of physical performance tests and compare them between men and women, of Brazilian national team of sitting volleyball players. In addition, describing the right and left-sided strength profile of elite SV players on a glenohumeral level through isokinetic muscle performance, and also compare it among the male and female players.

METHODS

Participants

The study sample consisted of thirteen highest-level elite SV players (male: n= 6, and female: n= 7), at the time all being part of the national Brazilian SV team. All participants were right handed. At the time of conducting the present study, participants were in the middle of a league competition, and their weekly volume (hours) of training per week were 10.3±0.8 and 10.8±1 hours for female and male players, respectively. A former history of shoulder injuries was not applied as exclusion criteria. All of the players were without any injuries at the moment of testing. There was an immediate exclusion, if the participants experienced any shoulder complaints in the past 6 months such as shoulder dislocation, rotator cuff tear, shoulder surgery, and shoulder rehabilitation, or other upper limb form of impairment. All participants completed a demographic questionnaire and prior to their participation read and signed an informed consent. The current research study was approved by the Brazilian Platform Research Ethics Committee of University of Campinas (2.623.954). The characteristics of the participants are summarized in Table 1.

Table 1. Characteristics of the participants

Variable	Male (n= 6)	Female (n= 7)
	Mean ± SD or n(%)	Mean ± SD or n(%)
Age (years)	32.8 ± 4.1	31.5 ± 9.2
Body mass (kg)	83.2 ± 19.4	80.1 ± 17.9
Seat height (m)	1.47 ± .04	1.36 ± .05⁑
SV experience (years)	12.3 ± 4.5	7.1 ± 2.6*
Weekly practice (hours)	10.3 ± .8	10.8 ± 1
Classification (D - MD)	D 5(83.4%)-MD 1(16.6%)	D 5(71.5%)–MD 2(28.5%)

* p < .05 for male vs. female; ⁑ p < .01 for male vs. female.

D: players with disability; MD: players with minimal disability [Only people with physical impairment (e.g. amputations, poliomielitis, cerebral palsy) or with minimal impairments can play SV at a Paralympic level. The SV athletes are divided into two classes: D– people with impairment and MD– people with minimal impairments. International rules allow one athlete with MD on each team to play on the court. This division of players is based on a medical classification system, which is supervised by the World ParaVolley and the International Paralympic Committee].[27]

Procedures

All participants were informed about the tests procedure and they completed a demographic questionnaire prior to the tests. All players were familiarized with tests' protocols and had undergone tests at least once prior to the study. The tests were completed within time difference of a week and different locations (Five test trials in the SESI sports complex, Suzano, SP; and isokinetic tests in the FEF-UNICAMP, Campinas, SP). Then five test trials were conducted in two interspersed sessions for each player. Modified agility t-test (MAT), speed & agility test (SAT), speed & endurance test (SET), seated chest pass (SCP), handgrip (HG), and isokinetic tests were conducted as randomized balance trials among the 13 players. Participants performed tests one by one and were instructed to apply maximal attempt and were verbally encouraged during the test. Players wore the same sport clothes for all their test trials. They had warm-up which was followed by 5 min of self-stretching specifically in upper limb muscles.

Handgrip (HG) Test

The HG test measured the maximal strength in kilograms. Before starting the test, the examiner indicated how to hold a dynamometer. During the evaluation, subjects were requested to grip the handle and generate maximum handgrip strength until a vocal stop sign. Applicants were asked to grip the dynamometer with their dominant hand. A standardized direction was given to all subjects: a clear order to "squeeze the HG as hard as possible for the count of 3 seconds".[28] Participants performed two attempts only and a rest time from 2 to 5 seconds was given for recording the maximal HG strength between them.[2,29]

Seated Chest Pass (SCP) Test

Upper-body power has been quantified using SCP test, it measures power of upper body, especially pectoral major and deltoids muscles which has restricted movements in horizontal adduction of shoulder joints while extension of elbows is performed, as in a chest pass test or push-up exercise. SCP is a field fitness test of anaerobic performance in sitting volleyball which could be the most suitable performance test for coaches to use.[2,4,30] The athletes were seated on the floor with extended legs, feet 60 cm apart and the back against a wall. The medicine ball (4 kg men and 2 kg women),[31,32] was held with both hands on the side and a little behind centre and back against chest. Forearms were located parallel to the floor. Participants threw the medicine ball powerfully as far straight forward as they could while their back was maintained against the wall. Participants were allowed two attempts only and the thrown distance was recorded (figure 1).[33]

Figure 1. Seated Chest Pass (SCP) Test

Modified Agility T-Test (MAT)

The MAT was developed from the standard t-test and was performed using the same instructions protocol of the t-test, excluding entire space covered and measures of inter-cone distance were modified. Number of directional changes are maintained the same. Participants covered a whole distance of 20 m on MAT instead of 36.56 m on the t-test.[34,35] Participants were firstly instructed through the course by the test administrator, who emphasized the importance of performing a shuffling movement using hands for movement as a real game movement in sitting volleyball court. The MAT was used to determine agility with directional shifts such as forward movement, left and right locomotion, and backpedalling. Based on the protocol defined by Sassi et al.,[34] participants began seated behind the starting line cone A. After examiner's vocal start sign, each subject moved forward to cone B and touched it with the right hand. They moved to cone C in the left and touched it with the left hand. Participants then moved to cone D in the right and touched it with the right hand. They moved back to cone B in the left and touched it. Finally, subjects moved backward as quickly as possible and returned to line A. The recorded score for MAT test is the best time recorded of the two trials (Figure 2).

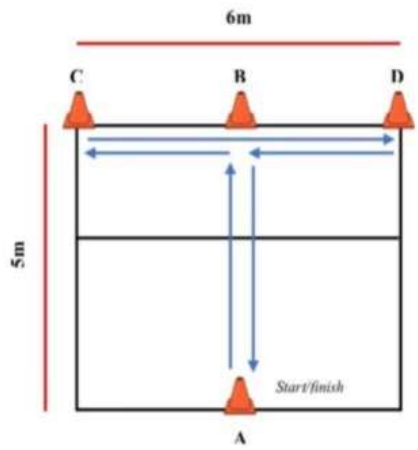


Figure 2. Modified Agility T-Test (MAT)

Speed & Agility Test

This test was used to determine agility and speed fitness factors of sitting volleyball players with directional shifts such as forward movement, left and right locomotion based on the protocol defined by Marszalek et al.[4]. Subjects began seated behind the starting line cone A. After examiner's vocal start sign, each subject moved forward to cone B and touched it then shuffled to the right to cone C and touched it and then returned to cone A again. They moved forward from cone A to cone D and then revolved to cone B and touched it. Then, they shuffled to the right to cone E and touched it too. Finally, participants moved forward as quickly as possible and returned to cone A and passed the line. The recorded score for SAT test is the best time of the two trials (Figure 3).[2,4]

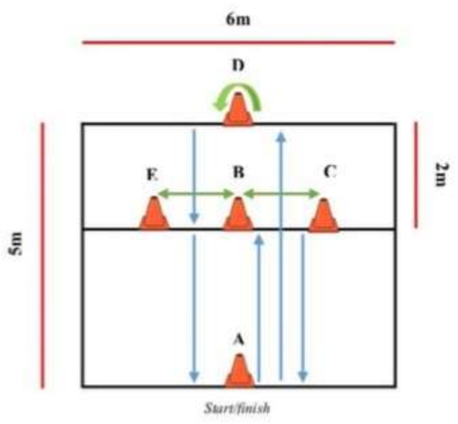


Figure 3. Speed & Agility Test

Speed & Endurance Test (SET)

The SET test was used to determine endurance and speed factors of players based on the protocol defined by Marszalek et al.[4]. Subjects began seated behind the starting line cone A. After the examiner's start sign, each participant shuffled as quickly as possible back and forth to cones B, C, D, E, F and G respectively, from cone A. Participants had to touch the base of all cones during the test. The recorded score for SET test is the best time of the two trials (Figure 4).[2,4]

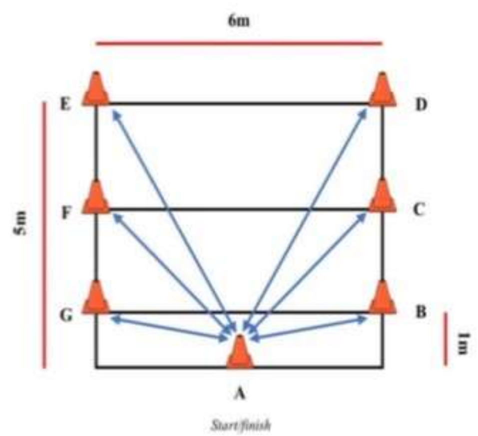


Figure 4. Speed & Endurance Test (SET)

Isokinetic Testing

All isokinetic tests were performed using a Biodex System 4 Pro isokinetic dynamometer (Biodex Medical Systems, Inc., Shirley, New York, USA). The shoulder internal rotation (IR) and external rotation (ER) movements were tested. The internal-external rotation test was firstly performed on the dominant side and followed by the non-dominant side. All movements were performed in the concentric-concentric mode. Based on the protocol defined by Cools et al.,[36] participants performed the testing procedure for the IR and ER movements. The participants were placed in a seated position with a modified neutral position of the arm. The arm rested in 90° of elbow flexion on the rotation cuff pad; the olecranon was also aligned with the rotational axis of the dynamometer. The participants asked to hold the input shaft by hand while the forearm and wrist were positioned neutrally. The chair was rotated 90° relative to the dynamometer and the height of the dynamometer was set on the lowest point. The participants' trunk was stabilized by placing a belt from the contralateral shoulder across the chest and fixed with a buckle. The participants were clearly instructed to grasp the handgrip on the side of the chair by the contralateral hand as well. They had to perform movements of IR and ER, beginning in an internally rotated position. Ninety degrees of range of motion was established prior to the start of the measurement (figure 5). The participants performed the strength isokinetic test in a concentric/concentric mode after 5 minutes warm up with an ergometer, which involved 5 repetitions at an angular velocity of 60°/s and 10 repetitions at an angular velocity of 180°/s (table 2). All participants received standardized verbal encouragement during the test. They were asked to perform an attempt with 5 repetitions before starting each actual test. The two attempts were fulfilled in submaximal contractions (enough effort to clearly feel the resistance) in the same circumstances as the two real tests. These two trials purposed to familiarize the participants with the test movements, and to prepare them for the real maximal test.

Figure 5. Isokinetic testing of the internal and external rotator muscles of the shoulder is performed with the SV players seated and the trunk, waist, and arm stabilized. The testing is done in the 90°/90° position: 90° of shoulder abduction and 90° of elbow flexion.

Table 2. Test protocol

Velocity (°/s)	Mode	Submaximal (repetition)	Test (repetition)	Rest time (second)
60	Concentric	5	5	120
180	Concentric	5	10	120

Peak torque (PT) and agonist/antagonist ratio values determined in both of testing velocities by the Biodex software. Additionally, work fatigue (WF) ratio that is a difference between the work executed in the first third and the ultimate third of the test was measured just in 180°/s velocity. The agonist/antagonist ratio was obtained with the ER movement as the agonist and the IR movement as the antagonist values. A positive WF index value means a decline in work between the first and the last third of the test as a negative WF index value would show an incline in work. Besides, the coefficient of variation (CV) was mentioned for each performed test. The CV measures the variability of a series of numbers independently of the unit of measurement used for these numbers during testing,[37] which makes available a percentage indication of typical error between trials and thus assesses consistency between trials.[38]

The CV value is normally used as a guideline to help measure whether the test was performed with maximal effort or not, as hypothesized, the isokinetic strength tests identical performances can only be reproduced by maximal effort.[39] The less CV percentage, means lower variability between trials and therefore a higher consistency between trials. Accordingly, maximal efforts during testing would lead to a low CV percentage and submaximal efforts would show a high CV percentage.[40] Value of the CV $\leq 10\%$ is generally denoted as a representation reliability of a maximal isokinetic strength test.[38,41,42] The calculation of the CV is shown in Equation 1:

$$CV = \left(\frac{SD}{M}\right) \times 100 \qquad (1)$$

Additionally, inter-limb asymmetries were calculated for both groups, movements, velocities and side separately. Therefore, based on Bishop et al.[43] protocol, the Bilateral Strength Asymmetry (BSA) equation was used. Also inter-limb asymmetry direction was measured for each participant separately. As a result, a percentage could be represented for ER and IR movements at both velocities, for each group, illustrating which side the calculated asymmetry favored. BSA is shown in Equation 2:

$$\text{BSA} = \frac{(stronger\ limb - weaker\ limb)}{stronger\ limb} \times 100 \qquad (2)$$

Statistical analysis

All statistical analyses were performed with IBM SPSS Statistics version 23.0. The normality of distribution was assessed by the Shapiro–Wilk test, which the results indicated a normality distribution.[44,45] Descriptive statistical analysis used to determine group differences between the male and female players. A student t-test was used to examine mean performance test differences between male and female players. Cohen’s effect size (d) was calculated for each mean comparison to test the strength of difference between the two groups. A repeated two-way ANOVA with a Bonferroni post hoc test were used for statistical analyzing of the strength results. The within-subjects factor was side (two levels: dominant side and non-dominant side) and the between-subjects factor was group (two levels: male players and female players). Main group (sex) and side (dominance) effects, further interaction effects of group and side, were of interest. To analyze the inter-limb asymmetry data of the variables, independent samples t-tests were performed. Quantifying differences between the players in performed tests and its magnitude can be objectively reported using effect size. Therefore, Partial eta-squared was used to determine it. The α level was set on 0.05 for all analyses.

RESULTS

Descriptive statistics and effect sizes for the five test trials are reported in Table 3. There are statistically significant differences (P<0.05) between Brazilian male and female sitting volleyball players in MAT (t (12)= -4.21, P= 0.001), SAT (t (9)= -3.32, P= 0.008), SET (t (8)= -3.48, P= 0.008) and SCP (t (13)= 2.32, P= 0.03) scores. Results showed that men had higher scores in all the performance tests, but no statistical difference exists between males and females in HG scores (t (13)= 2.08, P= 0.58). Effect sizes were totally large among all of the performance tests.

Table 3. Performance test differences between the female and male SV players

Tests	Male (n= 6)	Female (n= 7)	T	df	P	D
	Mean ± SD	**Mean ± SD**				
MAT (s)	10.13±1.03	12.95±1.53	-4.21	12.26	0.001*	-2.16
SAT (s)	10.03±0.68	12.25±1.74	-3.32	9.33	0.008*	-1.68
SET (s)	24.84±1.06	30.57±4.5	-3.48	7.88	0.008*	-1.75
SCP (m)	5.37±0.57	4.51±0.8	2.32	13	0.03*	1.23
HG (kg)	54.29±16.15	40±10.15	2.08	13	0.058	1.05

* p < 0.05.

Abbreviations: MAT- Modified Agility T-test, SAT- Speed & Agility Test, SET- Speed & Endurance Test, SCP- Seated Chest Pass Test, HG- Handgrip.

Descriptive data for comparing glenohumeral strength between male and female SV players are reported in table 4. At low velocity movements (60°/s), PT and agonist/antagonist (ER/IR) ratios are presented. At high velocity movements (180°/s) in addition to the aforementioned variables, also work fatigue (WF) is added. Furthermore, inter-limb asymmetry (%) and CV (%) are reported in separate columns. A summary of the statistical analysis results of mean differences with 95% confidence interval (CI) for group and side, p-values and effect size (partial Eta squared) were presented in table 5. An overview of the direction (preference the dominant or non-dominant side) of the calculated inter-limb asymmetries is represented in table 6.

Table 4. Isokinetic external (ER) and internal rotation (IR) strength (Mean ± SD)

Movement and test velocity	Variable	Dominant		Non-dominant		Inter-limb asymmetry (%)
		Mean ± SD	CV (%)	Mean ± SD	CV (%)	
Male (n = 6)						
ER 60°/s	PT (N.m)	51.8±11.4*	22.1	45.1±3*	6.7	14±11.3
IR 60°/s	PT (N.m)	69.7±14.2*†	20.4	58.7±6.8*†	11.6	16.1±10.6
ER/IR 60°/s	Ratio (%)	74.9±13.5		77.8±11.6		
ER 180°/s	PT (N.m)	47.9±8.4*†	17.4	41.3±3.3*†	8	12.5±10
	WF (%)	9.2±8.9†		17.7±6.4†		
IR 180°/s	PT (N.m)	69.8±10.3*	14.7	63.5±4.7*	7.4	12.7±9.3⁋
	WF (%)	14.8±8.3		17.7±23.6		
ER/IR 180°/s	Ratio (%)	69±10.3		65.1±4.5		
Female (n = 7)						
ER 60°/s	PT (N.m)	34.8±7.9*	22.6	32.6±4.5*	13.8	16.7±9.2
IR 60°/s	PT (N.m)	45±7.6*†	16.7	42.4±7.7*†	18.2	10.5±6.9
ER/IR 60°/s	Ratio (%)	77.8±16.2		78.1±10.8		
ER 180°/s	PT (N.m)	32.7±7.8*†	23.9	30.8±3.7*†	11.9	16±7.7
	WF (%)	9.5± 11.9†		13.7±10†		
IR 180°/s	PT (N.m)	45.1±8*	17.6	44.5±5.6*	12.6	5.2±3.7⁋
	WF (%)	16.1±15.9		21.1±16.8		
ER/IR 180°/s	Ratio (%)	72.9±14.3		69.6±7.6		

* $p<0.05$ for group effects.

† $p<0.05$ for side effects.

⁋ $p<0.05$ for inter-limb group differences.

Abbreviations: ER- external rotation, IR- internal rotation, PT- peak torque, WF- work fatigue.

The general linear model 2-way ANOVA with repeated-measures design revealed no significant group × side interaction effects for ER and IR measurements. In spite of this, significant main group effects and significant main side effects were revealed. Regarding PT, male players were stronger than the female players in movements and velocities at both sides. With regard to the side effects, significant differences were found for IR at low velocity (60°/s) (F= 7.546, p= 0.019) and ER at high velocity (180°/s) (F= 5.914, p= 0.033), with higher values of PT on the dominant side in comparison to the non-dominant one for both the male and the female players. In addition, a significant difference was found for WF in ER movement (F= 6.638, p= 0.026), with higher values on the non-dominant side in comparison to the dominant one for both the male and the female players.

The mean value of the CV for ER and IR was 13.6% and 13.5% for the male players and 18.1% and 16.3% for the female players, respectively. The independent samples t-test showed significant group differences for the IR inter-limb asymmetry at high velocity (180°/s), with a greater asymmetry between both shoulders in the male players (M= 12.7, SD= 9.3) compared to the female (M= 5.2, SD= 3.7) players, preference for dominant side in both groups (t= 1.97, P= 0.02).

Table 5. Model summary for glenohumeral muscle strength results

Movement and test velocity	Variable	Parameter	Mean difference (95% CI)	P	Partial η^2
ER 60°/s	PT (N.m)	Group	14.8* (7.4 ; 22.2)	0.001	0.637
		Side	4.8 (-.8 ; 9.6)	0.088	0.242
IR 60°/s	PT (N.m)	Group	20.5* (10.3 ; 30.6)	0.001	0.642
		Side	6.8* (1.4 ; 12.2)	0.019	0.407
ER/IR 60°/s	Ratio (%)	Group	-1.6 (-14.6 ; 11.4)	0.791	0.007
		Side	-1.6 (-11.3 ; 8)	0.716	0.012
ER 180°/s	PT (N.m)	Group	12.9* (6.3 ; 19.4)	0.001	0.628
		Side	4.3* (.4 ; 8.2)	0.033	0.349
	WF (%)	Group	1.8 (-8.6 ; 12.3)	0.705	0.014
		Side	-6.4* (-11.9 ; -.9)	0.026	0.376
IR 180°/s	PT (N.m)	Group	21.9* (14.2 ; 29.5)	0.000	0.783
		Side	3.5 (-1.5 ; 8.4)	0.151	0.178
	WF (%)	Group	-2.4 (-13.7 ; 8.9)	0.652	0.019
		Side	-3.92 (-21.4 ; 13.6)	0.631	0.022
ER/IR 180°/s	Ratio (%)	Group	-4.17 (-14.6 ; 6.2)	0.396	0.066
		Side	3.62 (-2.9; 10.1)	0.244	0.121

* p<0.05 for group effects.

Abbreviations: ER- external rotation, IR- internal rotation, PT- peak torque, WF- work fatigue.

Table 6. Direction of inter-limb asymmetry (inter-limb asymmetry (mean ± SD); direction of asymmetry (%))

Movement and test velocity	Male (n = 6)			Female (n = 7)		
	Inter-limb asymmetry (%)	DSL	NDSL	Inter-limb asymmetry (%)	DSL	NDSL
ER 60°/s	14.0±11.26	66.7	33.3	16.67±9.19	71.4	28.6
IR 60°/s	16.05±10.59	83.3	16.7	10.5±6.92	85.7	14.3
ER 180°/s	12.45±10.2	100	0	16.2±7.69	71.4	28.6
IR 180°/s	12.68±9.26	50	50	5.17±3.73	57.1	42.9

Abbreviations: ER- external rotation, IR- internal rotation, DSL- dominant strongest limb, NDSL- non-dominant strongest limb.

DISCUSSION

The aim of this chapter was to evaluate the field physical performance and a descriptive profile of glenohumeral muscle strength in elite SV male players compared to same level SV female players. In order to perform SV skills in the best way, a high level of physical fitness is required.[4,6,46,47] MAT [s], SAT [s], SET [s], SCP [m] and HG [kg] tests supported that these selected field tests could be a useful way for coaches to measure anaerobic performance among SV players in a field fitness test.[4] The results of this study confirmed that the male players showed higher scores in all the performance tests than female players. The effect sizes demonstrated between Brazilian male and female SV national team players emphasized the differences of the performance tests. In addition, asymmetrical findings were established in the shoulders' rotational strength of the SV para-athletes, for both rotation movements but in different velocities.

These results were in agreement with the study's hypothesis that generally men tend to have more lean body mass in comparison with women.[48] According to the findings of Tikuisis et al.[11] and Cote[12] men have better physical performance than women, specifically in upper limb tasks, and it was in agreement with the results of the present study. While skill training often contains a substantial amount of practice time for team sports, training programs for SV players, must include enough fitness factors. This topic is underlined by the more distinctions among groups on more skill-based performance factors, namely agility. De Witte et al.[49] found that in wheelchair basketball, there were significant differences among male and female athletes on the whole performance time. Male players did perform all activities faster than females. Sassi et al.,[34] in a similar study on SV players found significant differences between female and male players for MAT test. Additionally, there was a weak relationship between MAT and strength which also suggested that agility requires other determinants of performance such as coordination. Similar results in the present study showed that the greatest and smallest effect sizes were realized on MAT and HG, between male and female players respectively. Also, Kimura et al.[50] in a study found less HG statistical difference between males and females compared to the agility of them. The effect size of SET and SAT tests scores were approximately close together and more than HG test scores. Other studies, like the current study stated that males had significantly higher power results in all performance tests. There were huge effect sizes in SCP test between male and female participants.[51,52]

Males have greater muscle strength than females,[53] which the assumption is based on more differences in upper limbs strength and trunk resistance.[54] Montoye and Lamphiear,[55] investigated physical abilities between males and females, and reported huge gender differences in the HG strengths in them. In another study, males had more HG strength than females in both hands;[56] in HG strength in both hands by gender, males showed more HG strength than females and the dominant hand was stronger than the non-dominant hand in both genders.[56,57] In this study we found that males had greater HG score than females. On the other hand, there was no statistical difference between male and female players in HG test scores. These results are in line with previous studies that found exactly the same result at HG test.[58,59] Effect sizes were totally huge among all of the performance tests.

Considering PT, the male players were significantly stronger than the female players in ER and IR in both velocities and also both sides. According to the Ahmadi et al.,[5] these results were excepted, as they found that the male SV players are stronger than the female SV players in the strength field tests. At low velocity, the dominant shoulder had significantly stronger IR than the non-dominant shoulder. Also, at high velocity, ER of the dominant shoulder was significantly stronger than the non-dominant side, for the both groups. These results illustrated muscle strength asymmetry in the glenohumeral of SV players, with the dominant upper extremity tending to produce greater values for PT compared to the non-dominant side. These findings were in agreement with some studies with similar protocols of this study, but among elite conventional volleyball players from different countries which include: Franceschini et al.[60] and Maledonça et al.[61] (Brazilian players), Hadzic et al.[62] (Slovenian players), Markou and Vagenas[63] (Greek players), Michael et al.[64] (German players), Van Cingel et al.[65] (Dutch players), and Wang et al.[66] (English players).

High-intensity muscle contractions leads to significant decrease in contractile function.[67] Additionally, isokinetic muscle endurance defined as the capacity of a muscle to perform work, and fatigue is evaluated as a decline in work production over a series of consecutive contractions.[68] In our study, the non-dominant shoulder had significantly higher value of the WF than the dominant shoulder, in the ER for both of the groups. The nature of SV sport and way of movement on the game court, could be a reason of this result in the non-dominant sides of ER movement in both of the male and female players.

There was inter-limb asymmetry in the ER and IR movements, at both velocities, ranged between 12.5% to 16.1% in the male players and 5.2% to 16.7% in the female players.

In the dominant side all inter-limb values were smaller than the CV values for the respective movements, but except IR at high and low velocity in female players, all inter-limb values in the non-dominant side were greater than the CV values for the rest of movements and velocities. However, according to the Vanderstukken et al.,[42] inter-limb values greater than the CV values are confirming the existence of relevant asymmetry during movements.[43,69] In addition, we found a statistically significant difference in inter-limb asymmetry. There was a greater asymmetry between both shoulders in the male players in comparison to the female players during IR at high velocity. This asymmetry for the dominant side was in 57.1% of the female players and in 50% of the male players, also for the non-dominant side was in 42.9% of the female players and in 50% of the male players. The rest of inter-limb asymmetries had preference in the dominant side, for both movements at both velocities and also in both groups. In other words, the asymmetry favored the dominant side as the strongest side for both rotations in both groups. At low velocity, asymmetry for ER was in 66.7% of the male players and in 71.4% of the female players. Also, in IR the strongest side was in 83.3% of the male players and in 85.7% of the female players. Interestingly, at high velocity the strongest side was the dominant one in 100% of the male players and 71.4% of the female players during IR.

There were not significant differences in ER/IR ratio between both groups neither in both velocities, but the ER/IR ratio values were a little more than normal ratio values (ER/IR norm value of 65%-75%)[68,70-72] for both male and female players. This results are in line with the findings of Franceschini et al.,[60] in which the protocols and movements of the study were the same as our study but in Brazilian Volleyball players' population. A study found a relationship between an abnormal ER/IR ratio and the incidence of shoulder injuries among athletes of overhead sports.[71] According to Edouard et al.,[73] athletes with this kind of imbalances have 2.5 times more possibility of having a shoulder injury. Beside body health aspects, injury to a professional para-athlete can result in loss of income, decreased career length, and their sport life. To prevent possible injuries and according to the nature of SV sport, there is an essential need to develop more studies to assess isokinetic strength of glenohumeral of SV players for more understanding about agonist/antagonist ratio in the shoulder rotators of this population.

The main limitation in this study was the sample size of the study population, only 13 tested elite SV players was rather small. However, this number was the extent of the entire male and female Brazilian national SV team at the time of the study who were available or were without injury. Therefore, there was not the opportunity to test more elite SV players. Also another limitation in the present study was geographical bias. Subjects were not selected from several national team camps; consequently, selection of players was determined by only one group of coaches. In addition, another important limitation was the mode which performed in the isokinetic testing. All tests were carried out in the concentric/concentric mode, and no eccentric testing was performed. However, Johansson et al.[74] realized that eccentric strength measurements are an important part of the clinical examination of the shoulder of athletes. There is a necessity to continue the study on larger sample size groups of SV players in international level to confirm the results of the present study. Future studies should investigate different aspects among male and female players from multiple international Paralympic teams. In addition, the validity and reliability of some of the field tests have not been established clearly in the literature. In clinical implication perspective, the present study can be seen as a first step in establishing a reference base concerning shoulder strength values in this specific para-athlete population. Also, this reference base could help Paralympic coaches, physiotherapists and Para-sports physicians in the evaluation of shoulder strength and muscle function in SV players. Finally, as Vute[9] explained both gender can play SV together, except at some higher level competitions; results of present study showed that regarding to the differences performance between both genders, playing together could be just for entertainment and in formal games would not be fair.

CONCLUSION

In conclusion, the male players presented higher scores in all the performance tests. From a coaching perspective, as female players are often need to perform the same tasks as male players during SV practice, they may have a primary disadvantage in power-based activities. In addition, we presented a descriptive profile of IR and ER for glenohumeral strength in elite male and female SV players. These para-athletes have an asymmetrical rotational strength profile. As muscular imbalance is a common injury pattern in overhead players, more studies need to be conducted and focused on SV players in this field. Findings of this study may assist the SV coaches, trainers and physiotherapists in the evaluation and training of strength the ER and IR shoulders of SV players. Accordingly, female players should try to develop their upper limbs performance during SV training period with strength and conditioning coaches. On the other hand, physical performance in SV is just a part of it, also game skills like pass, serve and spike or perceptual-cognitive skills like anticipation, pattern recall, and decision making could be more important.

REFERENCES

1. Lee YA, Kim HC. Application of intensified program to increase physical fitness, mobility and confidence on specific sports among volleyball sitting athletes. *Korean Phys Mult Disabil*. 2010;53:89-109.
2. Jeoung B. Relationship between sitting volleyball performance and field fitness of sitting volleyball players in Korea. *J Exerc Rehabil*. 2017;13(6):647-652.
3. Fatih Yuksel M, Sevindi T. Physical fitness profiles of sitting volleyball players of the Turkish National Team. *Universal J Educ Res*. 2018;6(3):556–61.
4. Marszalek J, Molik B, Gomez MA, et al. Relationships between anaerobic performance, field tests and game performance of sitting volleyball players. *J Hum Kinet*. 2015;48:25–32.
5. Ahmadi S, Uchida MC, Gutierrez GL. Physical Performance Tests in Male and Female Sitting Volleyball Players: Pilot Study of Brazilian National Team. *Asian J Sports Med*. 2019;10(2):e85984.
6. Molik B, Morgulec-Adamowicz N, Marszałek J, Kosmol A, Rutkowska I, Jakubicka A, Kaliszewska E, Kozłowski R, et al. Evaluation of game performance in elite male sitting volleyball players. *Adapt Phys Activ Q*. 2017;34:104-124.
7. Andersen CH, Zebis MK, Saervoll C, Sundstrup E, Jakobsen MD, Sjogaard G, Andersen LL. Scapular muscle activity from selected strengthening exercises performed at low and high intensities. *J Strength Cond Res*. 2012;26(9): 2408–2416.
8. Vlychou M, Spanomichos G, Chatziioannou A, Georganas M, Zavras GM. Embolisation of a traumatic aneurysm of the posterior circumflex humeral artery in a volleyball player. *Br J Sports Med*. 2001;35:136-137.
9. Vute R. *Teaching and coaching volleyball for the disabled, foundation course handbook*. Ljubljana: World Organisation of Volleyball for the Disabled; 2009.
10. Kolkka T, Williams T. Gender and disability sport participation: Setting a sociological research agenda. *Adapt Phys Act Q*. 1997; 14(1):8–23.

11. Tikuisis P, Meunier P, Jubenville CE. Human body surface area: Measurement and prediction using three dimensional body scans. *Eur J Appl Physiol*. 2001; 85(3-4):264–71.

12. Cote JN. A critical review on physical factors and functional characteristics that may explain a sex/gender difference in workrelated neck/shoulder disorders. *Ergonomics*. 2012;55(2):173–82.

13. Rohr LE. Gender-specific movement strategies using a computer-pointing task. *J Mot Behav*. 2006;38(6):431–7.

14. Saucier D, Lisoway A, Green S, Elias L. Female advantage for object location memory in peripersonal but not extrapersonal space. *J Int Neuropsychol Soc*. 2007;13(4):683–6.

15. Croft L, Dybrus S, Lenton J, Goosey-Tolfrey V. A comparison of the physiological demands of wheelchair basketball and wheelchair tennis. *Int J Sports Physiol Perform*. 2010;5(3):301–15.

16. Barfield JP, Malone LA. Performance test differences and Paralympic team selection: Pilot study of the United States national wheelchair rugby team. *Int J Sports Sci Coa*. 2012; 7(4):715–20.

17. Vute R. Scoring skills performances of the top international men's sitting volleyball teams. *Gymnica J*. 1999;29(2):55–62.

18. McCleary RW, Andersen JC. Test-retest reliability of reciprocal isokinetic knee extension and flexion peak torque measurements. *J Athl Train*. 1992;27:362-365.

19. Frisiello S, Gazaille A, O'Halloran J, Palmer ML, Waugh D. Test-retest reliability of eccentric peak torque values for shoulder medial and lateral rotation using the Biodex isokinetic dynamometer. *J Orthop Sports Phys Ther*. 1994;19(6):341-344.

20. Drouin JM, Valovich-mc Leod TC, Shultz SJ, Gansneder BM, Perrin DH. Reliability and validity of the Biodex system 3 pro isokinetic dynamometer velocity, torque and position measurements. *Eur J Appl Physiol*. 2004;91(1):22-29.

21. Stark T, Walker B, Phillips JK, Fejer R, Beck R. Hand-held dynamometry correlation with the gold standard isokinetic dynamometry: A systematic review. *PM R*. 2011;3(5):472–479.

22. Zapparoli FY, Riberto M. Isokinetic evaluation of the hip flexor and extensor muscles: A systematic review. *J Sport Rehabil*. 2016;26(6):556–566.

23. Mayer F, Horstmann T, Bäurle W, Grau S, Handel M, Dickhuth HH. Diagnostics with isokinetic devices in shoulder measurements: Potentials and limits. *Isokinet Exerc Sci*. 2001;9(1):19–25.

24. Cools AM, Witvrouw EE, Danneels LA, Vanderstraeten GG, Cambier DC. Test-retest reproducibility of concentric strength values for shoulder girdle protraction and retraction using the Biodex isokinetic dynamometer. *Isokinet Exerc Sci.* 2002;10(3):129–136.

25. Cools AM, Borms D, Castelein B, Vanderstukken F, Johansson FR. Evidence-based rehabilitation of athletes with glenohumeral instability. *Knee Surg Sports Traumatol Arthrosc*. 2016;24(2):382–389.

26. World paravolley. 2018. Available from: http://www.worldparavolley. org/sitting-volleyball-rankings.

27. World Organization Volleyball for Disabled. Official Sitting Volleyball Rules 2011–2012. The Netherlands: Author. http://www.worldparavolley.org/wp-content/uploads/2017/06/2017-2020-SITTING-Volleyball-Rules-with-Diagrams.pdf.

28. Fess EE. Proceedings American Society of Hand Therapy. The effects of Jamar dynamometer handle position and test protocol on normal grip strength. *J Hand Surg*. 1988; 7:308–9.

29. Korei AE, Kempler M, Istenes I, Vagi OE, Putz Z, Horvath VJ, et al. Why not to use the handgrip test in the assessment of cardiovascular autonomic neuropathy among patients with diabetes mellitus? *Curr Vasc Pharmacol*. 2017;15(1):66–73.

30. Molik B, Laskin JJ, Kosmol A, Marszałek J, Morgulec-Adamowicz N, Frick T. Relationships between anaerobic performance, field tests, and functional level of elite female wheelchair basketball athletes. *Human Movement*. 2013;14(4).

31. Salonia MA, Chu DA, Cheifetz PM, Freidhoff GC. Upper-body power as measured by medicine-ball throw distance and its relationship to class level among 10- and 11-year-old female participants in club gymnastics. *J Strength Cond Res*. 2004;18(4):695–702.

32. Kim J, Yim J, Do K. The correlation between the physical power of golf players and the Titleist Performance Institute Level 1 test. *Phys Ther Rehabil Sci*. 2018;7(1):13–7.

33. Harris C, Wattles AP, DeBeliso M, Sevene-Adams PG, Berning JM, Adams KJ. The seated medicine ball throw as a test of upper body power in older adults. *J Strength Cond Res*. 2011;25(8):2344–8.

34. Sassi RH, Dardouri W, Yahmed MH, Gmada N, Mahfoudhi ME, Gharbi Z. Relative and absolute reliability of a modified agility t-test and its relationship with vertical jump and straight sprint. *J Strength Cond Res*. 2009;23(6):1644–51.

35. Myer GD, Schmitt LC, Brent JL, Ford KR, Barber Foss KD, Scherer BJ, et al. Utilization of modified NFL combine testing to identify functional deficits in athletes following ACL reconstruction. *J Orthop Sports Phys Ther*. 2011;41(6):377–87.

36. Cools AM, Declercq GA, Cambier DC, Mahieu NN, Witvrouw EE. Trapezius activity and intramuscular balance during isokinetic exercise in overhead athletes with impingement symptoms. *Scand J Med Sci Sports.* 2007;17(1):25–33.

37. Brown CE. *Coefficient of Variation. In: Applied Multivariate Statistics in Geohydrology and Related Sciences.* Springer, Berlin, Heidelberg. 1998.

38. Turner A, Brazier J, Bishop C, Chavda S, Cree J, Read P. Data analysis for strength and conditioning coaches: Using excel to analyze reliability, differences, and relationships. *J Strength Cond Res.* 2015;37(1):76–83.

39. Luoto S, Hupli M, Alaranta H, Hurri H. Isokinetic performance capacity of trunk muscles. Part II: Coefficient of variation in isokinetic measurement in maximal effort and in submaximal effort. *Scand J Rehabil Med*. 1996;28(4), 207–210.
40. Dvir Z. Isokinetic muscle testing: Reflections on future venues. *Hong Kong Physiotherapy Journal*. 2000;18(2):41–46.
41. Cormack SJ, Newton RU, McGuigan MR, Doyle TL. Reliability of measures obtained during single and repeated countermovement jumps. *Int J Sports Physiol Perform*. 2008;3(2):131–144.
42. Vanderstukken F, Jansen N, Mertens T, Cools AM. Elite male field hockey players have symmetric isokinetic glenohumeral strength profiles, but show asymmetry in scapular muscle strength. *J Sports Sci*. 2018;37(5):484-491.
43. Bishop C, Read P, Lake J, Chavda S, Turner A. Inter-limb asymmetries: Understanding how to calculate differences from bilateral and unilateral tests. *J Strength Cond Res*. 2018;40(4):1-6.
44. Shapiro SS, Wilk MB. An analysis of variance test for normality (complete samples). *Biometrika*. 1965;52(3/4):591–611.
45. Heirani A, Ahmadi S. *Evaluation and measurement in physical education*. Razi University Publication; 2012.
46. Van Dornick K, Bell GJ. Physiological characteristics and game heart rate responses of men’s national sitting volleyball players. *Med Sci Sport Exer*. 2014; 46:85–6.
47. Ko BG, Kim JH. Physical fitness profiles of elite ball game athletes. *Int J Appl Sport Sci*. 2005;17(1):71–87.
48. Janssen I, Heymsfield SB, Wang ZM, Ross R. Skeletal muscle mass and distribution in 468 men and women aged 18-88 yr. *J Appl Physiol*. 2000;89(1):81–8.
49. de Witte AMH, Hoozemans MJM, Berger MAM, van der Slikke RMA, van der Woude LHV, Veeger D. Development, construct validity and test-retest reliability of a field-based wheelchair mobility performance test for wheelchair basketball. *J Sports Sci*. 2018;36(1):23–32.
50. Kimura M, Hirakawa K, Okuno T, Oda Y, Morimoto T, Kitani T, et al. An analysis of physical fitness in the aged people with fitness battery test. *Jpn J Phys Fit Sport Med*. 1989;38(5):175–85.

51. Lockie RG, Dawes JJ, Orr RM, Stierli M, Dulla JM, Orjalo AJ. Analysis of the effects of sex and age on upper- and lower-body power for law enforcement agency recruits before academy training. *J Strength Cond Res*. 2018;32(7):1968–74.
52. Krause LM, Naughton GA, Benson AC, Tibbert S. Equity of physical characteristics between adolescent males and females participating in single- or mixed-sex sport. *J Strength Cond Res.* 2018;32(5):1415–21.
53. Christine LW. *Women, sport, & performance*. Leeds: Human Kinetics Publishers Ltd; 1985.
54. Gomez MA, Perez J, Molik B, Szyman RJ, Sampaio J. Performance analysis of elite men's and women's wheelchair basketball teams. *J Sports Sci*. 2014;32(11):1066–75.
55. Montoye HJ, Lamphiear DE. Grip and arm strength in males and females, age 10 to 69. *Res Q.* 1977;48(1):109–20.
56. Kubota H, Demura S. Gender differences and laterality in maximal handgrip strength and controlled force exertion in young adults. *Health*. 2011;3(11):684–8.
57. Sanchez AG, Dominguez AS, Turpin JAP, Tormo JMC, Llorca CS. Importance of hand-grip strength as an indicator for predicting the results of competitions of young judokas. *Sci Martial Art J*. 2011;7(3).
58. Armstrong CA, Oldham JA. A comparison of dominant and nondominant hand strengths. *J Hand Surg Br*. 1999;24(4):421–5.
59. Nicolay CW, Walker AL. Grip strength and endurance: Influences of anthropometric variation, hand dominance, and gender. *Int J Ind Ergonomics*. 2005;35(7):605–18.
60. Franceschini K, Nissola N, Zardo B, Tadielo G, Bonetti L. Isokinetic Performance of Shoulder External and Internal Rotators in Adolescent Male Volleyball Athletes. *Int Arch Med*. 2016; 9.
61. Mendonça LDM, Bittencourt NFN, Anjos MTS, Silva AA, Fonseca ST. Avaliação muscular isocinética da articulação do ombro em atletas da seleção brasileira de voleibol sub-19 e sub21 masculino. *Rev Bras Med Esporte*. 2010;16(2):107-111.
62. Hadzic V, Sattler T, Veselko M, Markovic G, Dervisevic E. Strength asymmetry of the shoulders in elite volleyball players. *J Athl Train*. 2014;49(3):338-44.
63. Markou S, Vagenas G. Multivariate isokinetic asymmetry of the knee and shoulder in elite volleyball players. *Eur J Sport Sci*. 2006;6(1):71-80.
64. Michael J, Konig D, Hessling U, Popken F, Eysel P. Results of shoulder isokinetic testing in volleyball players. *Sportverletz Sportschaden*. 2003;17(2):71-4.
65. Van Cingel R, Kleinrensink G, Stoeckart R, Aufdemkampe G, de Bie R, Kuipers H. Strength values of shoulder internal and external rotators in elite volleyball players. *J Sport Rehabil*. 2006;15(1):237-245.
66. Wang H, Macfarlane A, Cochrane T. Isokinetic performance and shoulder mobility in elite volleyball athletes from the United Kingdom. *Br J Sports Med*. 2000;34(1):39-43.

67. Mullaney MJ, McHugh MP. Concentric and eccentric muscle fatigue of the shoulder rotators. *Int J Sports Med*. 2006;27(9):725-729.
68. Dvir Z. *Isokinetics: Muscle Testing, Interpretation, and Clinical Applications.* Edinburgh: Church-Livingstone; 2004.
69. Exell TA, Irwin G, Gittoes MJR, Kerwin DG. Implications of intra-limb variability on asymmetry analyses. *J Sports Sci*. 2012;30(4):403–409.
70. Ellenbecker TS, Davies GJ. The application of isokinetics in testing and rehabilitation of the shoulder complex. *J Athl Train*. 2000;35(3):338-50.
71. Byram IR, Bushnell BD, Dugger K, Charron K, Harrell FEJr, Noonan TJ. Preseason shoulder strength measurements in professional baseball pitchers: Identifying players at risk for injury. *Am J Sports Med*. 2010;38(7):1375–1382.
72. Cools AM, Palmans T, Johansson FR. Age-related, sport specific adaptions of the shoulder girdle in elite adolescent tennis players. *J Athl Train*. 2014;49(5):647–653.
73. Edouard P, Degache F, Oullion R, Plessis JY, Gleizes-Cervera S, Calmels P. Shoulder strength imbalances as injury risk in handball. *Int J Sports Med*. 2013;34(7):654-60.
74. Johansson FR, Skillgate E, Lapauw ML, Clijmans D, Deneulin VP, Palmans T, et al. Measuring eccentric strength of the shoulder external rotators using a handheld dynamometer: Reliability and validity. *J Athl Train*. 2015;50(7):719–725.

CHAPTER 2

ANTROPOMETRY AND BODY COMPOSITION ASPECTS

BODY COMPOSITION IN ELITE SITTING VOLLEYBALL PLAYERS

Abstract

Among the fitness factors for evaluation physical performance of elite Paralympians, body composition is a fundamental component of physical fitness related to athletic performance. The objective of this chapter was to describe the body composition of male and female highly-trained SV players and to compare the values obtained of this population by two different methods. Thirteen Brazilian SV national team players, (5 males: age= 32.8±4.55 years, height= 184.4±8.02 cm, seat height= 148±4.42 cm, body mass= 85.64±20.68 kg, BMI= 24.92±3.93 kg/m^2; 8 females: age= 30.25±8.39 years, height= 172.38±7.62 cm, seat height= 136.25±5.8 cm, body mass= 75.83±15.73 kg, BMI= 25.41±4.44 kg/m^2 participated in this study. As a body composition evaluation, Skinfolds (SF) and Air-displacement plethysmography (ADP) methods were conducted for each player. There were no significant differences between the values of all players which measured by ADP and SF for body fat percentage (BF%) and body density (BD) ($p > 0.05$). The analysis of BF% for all players comparing ADP to SF resulted in a bias score of -3.09±4.29 (%) ($p = 0.02$), with no significant systematic bias ($R = 0.132$, SEE= 4.44). A high degree of reliability was found between ADP and SF measures of BF%. The analysis of body density (BD) for all players comparing ADP to SF resulted in a bias score of 0.001±0.01 (kg/l) ($p = 0.71$), with no significant systematic bias ($R = 0.119$, SEE= 0.01). A high degree of reliability was found between ADP and SF measures of BD. There were statistically significant positive correlations between BF% and BD in all values for both methods ($p < 0.01$). This study showed that, considering the magnitude of space, expense, and other limitations related with the ADP method against the SF method, we recommend the use of inexpensive and easily applied SF method is a valid and viable method for measuring body composition in elite SV players, which it helps SV coaches monitor training progress of the athletes.

Keywords: Paralympic Sport, Skinfolds, BOD POD, Gender Differences.

INTRODUCTION

Sitting volleyball (SV) is a quick, unpredictable and popular Paralympic team sport, in which players have to move quickly on the SV court by using their upper limbs.[1,2] The athletes who play SV are disabled in their lower limbs and it is very important for them to have a good physical performance.[2] For this purpose, among the fitness factors for evaluation physical performance of athletes, body composition is a fundamental component of physical fitness related to athletic performance.[3] There are many methods for measuring body composition, laboratory methods, such as air-displacement plethysmography (ADP), and field methods, such as the anthropometric method, which uses the sum of the skinfolds (SF) to measure body density (BD).[4,5]

ADP and SF methods have been used in different studies.[6-11] SF method mostly has been compared to dual-energy x-ray absorptiometry (DXA) method. A study found an overestimation of the body fat percentage (BF%) by the SF method compared to DXA in athletes with spinal cord injuries.[11] Stewart and Hannan,[12] in a study found a good agreement in BF% between the SF and DXA methods in male athletes. In a similar study to ours, Lemos et al.[10] compared the values of BD and BF% in national team players of three different Paralympic sports by ADP and SF methods. They found no significant differences between the values obtained by ADP and SF for BF% and BD. They mentioned when the ADP is not possible to use, estimating BD and BF% by SF is a viable alternative for Paralympic athletes (track, goalball, and swimming).

In spite of the SV apparent popularity, there are few publications focusing on SV athletes in comparison to the other Paralympic team sport athletes,[13,14] particularly for body composition. Also in SV both sexes can play together, except in the high levels and formal competitions.[15] However, gender is an important anthropometrical concept for researchers who wish to contribute to an understanding of disability sports.[16] Very few studies have focused particularly on gender differences in Paralympic sport contexts, although, needless to mention, the importance of this concept has been more recognized in the recent years. Therefore, this study aimed to describe the BF% and BD of male and female highly-trained SV players and to compare the values obtained of this population by ADP and SF.

METHODS

Participants

Thirteen SV players participated in this study (5 men: age= 32.8±4.55 years, height= 184.4±8.02 cm, seat height= 148±4.42 cm, body mass= 85.64±20.68 kg, BMI= 24.92±3.93

kg/m^2; 8 women: age= 30.25±8.39 years, height= 172.38±7.62 cm, seat height= 136.25±5.8 cm, body mass= 75.83±15.73 kg, BMI= 25.41±4.44 kg/m^2), at the time all being part of the national Brazilian SV team. Two (15.4%) players were in MD (Minimally Disabled) class and the rest players (84.6%) were in D (Disabled) class of SV classification.[17] Before beginning test protocol, all players were informed about the aims of the study and they signed an informed consent form. This study was approved by the Brazilian Platform Research Ethics Committee of University of Campinas No. 2.623.954. The characteristics of participants are presented in table 1.

Procedures

All of the players were hydrated and had not eaten food for 3 hours after breakfast, urinated before analysis, were not using diuretic medications, wore light clothing (swimsuit or bikini), and had removed all metal objects before the tests. The participants were informed about the tests procedure. All participants completed a demographic questionnaire prior to the tests. The tests were completed within time difference of one day and different locations (First day: ADP test in UNICAMP, Campinas, SP; and second day: skinfolds test in SESI, Suzano, SP).

Anthropometric evaluations

The body mass (kg) was measured using a digital scale, model Balmak® electronic Classe III with an accuracy of 0.01 kg. For height and seat height, a SANNY® (Personal Caprice Portable, Brazil) stadiometer with 0.1 cm precision was used. Body mass index (BMI) was calculated by the ratio of body mass to the square of the height.

Skinfolds (SF)

SF thickness of Chest, abdominal, front thigh, suprailiac, subscapular, triceps, and mid-axillary were measured using calipers (Lange®, UK). We used a dermatographic pen to mark the body sites for evaluation. All measures were performed 1 cm above the marked location with the thumb and index fingers. All measurements were performed on the right side of the players' body, except when the right limbs were the amputated limb. No athletes had both limbs sides amputated. SF evaluations were measured according to the Jackson and Pollock[18] procedures. The measurements were performed tree times for each player by a single trained technician. The mean of the three measurements was used as it representative value for each SF. After the SF measurements, BF% was calculated using the Siri[19] equation from the BD estimated by the seven SF protocol proposed by Jackson and Pollock[20] for male players and by Jackson, Pollock, and Ward[21] for female players.

Air-displacement plethysmography (ADP)

ADP is known as a reliable method for evaluation the body fat percentage.[8] The ADP test was repeated two times, and if it was observed significant difference (body volume > 0.150 L), a third measure was performed. Also, the volume of thoracic gas was measured by a three short breaths. All players had thoracic gas measured. Body composition analysis was performed using a BOD POD (Body Composition Tracking System; Cosmed, Chicago, USA). BOD POD calculates the player's BD and then uses the Siri' formula[19] to calculate their BF%. The players were instructed to enter the BOD POD chamber. The players were then asked to sit, limit their movement, and breathe normally throughout the BOD POD test (figure 1).

* The ADP evaluation test obtained without footwear

Figure 1. Body composition evaluations by the Bod Pod in both male and female SV players.

Statistical analyses

All statistical analyses were performed with IBM SPSS Statistics version 23.0. The normality of distribution was assessed by the Shapiro–Wilk test, which the results indicated a normality distribution.[22,23] All variables are summarised as the means ± standard deviation and confidence interval at 95% (CI 95%). T-test, paired t-test, Pearson correlation coefficients, and also multivariate analysis of variance (MANOVA) followed by Bonferroni's post hoc tests were used to compare the BD and BF% determined by ADP and SF between the both groups. Bland–Altman plots were used to illustrate the differences, biases, and agreement between SF and ADP.[24] Intraclass correlation (ICC) was used to evaluate the reliability of each measurement method. Analyses were considered statistically significant at $p<0.05$.

RESULTS

Table 1 shows the physical characteristics, age, SV experience, weekly practice, BD, and BF% of all players and also separated by gender. There were no significant differences between the values measured by ADP and SF for BF% (p= 0.06) or BD (p= 0.6). In following, there were significant differences between male and female players for BF% by SF (p= 0.04) and BD by SF (p= 0.04).

Table 1. characteristics of the participants

Variables	All players (N=13)	Men (n=5)	Women (n=8)
	Mean±SD (CI 95%)	Mean±SD (CI 95%)	Mean±SD (CI 95%)
Seat height (cm)	140.77±7.84 (136.03-145.51)	148±4.42 (142.5-153.5)	136.25±5.8** (131.4-141.1)
Height (cm)	177±9.61 (171.19-182.81)	184.4±8.02 (174.4-194.4)	172.38±7.62* (166-178.7)
Age (years)	31.23±7.05 (26.97-35.49)	32.8±4.55 (27.2-38.5)	30.25±8.39 (23.2-37.3)
SV experience (years)	10.62±4.43 (7.94-13.29)	13±4.69 (7.2-18.8)	9.13±3.79 (5.9-12.3)
Weekly practice (hours)	10.46±0.88 (9.93-10.99)	10±0.01 (10)	10.75±1.04 (9.9-11.6)
Body mass (kg)	79.61±17.65 (68.93-90.27)	85.64±20.68 (59.9-111.3)	75.83±15.73 (62.6-88.9)
BMI (kg/m^2)	25.22±4.09 (22.75-27.69)	24.92±3.93 (20.05-29.79)	25.41±4.44 (21.69-29.12)
Fat by SF (%)	25.95±9.02 (20.5-31.39)	19.78±8.34 (9.4-30.1)	29.81±7.45* (23.5-36.1)
Fat by ADP (%)	22.85±9.57 (17.07-28.64)	18.66±10.14 (6.1-31.3)	25.48±8.82 (18.1-32.8)
BD by SF (kg/L)	1.05±0.02 (1.03-1.06)	1.06±0.02 (1.03-1.08)	1.04±0.02* (1.02-1.05)
BD by ADP (kg/L)	1.05±0.02 (1.03-1.06)	1.06±0.02 (1.02-1.08)	1.04±0.02 (1.02-1.05)

Data are presented with mean, standard deviation, and 95% confidence interval.
* Difference between men and women players (P<0.05).
** Difference between men and women players (P<0.01).
Abbreviations. SV- sitting volleyball, BMI- body mass index, SF- skinfold, ADP- air displacement plethysmography, BD- body density.

Figure 2 (A) and (B) represent the box-plot graphs for BF% and BD in the all players. The figure 3 and 4 show that, there were no differences between BF% (A: r= 0.13; p= 0.6) and BD (B: r= 0.12; p= 0.7) according to Bland–Altman plot analysis. Mean differences were of -3.09±4.29 (-11.51-5.31) and 0.001±0.01 (-0.02-0.02) for BF% and BD, respectively.

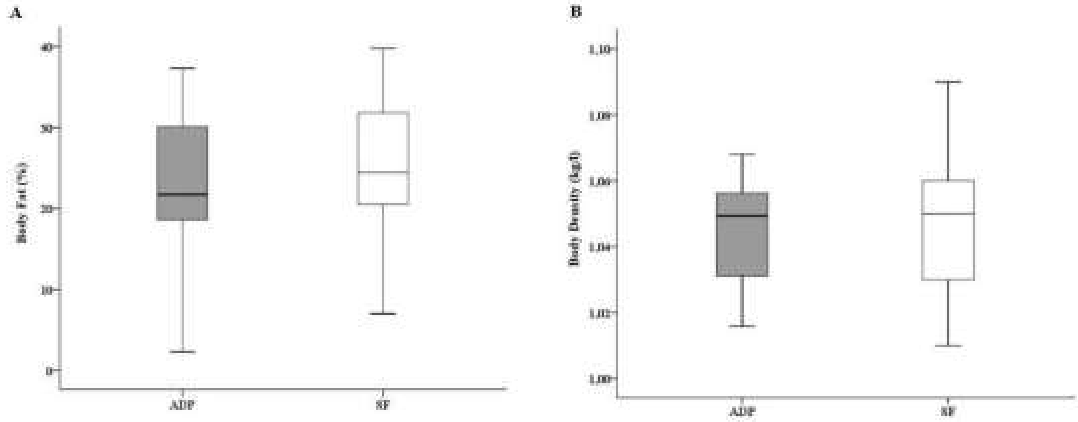
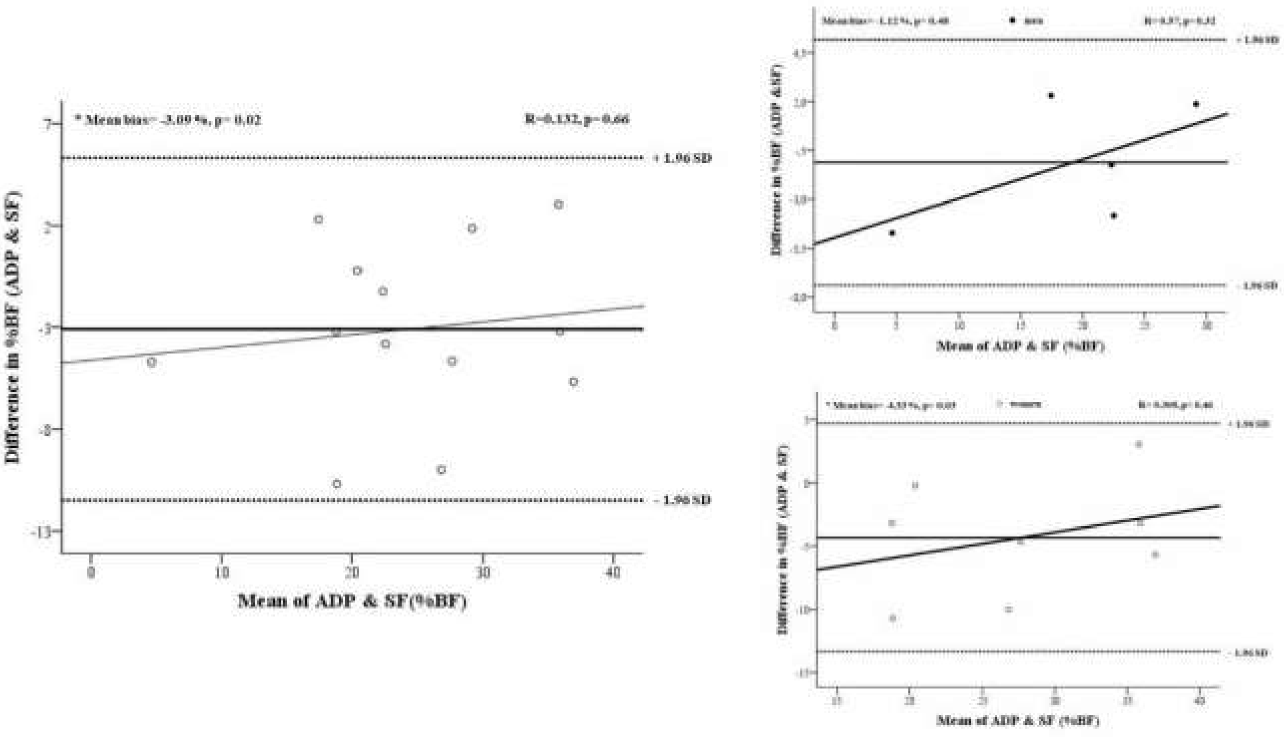


Figure 2. Boxplot comparing body fat percentage (A) and body density (B) determined by ADP and SF techniques for all players.

Abbreviations. SF- skinfold, ADP- air displacement plethysmography.

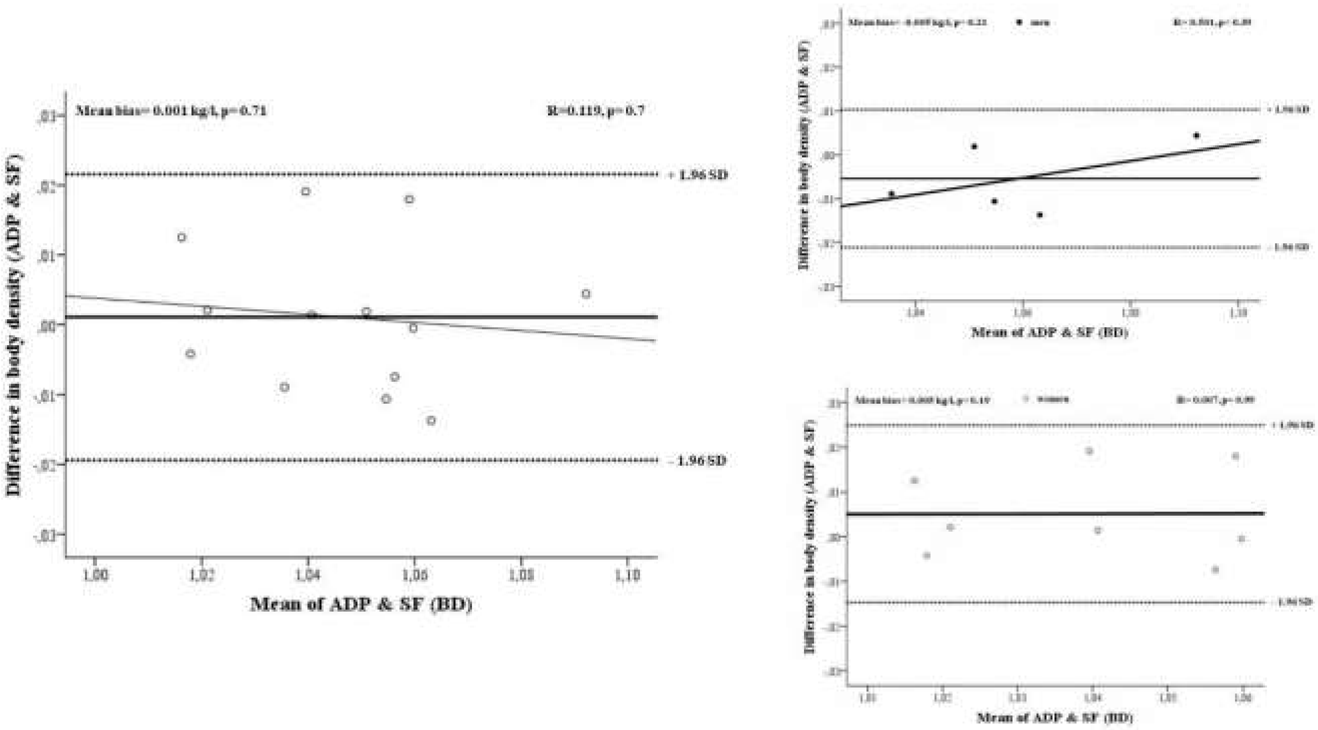
The analysis of BF% for all players comparing ADP to SF resulted in a bias score of -3.09±4.29 (%) (t(12)= -2.59, p= 0.02), with limits of agreement between -11.51 and 5.32 (%) and no significant systematic bias (R= 0.132, SEE= 4.44) (figure 3). In addition, the analysis of BF% for the male players comparing ADP to SF resulted in a bias score of -1.12±3.2 (%) (t(4)= 1.2, p= 0.48), with limits of agreement between -7.39 and 5.15 (%) and no significant systematic bias (R= 0.57, SEE= 3.04) (figure 3, • men). Also, the analysis of BF% for the female players comparing ADP to SF resulted in a bias score of -4.33±4.6 (%) (t(7)= 0.79, p= 0.03), with limits of agreement between -13.35 and 4.69 (%) and no significant systematic bias (R= 0.309, SEE= 4.73) (figure 3, ◦ women). A high degree of reliability was found between ADP and SF measures of BF%. For all players, the average measure ICC was 0.921 with a 95% confidence interval from 0.644 to 0.978 (F(12,12)= 17.769, p≤0.001). For male players the average measure ICC was 0.972 with a 95% confidence interval from 0.780 to 0.997 (F(4,4)= 32.617, p= 0.003). For female players the average measure ICC was 0.857 with a 95% confidence interval from 0.128 to 0.973 (F(7,7)= 11.571, p= 0.002).



Abbreviations. SD- standard deviation, BF- body fat, SF- skinfold, ADP- Air displacement plethysmography.

Figure 3. Bland and Altman plots comparing body fat percentage determined by ADP and SF techniques for all players and separated by gender (• men and ◦ women). Dashed black lines define the 95% limits of agreement between methods. Continuous black lines define the mean bias. Inclined and continuous black lines represent the relationship between mean and difference between SF and ADP methods.

The analysis of BD for all players comparing ADP to SF resulted in a bias score of 0.001±0.01 (kg/l) (t(12)= 0.37, p= 0.71), with limits of agreement between -0.019 and 0.022 (kg/l) and no significant systematic bias (R= 0.119, SEE= 0.01) (figure 4). In addition, the analysis of BD for the male players comparing ADP to SF resulted in a bias score of -0.005±0.01 (kg/l) (t(4)= 1.003, p= 0.21), with limits of agreement between 0.01 and -0.021 (kg/l) and no significant systematic bias (R= 0.501, SEE= 0.008) (figure 4, • men). Also, the analysis of BD for the female players comparing ADP to SF resulted in a bias score of 0.005±0.01 (kg/l) (t(7)= 0.016, p= 0.19), with limits of agreement between 0.025 and -0.015 (kg/l) and no significant systematic bias (R= 0.007, SEE= 0.01) (figure 4, ◦ women). A high degree of reliability was found between ADP and SF measures of BD. For all players, the average measure ICC was 0.944 with a 95% confidence interval from 0.816 to 0.983 (F(12,12)= 16.667, p≤0.001). For male players the average measure ICC was 0.955 with a 95% confidence interval from 0.638 to 0.995 (F(4,4) = 27.217, p= 0.004). For female players the average measure ICC was 0.917 with a 95% confidence interval from 0.621 to 0.983 (F(7,7) = 13.546, p= 0.001).



Abbreviations. SD- standard deviation, SF- skinfold, ADP- air displacement plethysmography.

Figure 4. Bland and Altman plots comparing body density determined by ADP and SF techniques for all players and separated by gender (• men and ◦ women). Dashed black lines define the 95% limits of agreement between methods. Continuous black lines define the mean bias. Inclined and continuous black lines represent the relationship between mean and difference between SF and ADP methods.

Pearson correlation coefficients between BF% and BD by SF and ADP are shown in table 2. There were statistically significant positive correlations between BF% and BD in all values for both methods. There were statistically significant correlations between BF% of SF and ADP in all players (r= 0.895, $p<0.01$). For male players correlation between BF% of SF and ADP were, r= 0.959 ($p<0.01$) and for female players were r= 0.853 ($p<0.01$). Also there were statistically significant correlations between BD (kg/l) of SF and ADP in all players (r= 0.888, $p<0.01$). For male players correlation between BD (kg/l) of SF and ADP were, r= 0.945 ($p<0.01$) and for female players were r= 0.863 ($p<0.01$).

Table 2. Pearson correlation coefficients (r) and P values between measures of body fat percentage and body density by SF and ADP

	All players (n= 13)		Men (n= 5)		Women (n= 8)	
	BF by ADP (%)	BD by ADP (kg/L)	BF by ADP (%)	BD by ADP (kg/L)	BF by ADP (%)	BD by ADP (kg/L)
BF by SF (%)	0.895**	-	0.959**	-	0.853**	-
BD by SF (kg/L)	-	0.888**	-	0.945**	-	0.863**

** Correlation is significant at the 0.01 level.

Abbreviations. BD- body density, BF- body fat, SF- skinfold, ADP- Air displacement plethysmography.

DISCUSSION

The purpose of present study was to describe the BF% and BD of male and female highly-trained SV players and to compare the values obtained for this population by ADP and SF. To the best of our knowledge, this is the first study that investigating body composition in SV players, particularly by ADP. As a first result of this study, the different non-invasive methods for measuring body composition have similar results. In addition, we found that the anthropometric method using SF is a valid method for measuring body composition in SV players.

ADP and SF measurements in our study, had shown differences but not significant for BF% in female players. This result was in agreement with study of Lemos et al.[10] for Paralympic swimming athletes. In addition, in a study Tseh et al.,[25] found the same results for 50 healthy participants. However, Vescovi et al.[26] stated that, %BF estimates by SF may be more accurate than those obtained by ADP for female college athletes, regardless of body composition. Also we found significant differences between the male and female players for BF% and BD which measured by SF, but there were not same results for ADP. Also Lemos et al.[10] found same results for Paralympic Goalball, and Swimming athletes. On the other hand, the box-plot graphs show that, there were no differences between BF% and BD according to Bland–Altman plot analysis.

The position of the players in the BODPOD chamber during the analyses could affects the parameters measured, not to a large extent.[27] Although our study followed the instructions of the BODPOD manufacturer concerning participant position, and we controlled the position of all players into the BODPOD, to avoid of any possible affects. In addition, as our participants had substantial muscle atrophy or limb loss, it can affect the constitution of the fat free mass and because of that the BD reflecting values under or overestimated body fat.[28,29] On the other hand, some studies found that different level of spinal cord injury does not seem to influence body composition, and BD method does not differ between subjects with spinal cord injury and without spinal cord injury.[30,31] According that, results of present study cannot be related to different levels of lesion.

When comparing the differences and potential biases between the ADP and SF results, it was found that the SF overestimating BF% compared with ADP. Similarly, Lemos et al.[10] found that, results in Goalball players revealed that the SF overestimating BF% (men: 24.22±7.92; women: 32.35±6.14) compared with ADP (men: 22.99±7.70; women: 30.32±7.29). Another cross-sectional study has found similar results in Israeli national team volleyball players;[32] however, a study showed that the SF (5 different equations) underestimating BF% compared with ADP among wheelchair basketball and wheelchair rugby athletes.[33] In addition, we found that BD was very similar between the 2 methods. This result was in agreement with the study of Lemos et al.[10] for Paralympic Goalball, and Track athletes. Also Vescovi et al.[26] found that, BD of female healthy college athletes was very similar between the SF and ADP results.

We found statistically significant positive correlations between BF% and BD in all values for both SF and ADP methods. Male players had more correlations between SF and ADP in both BF% and BD (kg/l) than female players. Tseh et al.,[25] found a strong, positive relationship between ADP and 7-site SF for BF% values, in both healthy men and women. In addition, we showed a high degree of reliability between ADP and SF measures of BF%. Similar to Lemos et al.[10] study, we used ADP as a reference method for the analysis BF% and BF of elite SV players in comparison with SF. These results of our study represented that the SF is a valid method for evaluation body composition in elite SV players. This finding is in agreement with Lemos et al.[10] study.

The main limitation in the present study was the sample size of the study population, only 13 tested elite SV players was rather small. However, this number was the extent of the entire male and female Brazilian national SV team at the time of the study who were available. Therefore, there was not the opportunity to test more elite SV players. On the other hand, there is a necessity to continue the study on larger sample size groups of SV players in international level to confirm the results of the present study. Additionally, we suggest future studies should use the dual energy x-ray absorptiometry (DXA) as a gold standard[34] (Wilson et al., 2012) reference measure of body composition to compare with ADP and SF methods in this population. In clinical implication perspective, the present study can be seen as a first step in establishing a reference base concerning body composition values in this specific para-athlete population. Also, this reference base could help Paralympic coaches, physiotherapists and Para-sports physicians in the evaluation of anthropometry and body composition of elite SV players.

CONCLUSION

This study showed that, the ADP and SF methods have similar results for measuring body composition in the SV national team players. On the other hand, we found a high degree of reliability between ADP and SF measurements. Finally, considering the magnitude of space, expense, and other limitations related with the ADP method against the SF method, we recommend the use of inexpensive and easily applied SF method is a valid and viable method for measuring body composition in elite SV players, which it helps SV coaches monitor training progress of the athletes.

REFERENCES

1. Jeoung B. Relationship between sitting volleyball performance and field fitness of sitting volleyball players in Korea. *J Exerc Rehabil*. 2017;13(6):647-652.
2. Lee YA, Kim HC. Application of intensified program to increase physical fitness, mobility and confidence on specific sports among volleyball sitting athletes. *Korean Phys Mult Disabil*. 2010;53:89-109.

3. Ackland TR, Lohman TG, Sundgot-Borgen J, Maughan RJ, Meyer NL, Stewart AD. Current status of body composition assessment in sport: Review and position statement on behalf of the ad hoc research working group on body composition health and performance, under the auspices of the I.O.C. Medical commission. *Sports Med*. 2012;42(3):227–249.

4. Madsen OR, Jensen JE, Sorensen OH. Validation of a dual energy X-ray absorptiometer: Measurement of bone mass and soft tissue composition. *Eur J Appl Physiol Occup Physiol*. 1997;75(6):554–558.

5. Shreeve S, Rowley N, Gilby C, Mitchell N. Changes in body composition and performance of a cerebral palsy Paralympic athlete in preparation for the London Paralympic games. *Br J Sports Med*. 2013;47(17):e4–e4.

6. Clasey JL, Gater DR Jr. A comparison of hydrostatic weighing and air displacement plethysmography in adults with spinal cord injury. *Arch Phys Med Rehabil*. 2005;86(11):2106–2113.

7. Douglas TD, Kennedy MJ, Quirk ME, Yi SH, Singh RH. Accuracy of six anthropometric skinfold formulas versus air displacement plethysmography for estimating percent body fat in female adolescents with phenylketonuria. *JIMD Rep*. 2013;10:23–31.

8. Fields DA, Goran MI, McCrory MA. Body-composition assessment via air-displacement plethysmography in adults and children: A review. *Am J Clin Nutr*. 2002;75(3):453–467.

9. Freedman DS, Wang J, Ogden CL, Thornton JC, Mei Z, Pierson RN. The prediction of body fatness by BMI and skinfold thicknesses among children and adolescents. *Ann Hum Biol*. 2007;34(2):183–194.

10. Lemos VA, Alves ES, Schwingel PA, Rosa JPP, Silva A, Winckler C, Vital R, Almeida AA, Tufik S, Mello MT. Analysis of the body composition of Paralympic athletes: Comparison of two methods. *Eur J Sport Sci*. 2016;16(8):955-64.

11. Mojtahedi MC, Valentine RJ, Evans EM. Body composition assessment in athletes with spinal cord injury: Comparison of field methods with dual-energy X-ray absorptiometry. *Spinal Cord*. 2009;47(9):698–704.

12. Stewart AD, Hannan WJ. Prediction of fat and fat-free mass in male athletes using dual X-ray absorptiometry as the reference method. *J Sports Sci*. 2000;18(4):263-74.

13. Ahmadi S, Uchida MC, Gutierrez GL. Physical Performance Tests in Male and Female Sitting Volleyball Players: Pilot Study of Brazilian National Team. *Asian J Sports Med*. 2019;10(2):e85984.

14. Marszalek J, Molik B, Go´mez MA, et al. Relationships between anaerobic performance, field tests and game performance of sitting volleyball players. *J Hum Kinet*. 2015;48:25–32.

15. Vute R. *Teaching and coaching volleyball for the disabled, foundation course handbook*. Ljubljana: World Organisation of Volleyball for the Disabled; 2009.

16. Kolkka T, Williams T. Gender and disability sport participation: Setting a sociological research agenda. *Adapt Phys Act Q*. 1997;14(1):8–23.

17. Marszałek J, Molik B, Gomez MA, Skučas K, Pokvytyte V, Mucha JL, Witold Rekowski W. Sitting Volleyball Classification System: The Athletes' Perspective. *Revista de Psicología del Deporte*. 2019;28(1):25-32.

18. Jackson AS, Pollock ML. Practical assessment of body composition. *Physician Sport Med*. 1985;13:76–90.

19. Siri WE. *Body composition from fluid spaces and density: Analysis of method*. Washington, DC: National Academy of Sciences; 1961

20. Jackson AS, Pollock ML. Generalized equations for predicting body density of men. *Br J Nutr*. 1978;40(3):497–504.

21. Jackson AS, Pollock ML, Ward A. Generalized equations for predicting body density of women. *Med Sci Sports Exerc*. 1980;12(3):175–181.

22. Heirani A, Ahmadi S. *Evaluation and measurement in physical education*. Razi University Publication; 2012.

23. Shapiro SS, Wilk MB. An analysis of variance test for normality (complete samples). *Biometrika*. 1965;52(3/4):591–611.

24. Bland JM., Altman DG. (1986). Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet*. 1986;1(8476):307–310.

25. Tseh W, Caputo JL, Keefer DJ. Validity and reliability of the BOD POD® S/T tracking system. *Int J Sports Med*. 2010;31(10):704-8.

26. Vescovi JD, Hildebrandt L, Miller W, Hammer R, Spiller A. Evaluation of the BOD POD for estimating percent fat in female college athletes. *J Strength Cond Res*. 2002;16(4):599-605.

27. Peeters MW. Subject positioning in the BOD POD(R) only marginally affects measurement of body volume and estimation of percent body fat in young adult men. *PLoS One*. 2012;7(3):e32722.

28. Moore CD, Craven BC, Thabane L, Laing AC, Frank-Wilson AW, et al. Lower-extremity muscle atrophy and fat infiltration after chronic spinal cord injury. *J Musculoskelet Neuronal Interact*. 2015;15(1):32-41.

29. Sherk VD, Bemben MG, Bemben DA. Interlimb muscle and fat comparisons in persons with lower-limb amputation. *Arch Phys Med Rehabil.* 2010;91(7):1077–1081.

30. George CM., Wells CL, Dugan NL. Validity of hydrodensitometry for determination of body composition in spinal injured subjects. *Hum Biol*. 1988;60(5):771–780.

31. Ribeiro Neto F, Lopes GHR. Analysis of body composition values in men with different spinal cord injury levels. *Fisioterapia em Movimento*. 2013;26(4):743–752.

32. Portal S, Rabinowitz J, Adler-Portal D, Burstein RP, Lahav Y, Meckel Y, Nemet D, Eliakim A. Body Fat Measurements in Elite Adolescent Volleyball Players: Correlation between Skinfold Thickness, Bioelectrical Impedance Analysis, Air-displacement Plethysmography, and Body Mass Index Percentiles. *J Pediatr Endocrinol Metab*. 2010;23(4):395-400.

33. Goosey-Tolfrey V, Keil M, Brooke-Wavell K, de Groot S. A comparison of Methods for the Estimation of Body Composition in Highly Trained Wheelchair Games Players. *Int J Sports Med*. 2016;37(10):799-806.

34. Wilson JP, Mulligan K, Fan B, Sherman JL, Murphy EJ, Tai VW, et al. Dualenergy X-ray absorptiometry-based body volume measurement for 4- compartment body composition. *Am J Clin Nutr*. 2012;95:25–31.

CHAPTER 3

PSYCHOLOGICAL ASPECTS

QUALITY OF LIFE, LIFESTYLE, AND MOOD STATES IN ELITE SITTING VOLLEYBALL PLAYERS

Abstract

Psychological researches on elite sitting volleyball (SV) players and gender differences are extremely rare. Therefore, the aim of this study was to present a profile of the quality of life (QOL), lifestyle, and mood aspects and compare them between male and female SV players of Brazilian national team. Fourteen Brazilian SV players took part in this study. The participants classified into male and female groups. The male group included 6 players (age= 31.8±4.1 yr; body mass= 84.7±20.8 kg; body height= 1.7±0.4 m; BMI= 25.4±3.9 kg/m²), and the female group contained 8 players (age= 29.6±8.3 yr; body mass= 75.9±17 kg; body height= 1.7±0.1 m; BMI= 25.3±4.4 kg/m²). They completed demographics, SF-36, FANTASTIC, and POMS questionnaires. There were not significant differences of the POMS, SF-36, and FANTASTIC variables between male and female players ($p>0.05$). The results of this study demonstrated there were not significant differences in the psychological aspects of this population. These findings may help SV coach and athletes for having expediency in their training programs.

Keywords: Quality of life, Mood, lifestyle, Parathletics

INTRODUCTION

Sitting volleyball (SV) was started in the Netherlands in 1956 and approved as an official Paralympic game in 1980. The SV is a big simplicity that shows an original example of adaptation and implementation of a team sport.[1] According to the accessibility, approachability and adaptability of the SV court (lower net, smaller size) allows people without or with physical impairments play together, as they sit down and get on the court, they are all in the same position, regardless to age, gender or (dis)ability.[2] Participation in the SV brings merits to the physical, psychological and social health to people with impairments.[3-7] However, many of sport psychologists have examined the psychology of elite athletes since the late 1970s,[8] they have begun to conduct sport psychology research on athletes with physical impairments in the last two decades.

The participation of people with impairments in sport activities can improve their quality of life (QOL), especially in social domains.[9] A review study about QOL and physical activity in people with spinal cord injury found that, participating in physical activities is an important factor to improve QOL of this population.[7] Tasiemski et al.,[6] found that people with physical impairments which participate in sport activities have high levels of satisfaction in life, with low levels of anxiety and depression. In another study (seems to be single study directly about QOL in SV players), they found that almost all of the SV players had not satisfy physical functioning and physical role facets in QOL.[10] For most of the elite SV players, sport activities are a lifelong orientation and remains significant even after retirement from the national team.[11] The sporting lifestyle has its roots in early childhood, where parents, friends, teachers and later coaches create and direct it. Today it is a synonym for a healthy and sensible way of live.[11,12]

The growth of SV in the recent years has led to improved competitiveness among the para-athletes and search for satisfying results. Several factors or feelings that make up the sports scene can support or prevent the player's performance, such as, mood[13] or depression.[14] The profile of mood state (POMS) is weighed an influential factor in sports performance of Paralympic athletes.[15] Besides, the assessment of mood states can contribute to the recognition of overtraining, allowing for interventions in the athletes' training to prevent them from achieving this phase.[16] Depression is one of the most ordinary mental disorders, which athletes do not release or stable to this mood disorder.[17] In general, athletes tend to have more positive mood states than non-athletes or athletes which participating at lower levels of competition. Sport psychologists have suggested that participation in sports for people with impairments might be associated with positive moods states.[15]

Plenty of sport psychologists note that often the forming a national team is psychological in nature as athletes at high levels of competition (national level) have similar physical and game skills.[15] The disbalance between psychological and physical training is aggravated for Paralympic athletes who often not engage in psychological skills training.[18] Thus, high-level Paralympic athletes which selected as national team players might have a strong psychological characteristics (adaptive mood states or better QOL and lifestyle). Therefore, the aim of this chapter was to present the profile of the QOL, lifestyle, and mood states aspects and compare them between male and female SV players of Brazilian national team. To our best knowledge, the present study is the first research in SV which clearly compares male and female players in terms of psychological aspects.

METHODS

Participants

Fourteen Brazilian SV players whom were 14.3% in MD (Minimally Disabled) and 85.7% in D (Disabled) classifications of SV,[19,20] took part in this study. The participants classified into male and female groups. The male group included 6 players (age= 31.8 ± 4.1 yr; body mass= 84.7 ± 20.8 kg; body height= 1.7 ± 0.4 m; BMI= 25.4 ± 3.9 kg/m²), and the female group contained 8 players (age= 29.6 ± 8.3 yr; body mass= 75.9 ± 17 kg; body height= 1.7 ± 0.1 m; BMI= 25.3 ± 4.4 kg/m²). The players were familiarized with tests' protocols. All participants signed an informed consent form. The study protocol followed the declaration of Helsinki and was approved by the ethics committee of the university of Campinas, Brazil. [2.623.954].

Procedure

Participants were informed about the study procedure. Four questionnaires and anthropometric measurements were conducted among the 14 players along one session. The following measurements were collected:

Demographics questionnaire

The authors created a brief demographic questionnaire to provide information regarding the SV player's background which contained the following variables: sex, age, SV classification and weekly training in the last six months (Table 1).

QOL questionnaire

SF-36 is a generic instrument whose conceptual basis is "health-related quality of life". This construct is represented by 36 questions divided into eight domains: physical functioning, role physical, pain, general health, energy and fatigue, role social, role emotional and mental health. Weighted combinations of all eight scale scores are used to calculate global measures of physical [physical component summary (PCS)] and mental [mental component summary (MCS)] functioning and well-being. Items are scored by a Likert scale. All items of SF-36 are used to score the eight domains, except for item 2, which refers to a self-report of health transition. Each item contributes to only one domain. After re-measure two items and reverse the score of nine items, the answers to items are summed. The highest scores show better health status. If items of one scale are not answered, one score for missing values is computed. Scores range from 0 to 100, 0 indicating the less favorable health status and 100 is the most favorable one. The SF-36 is proportional for people above than 14 years old. It can be administered in 5 to 10 minutes with high degree of acceptability and quality of data.[21] The SF-36 used in this study was previously translated into Brazilian Portuguese and validated in Brazil by Ciconelli et al.[22]

Lifestyle questionnaire

The research tool used to examine lifestyle of SV players was the FANTASTIC checklist by Wilson & Ciliska.[23] The Fantastic survey covers a wide range of issues which have a subtle but strong influence on health. The lifestyle survey supplements the assessment of health-related physical fitness and permits a more comprehensive view of the individual.[24] Cronbach's alpha coefficient measured the correlation between items and total was 0.69 (for the Brazilian Portuguese version), which is considered reasonable for an instrument designed to evaluate a hidden variable.[25] The acronym FANTASTIC represents first letters of nine domains (in English) which 25 closed-end questions are distributed: F= Family and Friends; A= Activity (Physical activity); N= Nutrition; T= Tobacco & Toxics; A= Alcohol Intake; S= Sleep, Seatbelts, Stress, and Safe sex; T= Type of behavior (Type A or Type B behavior pattern); I= Insight; C= Career (Work, satisfaction with profession). Questions of the questionnaire are distributed on a Likert scale; 23 of them have multiple-choice questions (five answers) and two are dichotomous. Questions are coded as follows: zero point for the first column, 1 point for the second, 2 points for the third, 3 points for the fourth, and 4 points for the fifth column. For questions with, the score is zero for the first column and 4 points for the last column. Summary of all points yields a total score that classifies individuals in 5 categories, as follows: “Excellent” (85 to 100 points), “Very good” (70 to 84 points), “Good” (55 to 69 points), “Regular” (35 to 54 points), and “Needing improvement” (0 to 34 points). The lower score, the greater requirement for change.

Profile of Mood States (POMS)

The POMS is a self-administered questionnaire, which was developed by McNair et al.[26] This construct is represented by 65 items divided into six subscales: anxiety, depression, anger, confusion, fatigue, and vigor. Participants were asked to respond to each item on a 5-point Likert-type scale ranging from 0 (not at all) to 4 (extremely). Weighted combinations of all six scale scores (negatively vigor) are used to calculate global measures of a total mood disturbance (TMD). Scores ranged between 0 and 40–44 per subscale and higher scores represent stronger mood states. Also the participants were asked to respond to the POMS items based on the “past week, including today.” As reported in a lot of studies, the POMS have well established validity and reliability in sport and exercise psychology[27] and also in researches conducted for athletes with impairments.[28] The POMS used in this study was previously translated into Brazilian Portuguese and validated in Brazil by Viana et al.[29]

Anthropometric measurements

Body mass (kg) was determined using a digital scale, model Balmak® electronic Classe III with an accuracy of 0.01 kg. For body height, a SANNY® compact stadiometer, model ES:2040 (Sanny – American Medical do Brasil, Ltda, São Bernardo do Campo, Brazil) with 0.1 cm precision was used. Body Mass Index (BMI) was calculated by the ratio of body mass to the square of the height (also Table 1).

Statistical analysis

A cross-sectional comparative study design was adopted. Data were assessed for normality with the Shapiro-Wilk test.[30,31] Internal reliability via alpha coefficients, validity evidence, and descriptive analyses were calculated and examined first. Variables were compared between the male and female SV players using the t-test for continuous variables. Mood state, lifestyle, and QOL variables were compared between the two groups using the Mann–Whitney U test. According to Fritz et al.,[32] r can be calculated as an effect size for the Mann-Whitney U-test using the formula:

$$r = \frac{z}{\sqrt{N}}$$

Therefore, r effect size was used to compare characteristics of participants. We used box plot to show differences between male and female players in PCS, MCS, TMD, and FANTASTIC variables. All statistical analysis was carried out with IBM SPSS Statistics 23.0. The alpha value was set at $p \leq 0.05$.

Table 1. Characteristics of the fourteen participants

Variables	Male	Female
	M±SD or %	M±SD or %
Sex n(%)	6(42.9%)	8(57.1%)
Age (year)	31.8 ± 4.1	29.6 ± 8.3
Body height (m)	1.7 ± 0.4	1.7 ± 0.1
Body mass (kg)	84.7 ± 20.8	75.9 ± 17
BMI (kg/m²)	25.4 ± 3.9	25.3 ± 4.4
Weekly training (hour)	460 ± 159.5	530 ± 77.1
Classification [D/MD] n(%)	1(16.7%)/5(83.3%)	1(12.5%)/7(87.5%)

Abbreviations. D- players with disability, MD- players with minimal disability [Only people with physical impairment (e.g. amputations, poliomielitis, cerebral palsy) or with minimal impairments can play SV at a Paralympic level. The SV athletes are divided into two classes: D– people with impairment and MD– people with minimal impairments. International rules allow one athlete with MD on each team to play on the court. This division of players is based on a medical classification system, which is supervised by the World ParaVolley and the International Paralympic Committee].[19,20]

RESULTS

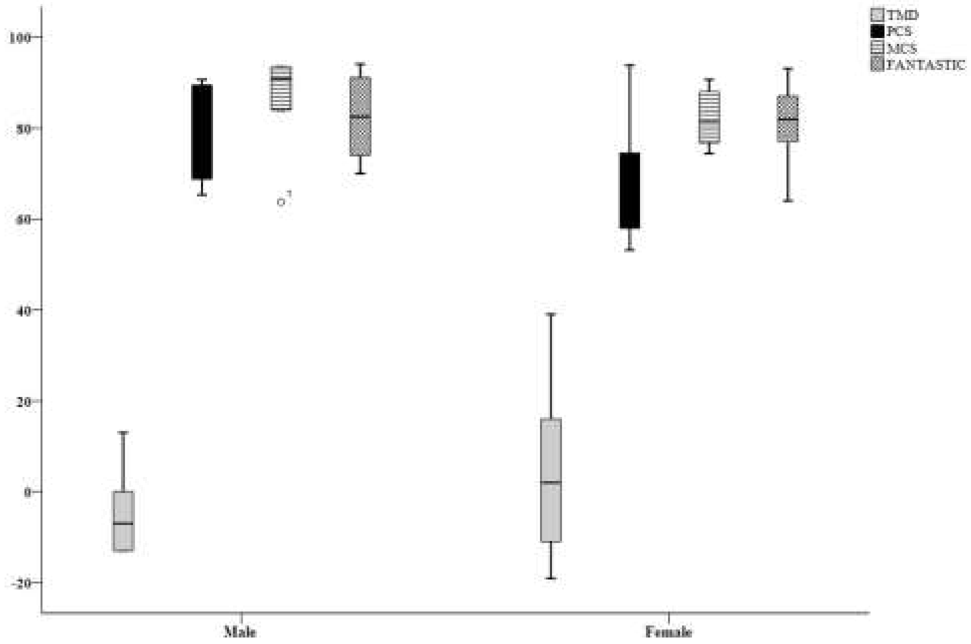
A total of fourteen elite SV players were recruited that included 6 male players and 8 female players. There were not any significant differences in the characteristics variables in table 1 between both groups. Follow-up tests revealed no significant difference of the POMS, SF-36, and FANTASTIC variables between male and female players (Table 2).

Table 2. Comparison of QOL, lifestyle, and mood between male and female elite SV players

Variables	Male (n= 6)	Female (n= 8)	Z	Effect size *r*
	Mean ± SD	Mean ± SD		
Mood				
TN	8.7 ± 3.5	9.3 ± 7.4	-0.19	0.05
DP	1.3 ± 1.8	2 ± 1.5	-0.74	0.19
AG	3.7 ± 3.8	6.4 ± 8.6	-0.13	0.03
FT	4 ± 4.1	3.4 ± 3.7	-0.33	0.09
CF	3.2 ± 1.9	4.9 ± 2.9	-1.38	0.37
VG	25.3 ± 3.2	21.6 ± 5.6	-1.43	0.38
Quality of life				
PF	79.2 ± 27.5	68.8 ± 26.2	-0.98	0.26
PR	86.5 ± 15.1	74.2 ± 20.4	-0.98	0.26
P	58.8 ± 8.3	57.8 ± 23.6	-0.39	0.11
GH	89.2 ± 14.3	72.5 ± 18.9	-1.76	0.47
ER	91.7 ± 10.5	92.7 ± 6.9	0	0
EF	79.2 ± 17.1	64.8 ± 15.9	-1.63	0.44
EW	81.7 ± 14.4	81.9 ± 3.7	-0.67	0.18
SF	91.7 ± 12.9	89.1 ± 18.2	-0.15	0.04
Lifestyle				
Fa	7.6 ± 0.8	7.9 ± 0.4	-0.83	0.22
Ac	6.4 ± 1.3	6.1 ± 0.9	-0.42	0.11
Nu	8.6 ± 2.4	6.9 ± 2.9	-1.22	0.33
To	14.6 ± 0.9	13 ± 2	-1.73	0.46
Al	9.7 ± 2.4	10.9 ± 1.4	-1.01	0.27
Sl	17.9 ± 2.5	16.8 ± 1.9	-1	0.27
Tp	4.9 ± 1.9	5.6 ± 1.8	-0.53	0.14
In	9.1 ± 1.6	10.4 ± 1.6	-1.2	0.32
Ca	3.6 ± 0.8	3.9 ± 0.4	-0.83	0.22

Abbreviations. Mood: TN- tension, DP- depression, AG- anger, FT- fatigue, CF- confusion, VG- vigor; Quality of life: PF- physical functioning, PR- physical role, P- pain, GH- general health, ER- emotional role, EF- energy fatigue, EW- emotional wellbeing, SF- social functioning; Lifestyle: Fa- Family, Ac- Activity, Nu- Nutrition, To- Tobacco, Al- Alcohol, Sl- Sleep, Tp- Type of personality, In- Insight, Ca- Career.

To examine the PCS, MCS, TMD, and FANTASTIC variables more closely, the researchers created the clustered box plot shown in Fig 1. The box plot shows the median, interquartile range, and extreme cases of the variables for both male and female players.



Abbreviations. PCS- physical component score, MCS- mental component score, TMD- total mood disturbance.

Figure 1. Box plot of TMD, PCS, MCS, and FANTASTIC scores.

DISCUSSION

The present study is the first to investigate the psychology aspects (lifestyle, QOL, and mood) between males and female of SV national team players. The results of this chapter demonstrate that substantial differences were not found in the anthropometrical and psychological measures between the two groups. Edwards et al.,[33] in a study found that differences between elite and amateur players revealed that elites had higher scores on the psychological health than the amateurs. In the present study, both of the groups were elite players, which they had differences in sex.

Ku,[34] in a study found that males and females emphasize different aspects of their lives when evaluating their level of QOL. Females with spinal cord injury (SCI) were overrepresented in the group suffering from psychiatric ill health. In another study, researchers found gender differences in both vitality and mental health, when females scored lower than males.[35] Leduc and lepage,[36] also found differences in the vital, mental health, and physical functioning scores between males and females with SCI. However, a study in agreement with our findings found that the QOL scores of people with SCI did not show any significant differences between males and females.[37]

Some evidences shown that sports participation may present an array of psychosocial benefits of critical importance to people with impairments including better QOL, and higher self-esteem, and social functioning.[33,38] Akasaka et al.,[10] found that participating in SV contribute to improve QOL of the players. Also they represented that the SF-36 is an ideal survey to evaluate the QOL of SV players. Arbour et al.,[39] explained that people with physical impairments are at a higher risk of mental health conditions such as depression, which have been related with a lower QOL. Hence, some studies in literature demonstrated that athletes with impairments reported lower scores for depressed mood than non-athletes with impairments.[40-42] The effect sizes demonstrated between Brazilian male and female SV national team players emphasized a big score for male than female players in the vigor for the mood state, energy and fatigue and general health for the QOL, and in the tobacco for the lifestyle. The female SV players had only better score in the confusion for the mood state than male players.

Limitations of this study include a small sample size and a focus on only one sport. Therefore, generalizability of our results may be restricted. However, the fourteen SV players were the extent of the entire male and female Brazilian national SV team at the time of the study who were available. Therefore, there was not the opportunity to test more SV national team players. While the results of the current study clearly demonstrate differences in lifestyle, mood, and QOL aspects among male and female elite Brazilian SV players, these findings provide no information on responsiveness for training SV. Further, while the ability to perform sport skills successfully is constrained by physical, physiological limitations,[43] and level of motor fitness for SV players,[44] no data was collected on the skill levels of the SV players and their ability to play the game. For future researches, obtaining larger samples of Paralympians and other Paralympic sports would support or reject our results.

CONCLUSION

In conclusion, the current study investigated the lifestyle, QOL, and mood state of male and female Brazilian SV players. The results of this study demonstrated there were not significant differences in the psychological aspects of this population. These findings may help SV coach and athletes for having expediency in their training programs.

REFERENCES

1. Vute R. *Teaching and coaching volleyball for the disabled: foundation course handbook*. Ljubljana: University of Ljubljana; Faculty of Education; 2008.
2. De Haan J. *Sitting Volleyball: technique and exercises.* Haarlem: Uitgeverij De Vrieseborch; 1986.
3. Ahmadi S, Uchida MC, Gutierrez GL. Physical performance tests in male and female sitting volleyball players: pilot study of Brazilian national team. *Asian J Sports Med* 2019;10:e85984.
4. Jeoung B. Relationship between sitting volleyball performance and field fitness of sitting volleyball players in Korea. *J Exerc Rehabil* 2017;13:647-652.
5. Rimmer JH, Ming CH, McCubbin JA, Drum CH, Peterson J. Exercise intervention research on persons with disabilities: what we know and where we need to go. *Am J Phys Med Rehabil* 2010;89:249–263.
6. Tasiemski T, Bergstrom E, Savic G, Gardner BP. Sports, recreation and employment following spinal cord injury: Pilot study. *Spinal Cord* 2000;38:173-184.
7. Tomasone JR, Wesch NN, Ginis KAM, Noreau L. Spinal Cord Injury, Physical Activity, and Quality of Life: A Systematic Review. *Kinesiology Review* 2013;2:113-129.
8. Mahoney MJ, Avener M. Psychology of the elite: An exploratory study. *Cogn Ther Res* 1977;1:135–141.
9. Mockeviciene D, Savenkoviene A. Aspects of life quality of persons with physical disabilities. *Social Welfare Interdisciplinary Approach*, 2012;2:84-93.
10. Akasaka K, Yasuyuki T, Osamu O, Shusuke K, Tetsou S, Mitsuru Y, Naoyuki O, Kuniyasu T, Yousuke K. SF-36 Health Survey in Disabled Sitting Volleyball Players in Japan. *Journal of Physical Therapy Science* 2003;15:71–73.
11. Vute R, Krpač F. Sporting Values Among Europe's Elite Sitting-Volleyball Players. *Acta Gymnica Journal* 2000;30:33-39.
12. Bagarić, K., Tudor, A., & Ružić, L. Sitting volleyball and some aspects of the quality of life in athletes with disabilities. *Hrvatski športskomedicinski vjesnik.* 2016;31:70-78.
13. Lastella M, Lovell GP, Sargent C. Athletes' precompetitive sleep behaviour and its relationship with subsequent precompetitive mood and performance. *Eur J Sport Sci* 2014;14:123-130.

14. Kontos AP, Covassin T, Elbin R, Parker T. Depression and neurocognitive performance after concussion among male and female high school and collegiate athletes. *Arch Phys Med Rehabil*. 2012;93: 51-56.
15. Martin JJ, Malone LA, Hilyer JC. Personality and mood in women's Paralympic basketball champions. *J Clin Sport Psychol* 2011;5:197-210.
16. Kreher JB, Schwartz JB. Overtraining syndrome: a practical guide. *Sports Health* 2012;4:128-138.
17. Rodrigues DF, Silva A, Rosa JPP, Ruiz FS, Veríssimo AW, Winckler C, Rocha EA, Parsons A, Tufik S, Mello MT. Profiles of mood states, depression, sleep quality, sleepiness, and anxiety of the Paralympic athletics team: A longitudinal study. *Apunts. Medicina de l'Esport* 2017; 52:93-101.
18. Martin JJ. *Psychological skills for athletes with physical disabilities*. Handbook of applied sport psychology. New York: Routledge Publishing; 2010:432–440.
19. World Organization Volleyball for Disabled. Official Sitting Volleyball Rules 2011–2012. The Netherlands: Author. http://www.worldparavolley.org/wp-content/uploads/2017/06/2017-2020-SITTING-Volleyball-Rules-with-Diagrams.pdf.
20. Marszałek J, Molik B, Gomez MA, Skučas K, Pokvytyte V, Mucha JL, Witold Rekowski W. Sitting Volleyball Classification System: The Athletes' Perspective. *Revista de Psicología del Deporte*. 2019;28:25-32.
21. Ware JE. SF-36 health survey update. *Spine*. 2000;25:3130-3139.
22. Ciconelli RM, Ferraz MB, Santos W, Meinão I, Quaresma MR. Brazilian-Portuguese version of the SF-36. A reliable and valid quality of life outcome measure. *Revista Brasileira de Reumatologia*. 1999;39:143-150.
23. Wilson DMC, Ciliska D. Lifestyle assessment: Development and use of the FANTASTIC checklist. *Canadian Family Physician*. 1984;30:1527–1532.
24. CSEF - Canadian Society for Exercise Physiology. *The Canadian Physical Activity, Fitness and Lifestyle Appraisal: CSEP's guide to health active living*. (2nd ed). Ottawa: CSEF; 2003.
25. Añez CRR, Reis RS, Petroski EL. Brazilian Version of a Lifestyle Questionnaire: Translation and Validation for Young Adults. *Arquivos Brasileiros de Cardiologia*. 2008;91(2):92-98.
26. McNair DM, Lorr M, Droppleman LF. *Manual for the Profile of Mood States*. San Diego; CA: EdITS/Educational and Indus-trial Testing Service; 1992.
27. LeUnes A. Updated bibliography on the Profile of Mood States in sport and exercise psychology research. *J Appl Sport Psychol*. 2000;12:110–113.
28. Campbell E. Psychological well-being of participants in wheelchair sports: Comparison of individuals with congenital and acquired disabilities. *Percept Mot Skills*. 1995;81:563–568.
29. Viana MF, Almeida PLD, Santos RC. Adaptação portuguesa da versão reduzida do Perfil de Estados de Humor: POMS. *Análise Psicológica*. 2001;19:77-92.

30. Heirani A, Ahmadi S. *Evaluation and measurement in physical education*. Razi University Publication; 2012.
31. Shapiro SS, Wilk MB. An Analysis of Variance Test for Normality (Complete Samples). *Biometrika*. 1965;52:591-611.
32. Fritz CO, Morris PE, Richler JJ. Effect size estimates: current use, calculations, and interpretation. *J Exp Psychol Gen*. 2012;141:2-18.
33. Edwards SD, Ngcobo HSB, Edwards DJ, Palavar K. Exploring the relationship between physical activity, psychological well-being and physical self-perception in different exercise groups. *AJOL.* 2005;27:75-90.
34. Ku JH. Health-Related Quality of Life in Patients with Spinal Cord Injury: Review of the Short Form 36-Health Questionnaire Survey. *Yonsei Med J*. 2007;48(3):360-370.
35. Westgren N, Levi R. Quality of life and traumatic spinal cord injury. *Arch Phys Med Rehabil*. 1998;79(11):1433-9.
36. Leduc BE, Lepage Y. Health-related quality of life after spinal cord injury. *Disabil Rehabil*. 2002;24(4):196-202.
37. Oh SJ, Ku JH, Jeon HG, Shin HI, Paik NJ, Yoo T. Health-related quality of life of patients using clean intermittent catheterization for neurogenic bladder secondary to spinal cord injury. *Urology*. 2005;65(2):306-10.
38. Tweedy SM, Beckman EM, Johnston LM, Connick MJ. Performance focused sport– an avenue to gold-medal clinical outcomes for people with neurological impairments? *Brain Impairment.* 2016;17:99–110.
39. Arbour KP, Latimer AE, Ginis MKA, Jung ME. Moving beyond the stigma: The impression formation benefits of exercise for individuals with a physical disability. *Adapt Phys Act Q.* 2007;24:144–159.
40. Campbell E, Jones G. Psychological well-being in wheelchair sport participants and nonparticipants. *Adapt Phys Act Q*. 1994;11:404–415.
41. Jacobs DP, Roswal GM, Horvat MA, Gorman DR. *A comparison between the psychological profiles of wheelchair athletes, wheelchair non-athletes, and able bodied athletes*. Adapted physical activity: An interdisciplinary approach; New York; Springer-Verlag; 1990:75–79.
42. Martin DT, Andersen MB, Gates W. Using the Profile of Mood States (POMS) to monitor high-intensity training in cyclists: Group versus case studies. *Sport Psychol*. 2000;14:138–156.

43. Starkes JL, Ericsson KA. *Expert Performance in Sports. Advances in Research on Sport Expertise*. Champaign, IL: Human Kinetics; 2003.

44. Jadczak Ł, Kosmol A, Wieczorek A, Śliwowski R. Motor Fitness and Coordination Abilities Vs. Effectiveness of Play in Sitting Volleyball. *Antropomotoryka Journal*. 2010;49:57-67.

CONCLUSIONS

The chapters presented here provide an overview of the elite Brazilian SV players in physical, and psychological aspects, in which in all aspects gender differences of this population were considered.

In the first chapter, the male players presented higher scores in all the performance tests. From a coaching perspective, as female players are often need to perform the same tasks as male players during SV practice, they may have a primary disadvantage in power-based activities. In addition, in this chapter we presented a descriptive profile of IR and ER for glenohumeral strength in elite male and female SV players. These para-athletes have an asymmetrical rotational strength profile. As muscular imbalance is a common injury pattern in overhead players, more studies need to be conducted and focused on SV players in this field. Findings of this chapter may assist the SV coaches, trainers and physiotherapists in the evaluation and training of strength the ER and IR shoulders of SV players. Accordingly, female players should try to develop their upper limbs performance during SV training period with strength and conditioning coaches. On the other hand, physical performance in SV is just a part of it, also game skills like pass, serve and spike or perceptual-cognitive skills like anticipation, pattern recall, and decision making could be more important.

In the second chapter, it was found that, a high degree of reliability between ADP and SF measurements. Finally, considering the magnitude of space, expense, and other limitations related with the ADP method against the SF method, we recommend the use of inexpensive and easily applied SF method is a valid and viable method for measuring body composition in elite SV players, which it helps SV coaches monitor training progress of the athletes.

In the last chapter, which investigated the lifestyle, QOL, and mood state of male and female Brazilian SV players. The results of this chapter demonstrated there were not significant differences in the psychological aspects of this population. These findings may help SV coach and athletes for having expediency in their training programs.

There is a necessity to continue the study on larger sample size groups of SV players in international level to confirm the results of the present research. Future studies should investigate game skills among male and female players from multiple international Paralympic teams. In clinical implication perspective, the present research can be seen as a first step in establishing a reference base concerning physical and psychological aspects in this specific para-athlete population. Also, this reference base could help Paralympic coaches, physiotherapists and Para-sports physicians in the evaluation and classification of SV players.

REFERENCES

1. Vute R. *Teaching and coaching volleyball for the disabled: foundation course handbook*. Ljubljana: University of Ljubljana; Faculty of Education; 2008.
2. De Haan J. *Sitting Volleyball: technique and exercises*. Haarlem: Uitgeverij De Vrieseborch; 1986.
3. Lee YA, Kim HC. Application of intensified program to increase physical fitness, mobility and confidence on specific sports among volleyball sitting athletes. *Korean Phys Mult Disabil*. 2010;53:89-109.
4. Jeoung B. Relationship between sitting volleyball performance and field fitness of sitting volleyball players in Korea. *J Exerc Rehabil*. 2017;13(6):647-652.
5. Fatih Yuksel M, Sevindi T. Physical fitness profiles of sitting volleyball players of the Turkish National Team. *Universal J Educ Res*. 2018;6(3):556–61.
6. Marszalek J, Molik B, Gomez MA, et al. Relationships between anaerobic performance, field tests and game performance of sitting volleyball players. *J Hum Kinet*. 2015;48:25–32.
7. Ahmadi S, Uchida MC, Gutierrez GL. Physical Performance Tests in Male and Female Sitting Volleyball Players: Pilot Study of Brazilian National Team. *Asian J Sports Med*. 2019;10(2):e85984.
8. Molik B, Morgulec-Adamowicz N, Marszałek J, Kosmol A, Rutkowska I, Jakubicka A, Kaliszewska E, Kozłowski R, et al. Evaluation of game performance in elite male sitting volleyball players. *Adapt Phys Activ Q*. 2017;34:104-124.
9. Andersen CH, Zebis MK, Saervoll C, Sundstrup E, Jakobsen MD, Sjogaard G, Andersen LL. Scapular muscle activity from selected strengthening exercises performed at low and high intensities. *J Strength Cond Res*. 2012;26(9): 2408–2416.
10. Vlychou M, Spanomichos G, Chatziioannou A, Georganas M, Zavras GM. Embolisation of a traumatic aneurysm of the posterior circumflex humeral artery in a volleyball player. *Br J Sports Med*. 2001;35:136-137.
11. Ackland TR, Lohman TG, Sundgot-Borgen J, Maughan RJ, Meyer NL, Stewart AD. Current status of body composition assessment in sport: Review and position statement on behalf of the ad hoc research working group on body composition health and performance, under the auspices of the I.O.C. Medical commission. *Sports Medicine*. 2012;42(3):227–249.
12. Madsen OR, Jensen JE, Sorensen OH. Validation of a dual energy X-ray absorptiometer: Measurement of bone mass and soft tissue composition. *European Journal of Applied Physiology*. 1997;75(6):554–558.

13. Shreeve S, Rowley N, Gilby C, Mitchell N. Changes in body composition and performance of a cerebral palsy Paralympic athlete in preparation for the London Paralympic games. *British Journal of Sports Medicine*. 2013;47(17):e4–e4.
14. Rimmer JH, Ming CH, McCubbin JA, Drum CH, Peterson J. Exercise intervention research on persons with disabilities: what we know and where we need to go. *Am J Phys Med Rehabil.* 2010;89:249–263.
15. Tasiemski T, Bergstrom E, Savic G, Gardner BP. Sports, recreation and employment following spinal cord injury: Pilot study. *Spinal Cord.* 2000;38:173-184.
16. Tomasone JR, Wesch NN, Ginis KAM, Noreau L. Spinal Cord Injury, Physical Activity, and Quality of Life: A Systematic Review. *Kinesiology Review.* 2013;2:113-129.
17. Mahoney MJ, Avener M. Psychology of the elite: An exploratory study. *Cogn Ther Res* 1977;1:135–141.
18. Mockeviciene D, Savenkoviene A. Aspects of life quality of persons with physical disabilities. *Social Welfare Interdisciplinary Approach*, 2012;2:84-93.
19. Vute R, Krpač F. Sporting Values Among Europe's Elite Sitting-Volleyball Players. *Acta Gymnica Journal* 2000;30:33-39.
20. Bagarić, K., Tudor, A., & Ružić, L. Sitting volleyball and some aspects of the quality of life in athletes with disabilities. *Hrvatski športskomedicinski vjesnik.* 2016;31:70-78.
21. Lastella M, Lovell GP, Sargent C. Athletes' precompetitive sleep behaviour and its relationship with subsequent precompetitive mood and performance. *Eur J Sport Sci* 2014;14:123-130.
22. Kontos AP, Covassin T, Elbin R, Parker T. Depression and neurocognitive performance after concussion among male and female high school and collegiate athletes. *Arch Phys Med Rehabil.* 2012;93: 51-56.
23. Martin JJ, Malone LA, Hilyer JC. Personality and mood in women's Paralympic basketball champions. *J Clin Sport Psychol* 2011;5:197-210.
24. Vute R. *Teaching and coaching volleyball for the disabled, foundation course handbook*. Ljubljana: World Organisation of Volleyball for the Disabled; 2009.
25. Kolkka T, Williams T. Gender and disability sport participation: Setting a sociological research agenda. *Adapt Phys Act Q*. 1997; 14(1):8–23.
26. Tikuisis P, Meunier P, Jubenville CE. Human body surface area: Measurement and prediction using three dimensional body scans. *Eur J Appl Physiol*. 2001; 85(3-4):264–71.
27. Cote JN. A critical review on physical factors and functional characteristics that may explain a sex/gender difference in workrelated neck/shoulder disorders. *Ergonomics*. 2012;55(2):173–82.
28. Rohr LE. Gender-specific movement strategies using a computer-pointing task. *J Mot Behav*. 2006;38(6):431–7.

29. Saucier D, Lisoway A, Green S, Elias L. Female advantage for object location memory in peripersonal but not extrapersonal space. *J Int Neuropsychol Soc*. 2007;13(4):683–6.
30. Croft L, Dybrus S, Lenton J, Goosey-Tolfrey V. A comparison of the physiological demands of wheelchair basketball and wheelchair tennis. *Int J Sports Physiol Perform*. 2010;5(3):301–15.

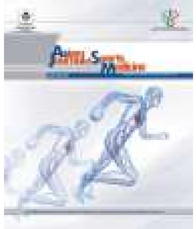
APPENDIX I

MEMORANDUM OF THE PhD PERIOD

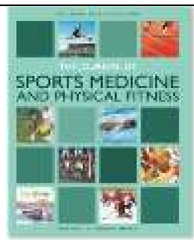
Shirko Ahmadi joined UNICAMP as a PhD student in 2017 through the selective process of the Department of Physical Education. With financial assistance from CAPES, he studied 3 compulsory subjects including FF017-Adaptations of organic systems to physical training; FF068-Independent studies in adapted physical education; FF194-Physiological bases of neuromuscular adaptation in physical activity, as well as Shirko participated as Training Assistant (PED) for undergraduate students in 2017 and 2019 (totally 24 credits). He has also published and submitted several article related to the PhD project which to the date, 1 article published, 1 article accepted, 8 articles submitted, and 5 congress participated.

APPENDIX II

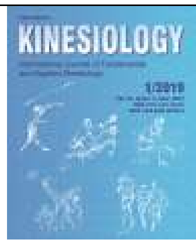
ARTICLES PUBLISHED IN JOURNALS

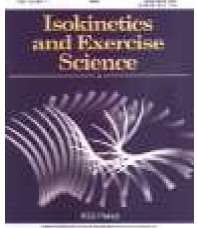
1	**Physical performance tests in male and female Sitting volleyball players: pilot study of Brazilian national team** Shirko Ahmadi, Marco Carlos Uchida, Gustavo Luiz Gutierrez ***Asian J Sports Med. 2019; 10(2):e85984.***	

ARTICLES ACCEPTED IN JOURNALS

1	**Asymmetry in glenohumeral muscle strength of Sitting volleyball players: an isokinetic profile of shoulder rotations strength** Shirko Ahmadi, Gustavo L. Gutierrez, Marco C. Uchida ***The Journal of Sports Medicine and Physical Fitness***	

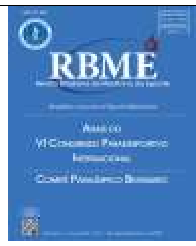
ARTICLES SUBMITTED IN JOURNALS

1	**Importance of physical performance and anthropometric measurements in sitting volleyball players: A systematic review** Shirko Ahmadi, Marco C. Uchida, Gustavo L. Gutierrez ***Asian Journal of Sports Medicine***	
2	**Sitting volleyball players: physical and psychological characteristics between national and league teams** Shirko Ahmadi, Jolanta Marszałek, Gustavo L. Gutierrez, Marco C. Uchida ***Kinesiology***	
3	**Handgrip strength correlated with isokinetic data of the shoulder muscles in elite Sitting volleyball players** Shirko Ahmadi, Gustavo L. Gutierrez, Marco C. Uchida ***Journal of Bodywork & Movement Therapies***	

4	**Chest pass test is not correlated with isokinetic data of the shoulder muscle rotators in elite Sitting volleyball players** Shirko Ahmadi, Ronaldo G. Oliveira,Valéria Bonganha, Gustavo L. Gutierrez, Marco C. Uchida ***Isokinetics and Exercise Sciences***	
5	**Quality of life in Sitting volleyball players** Shirko Ahmadi, Ahmad Fallahi, Edison Duarte, Maria L. T. Alves, Marco C. Uchida, Gustavo L. Gutierrez ***Physical Culture and Sport. Studies and Research***	
6	**Quality of life and mood in Sitting volleyball: a comparison between international and national players** Shirko Ahmadi, Marco C. Uchida, Gustavo L. Gutierrez ***MEDICINA DELLO SPORT***	
7	**Quality of life, lifestyle, and mood states in male and female elite Sitting volleyball players** Shirko Ahmadi, Marco C. Uchida, Gustavo L. Gutierrez ***Iranian Rehabilitation Journal***	
8	**Analysis of the body composition of highly-trained Sitting volleyball players by Skinfolds and Air-displacement plethysmography methods: A pilot study** Shirko Ahmadi, Ronaldo G. Oliveira, Gustavo L. Gutierrez, Marco C. Uchida ***Journal of Rehabilitation Medicine***	

CONGRESSES

1	**Relationships between Hip circumference and play levels of Sitting volleyball players.** Shirko Ahmadi, Ronaldo G. Oliveira, Marco C. Uchida, Gustavo L. Gutierrez *Internacional simpósio de atividades fisicas adaptadas* **Sao Carlos, Brazil, 2019**	

2	**Agility in Sitting Volleyball: case study Brazilian national team players** Shirko Ahmadi, Ronaldo G. Oliveira, Marco C. Uchida, Gustavo L. Gutierrez *VI International Paralympic Congress* **Sao Paulo, Brazil, 2018**	
3	**Quality of life among disabled athletes and non-athletes with disabilities** Shirko Ahmadi, Siavash Moshvaziri, Marco C. Uchida, Gustavo L. Gutierrez *VI Congresso Sudeste de Ciências do Esporte* **Campinas, Brazil, 2018**	
4	**Assessment of quality of life among iranian male amateur athletes via WHOQOL-Brief** Shirko Ahmadi, Ahmad Fallahi, Marco C. Uchida, Gustavo L. Gutierrez *World Academy of Science, Engineering and Technology* **Amsterdam, Netherlands, 2018**	
5	**Sitting volleyball among Brazilian and Iranian teams: in point of view Newell's constraints theory** Shirko Ahmadi, Marco C. Uchida, Gustavo L. Gutierrez *IV Fórum Dos Pesquisadores Pedagógica da Educação Física.* **Campinas, Brazil, 2017**	

APPENDIX III

UNICAMP - CAMPUS CAMPINAS

CEPUNICAMP

Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: PERFIL DE JOGADORES DE VOLEIBOL SENTADO SEGUNDO O MODELO DE RESTRIÇÕES DE NEWELL: ASPECTOS FUNCIONAIS, PSICOLÓGICOS E DE ESTILO E VIDA.

Pesquisador: Shirko Ahmadi

Área Temática:

Versão: 2

CAAE: 86614218.5.0000.5404

Instituição Proponente: Faculdade de Educação Física

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 2.670.262

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

CAMPINAS, 23 de Maio de 2018

Assinado por:
Renata Maria dos Santos Celeghini
(Coordenador)

Endereço: Rua Tessália Vieira de Camargo, 126
Bairro: Barão Geraldo **CEP:** 13.083-887
UF: SP **Município:** CAMPINAS
Telefone: (19)3521-8936 **Fax:** (19)3521-7187 **E-mail:** cep@fcm.unicamp.br