Indicators of Health and Quality of Life of People with Disabilities – Sitting Volleyball Players

Summary of the Doctoral Thesis for obtaining the scientific degree “Doctor of Science (PhD)”

Sector Group – Medical and Health Sciences
Sector – Health Sciences
Sub-Sector – Sports Medicine and Rehabilitation

Riga, 2023
Pāvels Mustafīns
ORCID 0000-0002-7017-911X

Indicators of Health and Quality of Life of People with Disabilities – Sitting Volleyball Players

Summary of the Doctoral Thesis for obtaining the scientific doctoral degree “Doctor of Science (PhD)”

Sector Group – Medical and Health Sciences
Sector – Health Sciences
Sub-Sector – Sports Medicine and Rehabilitation

Riga, 2023
The Doctoral Thesis was developed at the Faculty of Rehabilitation of the Rīga Stradiņš University (RSU) through the years 1995 to 2022

Scientific Supervisor:

Dr. med., Professor Aivars Vētra,
Rehabilitation Department of Rīga Stradiņš University, Latvia

Official Reviewers:

Dr. med., Professor Ivars Vanadziņš, Rīga Stradiņš University, Latvia

PhD, Professor Aija Kļaviņa, Latvian Academy of Sport Education

Emeritus Professor Nicolas Christodoulou, European University Cyprus

Defence of the Doctoral Thesis in Health and Sports Sciences will take place at the public session of the Promotion Council on 7 June 2023 at 13.00 via online platform Zoom

The Doctoral Thesis is available in RSU Library and on RSU website: https://www.rsu.lv/en/dissertations

Secretary of the Promotion Council:

Dr. med., Assistant Professor Guna Bērziņa
Table of Contents

Abbreviations used in the Thesis ................................................................. 4
Introduction ....................................................................................................... 5
  Aim of the Thesis .......................................................................................... 7
  Objectives of the Thesis ............................................................................... 7
  Hypotheses of the Thesis ............................................................................. 8
  Scientific novelty of the Thesis .................................................................... 8
1 Material and methods ................................................................................... 9
  1.1 Design and ethical aspects of the study ................................................... 9
  1.2 Assessment of quality of life ................................................................... 10
  1.3 Assessment of physical working capacity ............................................. 11
  1.4 Assessment of specific sports skills ....................................................... 11
  1.5 Data processing and statistical analysis ................................................. 12
2 Results ......................................................................................................... 13
  2.1 Characteristics of Latvian and international sitting volleyball players ........................................................................................................... 13
  2.2 Results of SF36 survey ........................................................................... 14
  2.3 Assessment based on norms ................................................................... 14
  2.4 Data of cardiorespiratory work capacity tests ...................................... 15
    2.4.1 Heart rate monitoring ..................................................................... 15
    2.4.2 Arm ergometry tests ...................................................................... 17
  2.5 Results of assessment of specific sports skills ...................................... 17
  2.6 Description of traumas limiting participation of athletes in sitting volleyball ........................................................................................................... 18
3 Discussion ...................................................................................................... 21
  3.1 SF-36v2 surveying .................................................................................. 21
  3.2 Testing of physical work capacity and physiological characteristics of sitting volleyball players ........................................................................................................... 23
    3.2.1 Cycle tet ....................................................................................... 23
    3.2.2 Arm ergometry test ...................................................................... 24
  3.3 Assessment of specific sports skills in Paralympic sports depending on medical and functional classification .............................................................. 25
  3.4 Analysis of predisposed factors of sports traumas and myoskeletal complaints in sitting volleyball .................................................................................. 26
Conclusions ...................................................................................................... 30
Publications and reports on the topic of the study ........................................ 33
Bibliography .................................................................................................... 36
Acknowledgements ......................................................................................... 40
**Abbreviations used in the Thesis**

BP  Bodi y pain
CF  Cardiac frequency
D  Disability (functioning limitations)
GH  General health
MCF  Maximum cardiac frequency
MCS  Mental health component summary
MD  Minimal disability
MH  Mental health
PCS  Physical health component summary
PF  Physical functioning
PWC170  Physical work capacity at heart rate of 170 beats per minute
RE  Role-emotional
RP  Role-physical
SF  Social functioning
V  Vitality
VO2max  Maximum oxygen consumption
VOS  Visual observation scale
Introduction

A human person as a social being is characterised by his/her functional abilities that are determined by interaction of the individual with the physical and social environment.

The life quality criterion is one of the most important criteria used to characterise the level of social integration of a person with limited functioning – a person with a disability. The quality of life is determined by individual’s ability to engage in social activities, including regular physical activities and sports events, such as the sitting volleyball. The sitting volleyball is practiced by about 20 000 players in all continents, and several hundreds of players take part in international competitions on a regular basis. The significant difference between the Olympic and Paralympic sports is the necessity to apply objective medical and functional classification system of Paralympic athletes that allows to divide the athletes into groups that correspond their functioning disorders and ensures equal competition for all athletes. In the sitting volleyball like in other kinds of sports this classification should describe correlation between certain movement capacity of the person’s functioning restrictions and the specific movements necessary for sitting volleyball (International Paralympic Committee, 2007).

Regular engagement in sports activities may be the cause of secondary health disorders and traumas, including cumulative traumas, limitations on physical abilities and secondary functioning. Sports traumas rank first by significance among all problems tackled by sports medicine. Still, there are insufficient studies of changes and damages to the locomotor system of sitting volleyball players (Howe, 2006; Ferrara, et al., 1992; Webborn, Willick, & Reeser, 2006), as well as their cardiorespiratory work capacity (Reeser, 2003).
The instrument for assessing the quality of life that is most often mentioned in the world’s medicine literature is SF-36 and SF-36v2 questionnaires (Quality Metric Inc., USA).

SF-36 surveys have been recognized as a trusted and useful method to assess the quality of life of healthy people and also people with different health disorders. (Hoogendoorn & van der Werken, 2001); (Hu, Gruber, & Hsueh, 2010; Wylie, Bershadsky, & Iannotti, 2010; Muhsen, Garty-Sandalon, Gross, & Green, 2010; Rameh & Magnan, 2010; Lahti, Laaksonen, Lahelma, & Rahkonen, 2010; Hemsley, Sitler, Moyer, & Oatis, 2010; Patel & Hamadeh, 2009; Tomey, Sowers, Zheng, & Jackson, 2009; Rogliani, Gentile, Labardi, Donfrancesco, & Cervelli, 2009; Cerin, Leslie, Sugiyama, & Owen, 2009), (Lustig, et al., 2009; Salzmann, et al., 2009; Karachalios, et al., 2009; Rhebergen, et al., 2010; Bekkers, de Windt, Raijmakers, Dhert, & Saris, 2009; Beebe, et al., 2009; Zidarov, Swaine, & Gauthier-Gagnon, 2009; Engelhardt, et al., 2008; Brandes, Schomaker, Möllenhoff, & Rosenbaum, 2008; Hafner, Willingham, Buell, Allyn, & Smith, 2007). The average life quality indicators for patients with different disorders of locomotor system and nervous system, according to SF-36 surveys, are lower than average in the population.

For people with permanent disorders of the locomotor system and nervous system there are several additional risk factors that promote sports traumas that are related to changed posture and biomechanics of movement, disturbed neurological control of movements. Literature sources describe data on people with disabilities who have reduced or even completely ceased their sports activities because they have had secondary damage to the locomotor system. The number of such people is growing both among beginners and top-class athletes (Howe, 2006; Ferrara, et al., 1992; Ferrara & Peterson, 2000; Webborn, Willick, & Reeser, 2006).
Restrictions of sports activities for people with disabilities can appear both due to acute traumas and damages of the locomotor system, and also after several years of training due to cumulative (chronic overload) traumas. Such incapability might turn very tough for the athlete because after 10–15 years of daily training the athlete might not be able to participate in the Paralympic games.

The set of these issues defined the topicality of the aim of the present Doctoral Thesis.

Aim of the Thesis

The aim of the study is to discover how regular sitting volleyball trainings influence the quality of life and functional abilities of people with disabilities.

Objectives of the Thesis

- To gather information about sitting volleyball players in Latvia and the world.
- To assess the quality of life of sitting volleyball players, assessing their level of integration in leisure activities.
- To assess cardiorespiratory work capacity of sitting volleyball players.
- To assess cardiorespiratory work capacity of people who have had amputations at different levels but who are not engaged in any sports activities.
- To assess the specific sports skills of sitting volleyball players, depending on their sports medical and functional class.
- To discover secondary health disorders of sitting volleyball players related to sports activities, including locomotor system traumas.
Hypotheses of the Thesis

People with amputated lower limbs, who regularly engage in sitting volleyball, have a better life quality.

People with amputated lower limbs, who are regularly engaged in sitting volleyball, have higher cardiorespiratory work capacity than people with amputated lower limbs, who are not engaged in sports activities.

The specific sports skills of sitting volleyball players do not depend on their medical or functional class.

Sitting volleyball players have predisposed (risk) factors of certain specific sports traumas, also cumulative traumas, the impact can be reduced by taking preventive measures.

Scientific novelty of the Thesis

- The quality of life of people with disabilities, who regularly engage in sitting volleyball, has been assessed.
- Cardiorespiratory work capacity and specific sports skills of people with disabilities, who regularly engage in sitting volleyball, have been assessed.
- A long-term study on sports traumas and secondary health disorders for sitting volleyball players.
- Analysis of predisposed (risk) factors of secondary locomotor system damages (traumas) of sitting volleyball players has been conducted in order to develop programmes preventing sports traumas in sitting volleyball.
- Information has been gathered about preconditions for development of the medical and functional classification system of sitting volleyball players.
1 Material and methods

1.1 Design and ethical aspects of the study

Collecting and compiling of the data was conducted anonymously – in line with the Vienna Declaration and Programme of Action. The study was conducted voluntarily. The study was conducted with the support of the European Committee Volleyball for Disabled (ECVD) and the medical research commission of the World Paravolley Foundation (WORLD PARAVOLLEY).

The permission of the Rīga Stradiņš University Ethics Commission was granted in March 2008. Academic structures of other countries engaged in the study received permissions of the ethics commissions of the responsible institutions.

Documentation for the Latvian sitting volleyball players was arranged in line with the general regulations, regulations on patient care of the Latvian Centre for Sports Medicine and Physical Rehabilitation (later, the State Agency for Sports Medicine), and the medical assurance of patients of the Latvian Paralympic Committee.

The study has five sections. The study was conducted while working with Latvian and foreign sitting volleyball players, performing the duties of international medical classification expert.

Participants of the study were people with disabilities, who play sitting volleyball on a regular basis. In Latvia, the health condition of sitting volleyball players, who play sitting volleyball at least twice a week, were examined.

The composition of sitting volleyball players:
1) Latvian sitting volleyball players – 20 people, the candidates of the Latvian sitting volleyball team for the Paralympic games;
2) Players of other sitting volleyball teams who had qualified for the Beijing Paralympic Games – 180 people.
1.2 Assessment of quality of life

A survey was used to assess the quality of life, applying SF-36v2 Health Quality Questionnaire as an instrument (Quality Metric Incorporated, USA, SF36v2) (Bennett, et al., 2005; Bjorner, Kosinski, & Ware, 2005; Fernández-Fairen, Sala, Ramírez, & Gil, 2007; Taft, Karlsson, & Sullivan, 2000).

SF-36v2 is an instrument to determine the health condition, and it is not aimed at any specific gender or age group of patients. SF-36v2 is an instrument to measure health condition on eight scales (or aspects) that are considered important, describing and examining individuals with diseases or health disorders. The survey assesses these health components from the point of view of human functioning. SF-36v2 assesses health in a general, broad sense – using health concepts that reflect basic human values that are relevant to everyone’s functional condition and well-being, regardless of age, gender or diagnosis.

The 1998 norms-based scoring was used to analyse data from health-related quality of life assessments in groups of patients with different functional impairments. When assessing both individual and group results, such an assessment is superior to the transformed assessment on a scale of 0–100. With norm-based scoring, each scale has the same arithmetic mean (50) and standard deviation (10). This method allows, for example, the following situation to be assessed: if a group of respondents scores lower than 47 on a scale, then the health indicator in question is below average. Such norms reflect a broad cross-section of the general population, allowing the transformation and cross-comparison of various previous Quality Metric Inc. survey results – including the SF-36. Norms-based assessment allows to compare results of different studies.
1.3 Assessment of physical working capacity

The following tests have been used to measure cardiorespiratory capacity:

- **PWC\textsubscript{170}** (*Physical Working Capacity*) cycle ergometer test – a test of physical working capacity, during which the patient performs three different levels of exercise on a cycle ergometer for 9 minutes, reaching a heart rate of 170 x’ at the end of the test;
- Cycling ergometry exercise test with gradual continuously increasing load, ECG recording in 12 sessions, under control of blood pressure and electrocardioscopic monitoring;
- Cycle test and arm ergometry test in Latvia was conducted for sitting volleyball players:
  a. cycle tests – 20 sitting volleyball players;
  b. arm ergometry test – 20 sitting volleyball players;
  c. attraction of contingent – voluntary, during routine specialized medical examinations.

1.4 Assessment of specific sports skills

The study assessed specific sports skills of sitting volleyball players based on their functional medical classification and anthropometric data. Method: recording specialized games and assessment of game episodes. Contingent – 72 sitting volleyball players in international competitions.

The study assessed basic moves of sitting volleyball: 1) serve; two episodes of attack: 2) hands over head, playing with fingers, 3) spike; 4) receiving the ball (including in movement); 5) passing the ball (upper – with hands above the head, with fingers, lower – with forearms); 6) blocking the ball.
A specially developed visual observation scale (VOS) of sitting volleyball players was used for the analysis to provide quantitative assessment of the basic moves of sitting volleyball players. During the study, three groups of players were controlled: 1) with disability (D), 2) with minimal disability (MD), 3) without disability or able (A). The participants were added to the D and MD groups based on the medical classification criteria of WORLD PARA VOLLEY.

1.5 Data processing and statistical analysis

Results of the study and statistical analysis were processed, using Microsoft Excel and also Quality Metric Inc. original statistics software (Ware, Kosinski, & Bjorner, 2007).

The following descriptive statistical methods were applied:

- average value,
- standard deviation of the average value,
- 95% confidence interval of the average value (CI),
- correlation coefficient,
- percentage.

The following was used for the statistical analysis:

- Pearson correlation coefficient (r),
- Spearman rank correlation coefficient (r),
- Cronbach alpha correlation coefficient (Rtt).
- Value of significance level p that is less than 0.05 (p < 0.05) has been considered statistically reliable.
2 Results

2.1 Characteristics of Latvian and international sitting volleyball players

The Latvian contingent of sitting volleyball players are people with different orthopaedic and neurological disorders and respective movement limitations. The biggest contingent of sitting volleyball players are people with lower limb deficiencies.

Amputations were mostly unilateral, on the level of upper leg and lower leg. Men were on average by five years older than women. The average time of disability (functional limitations) for men was by 3–4 years longer than for women. The length of disabled status varied between two and 25 years – depending on the character of functional limitations. Men had been engaged in sitting volleyball by 1–2 years longer than women. The average time they had been playing sitting volleyball was 2–3 years. Players with degenerative locomotor diseases were the oldest ones.

Sitting volleyball players from abroad were mostly people with amputated lower limbs. The average age of the players was 30 years (from 27.1 ± 5.0 to 35.5 ± 5.7), without any significant age difference between genders. The length of functional limitations had been from 5 to 25 years.

The time after amputation of lower limbs was five years on average for men and seven years for women. The average time they had been playing sitting volleyball was 4–5 years both for women and men.
2.2 Results of SF36 survey

Questionnaires, filled in line with all requirements and verified, were received from 75 players (43 women and 32 men). Those are 37.5% of all distributed questionnaires (20 questionnaires were distributed to the Latvian team, and 180 questionnaires to foreign teams, altogether 200 questionnaires).

After assessment of the survey data, it was concluded that both physical (PCS) and mental (MCS) health summary indicators for sitting volleyball players were lower than average population norms (US norms). MCS showed a lower profile – the average arithmetic and SD were respectively PCS $45.30 \pm 7.96$ un MCS $41.02 \pm 9.57$.

2.3 Assessment based on norms

Analysing separate components of SF–36v2 survey, it can be seen that sitting volleyball players had the lowest indicators in role-emotional $28.56 \pm 14.84$ and role-physical $32.43 \pm 11.70$ sections. The highest score was registered in the sections of vitality $50.55 \pm 7.30$ and general health $49.95 \pm 8.60$ (see Table 2.1).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Scales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PF</td>
</tr>
<tr>
<td>Arithmetic mean</td>
<td>70.6</td>
</tr>
<tr>
<td>25 percentiles</td>
<td>55.0</td>
</tr>
<tr>
<td>50 percentiles (median)</td>
<td>79.9</td>
</tr>
<tr>
<td>75 percentiles</td>
<td>95.0</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>26.1</td>
</tr>
<tr>
<td>Min.</td>
<td>0.0</td>
</tr>
<tr>
<td>Max.</td>
<td>100.0</td>
</tr>
<tr>
<td>N</td>
<td>75</td>
</tr>
</tbody>
</table>
Among separate reference scales, the lowest indicators were for physical functioning (39.00 ± 12.47), while the highest – for mental health (46.13 ± 11.57). Sitting volleyball players have better physical functioning (44.69 ± 11.01), and data on mental health are on a similar level (44.81 ± 9.17).

Role-emotional component was on an especially low level (28.56 ± 14.84) for sitting volleyball players. SF-36 reference table shows the average indicator at 43.58 ± 13.47 (for people with hand and/or leg impairment). For sitting volleyball players this component was significantly (p < 0.05) lower.

2.4 Data of cardiorespiratory work capacity tests

2.4.1 Heart rate monitoring

Heart rate monitoring was performed for Latvian sitting volleyball players during exercise and competition (Polar Sport Tester, Finland). Six men and nine women were tested. Altogether 30 heart rate records were made.

Resting heart rate for players ranged from 60 to 90 heart beats per minute. The maximum and minimum heart rate during exercise fluctuated on a broad range. The average pulse during the exercise was 61.7 % from the individual maximum cardiac frequency (MCF), where MCF = 220 – age (years). For some players with cerebral palsy, the submaximal pulse was reached. Such pulse was recorded, for example, during “long ball episodes” when the ball for a relatively longer time was in the hands of the respective team. During these moments heart rate for players was up to 100 % of MCF.

For the majority of players, the minimum heart rate during exercise varied from 90 to 100 heart beats per minute (exercise episodes without action). Load in cardio exercises ranged from 115 to 155 heart beats per minute. During the game, heart rate of athletes was relatively higher (by 10–20 heart beats on average) than during the exercise.
Cycle test results

When performing cycle tests, there were technical problems both with the sitting volleyball players and the control group. In total, eight tests were interrupted and repeated (two for the main contingent and six for the control group). The most common reasons for interruptions were: – the prosthesis slipping out of the pedal mechanism or the middle part of the cycle (depending on the placement of the prosthesis while sitting on the cycle), stump of the limb slipping out of the prosthesis socket.

An attempt was made to conduct the cycle test also without the prosthesis, but, in order to maintain uniformity of the testing conditions, all above-mentioned test results were obtained while conducting cycle tests with a prosthesis. For sitting volleyball players with transfemoral upper limb amputation, the cycle test (speed, smoothness of movements, etc.) was conducted with difficulties, still, all tests were conducted, reaching submaximal target pulse. The age of the main group participants was 28.9 ± 4.2, the age of the control group participants was 30.9 ± 5.5.

While conducting the cycle test, all tested individuals managed to reach the submaximal pulse. None of the tests was interrupted due to medical reasons. Cycle test was performed, using one leg (functionally healthy leg), in separate cases the non-amputated foot and the prosthetic foot were additionally fixed to the pedal with a tape (see Table 2.2).
Table 2.2

Cycle test results for sitting volleyball players and control group (amputation of lower limbs on different levels; x ± SD)

<table>
<thead>
<tr>
<th>Contingent</th>
<th>Heart rate at particular exercise load (× min)</th>
<th>PWC_{170}</th>
<th>PWC_{170}/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>118.0 ± 14.5 141.7 ± 8.1 168.4 ± 7.7 104.5 ± 22.7 1.45 ± 0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n = 20)</td>
<td>127.6 ± 20.0 150.0 ± 11.9 177.8 ± 9.8 88.5 ± 30.1 1.11 ± 0.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n = 20)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.4.2 Arm ergometry tests

While conducting arm ergometry tests, sitting volleyball players presented by 30.6 % higher relative cardiorespiratory work capacity than work capacity of the control group participants. Absolute physical work capacity (PWC_{170}) for the main contingent was by 18 % higher on average than for the control group (see Table 2.3).

Table 2.3

Arm ergometry tests (for athletes with disability, n = 20)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute maximum oxygen consumption (VO_{2max})</td>
<td>2.07 ± 0.37 l/min</td>
</tr>
<tr>
<td>Relative maximum oxygen consumption</td>
<td>29.0 ml/kg/min</td>
</tr>
</tbody>
</table>

2.5 Results of assessment of specific sports skills

Anthropometric assessment was conducted and games with participation of six men sitting volleyball teams (12 players in the list of each team, altogether 72 players) were analysed.
Statistically reliable correlation between anthropometric results and most of sitting volleyball skills (five out of six categories) was determined for group D players. All obtained correlation coefficients (both positive and negative correlations) were weak, Spearman rank correlation coefficients ranged from \(-0.24\) to \(0.20\) \((p < 0.05)\). The correlation slightly decreased in MD group in three categories, Spearman rank correlation coefficients ranged from \(-0.44\) to \(0.47\) \((p < 0.05)\). Correlation is not present in A group. Thus, statistically reliable correlation (both positive and negative) was determined between anthropometric indicators and separate sitting volleyball skills in D and MD groups.

Spearman rank correlation analysis did not reveal statistically reliable correlation between skills of sitting volleyball players and medical classification (in all categories \(p > 0.05\)).

**2.6 Description of traumas limiting participation of athletes in sitting volleyball**

The largest relative occurrence of traumas was recorded during tournaments, and it was lower during exercises. As it can be seen in Tables 2.4–2.5, the most common traumas were damages of soft tissues – sprains, strains and contusions of muscles, tendons, ligaments. Analysing all traumas and complaints that limit participation in sports, it can be concluded that their number was higher during exercise. The team members also had a higher number of traumas and myoskeletal complaints during training camps.
### Table 2.4

Traumas and myoskeletal complaints limiting participation of athletes in sitting volleyball (men, n = 386, x ± SD)

<table>
<thead>
<tr>
<th>Traumas and complaints, localization</th>
<th>Number of occurrences (player / team / year)</th>
<th>Period of athlete’s absence after trauma (player / trauma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprains, strains, contusions of tendons, ligaments in area of fingers, palm</td>
<td>6.1 ± 1.5</td>
<td>&lt; one week</td>
</tr>
<tr>
<td>Traumas in area of shoulders, shoulder joint rotator cuff syndrome (tendinitis, enthesitis, myositis, sprain)</td>
<td>4.0 ± 0.5</td>
<td>&lt; one week</td>
</tr>
<tr>
<td>Lumbago</td>
<td>4.4 ± 0.8</td>
<td>one week</td>
</tr>
<tr>
<td>Contusion (more often in gluteal area)</td>
<td>1.1 ± 0.4</td>
<td>&lt; one week</td>
</tr>
<tr>
<td>Skin abrasion (hands, gluteal area)</td>
<td>1.1 ± 0.5</td>
<td>&lt; one week</td>
</tr>
</tbody>
</table>

### Table 2.5

Traumas and myoskeletal complaints limiting participation of athletes in sitting volleyball (women, n = 88, x ± SD)

<table>
<thead>
<tr>
<th>Traumas and complaints, localization</th>
<th>Number of occurrences (player / team / year)</th>
<th>Period of athlete’s absence after trauma (player / trauma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprains, strains, contusions of tendons, ligaments in area of fingers, palm</td>
<td>4.4 ± 1.0</td>
<td>&lt; one week</td>
</tr>
<tr>
<td>Shoulder joint rotator cuff (tendinitis, enthesitis, myositis, sprain)</td>
<td>2.3 ± 0.6</td>
<td>&gt; one week</td>
</tr>
<tr>
<td>Lumbago</td>
<td>6.0 ± 1.2</td>
<td>&gt; one week</td>
</tr>
<tr>
<td>Contusions, sprains, strains (different areas)</td>
<td>2.0 ± 0.7</td>
<td>&gt; one week</td>
</tr>
</tbody>
</table>
The most typical traumas were sprains of interphalangeal joints (damages of ligaments) and contusions. Most often such traumas occurred during blocking or receiving the ball. These were the most typical acute traumas. Traumas in the area of wrists were related to athletes moving around the court. Such traumas were often caused by overload – with slow and unclear complaints at the beginning, and of unsteady character.

Athletes usually were not able to determine the movement or episode of the game that might have caused the complaints. In terms of seriousness, such traumas more often were described as light, and there was less than a week rest period required in sports activities. Fractures of fingers were not typical, even though their number has risen in the past years.

Lumbago was the most often named overwork trauma (myoskeletal pain syndrome). Pain in the low back was mentioned as the most common complaint related to sports activities in all volleyball respondent groups. Lumbago usually was the reason for sports activities to be interrupted for more than one week. In total, it was the most common reason for work incapability in sitting volleyball. The beginning of it was often related to exercise, seldom there was one typical movement recorded that could have caused beginning of lumbago complaints. The most often named traumas or diseases triggering lumbago were low back muscle extensor pain syndrome or strain (partial torn), spondylosis and spondyloarthrosis (both vertebral and extravertebral causes). If the exercising was not interrupted and athletes still continued the exercise, they felt pain in low back (for weeks or months). This also was the most common cause for use of painkillers or anti-inflammatory medicines.
3 Discussion

3.1 SF-36v2 surveying

Physical role is a health assessment component that consists of four questions and describes different health-related limitations of a person’s physical role. These are limitations in performing a task or other routine activities; longer time the person needs when performing a task or other routine activities; difficulties in performing a task or other routine activities; and limited productivity.

In order to make a direct comparison, data were available from a study in which Kiyokazu Akasaka (2003) and colleagues had conducted a survey of sitting volleyball players using SF-36 questionnaire. In the group of people with disabilities, participants were mostly people with amputated legs. A control group – sitting volleyball players without disability – were surveyed. The authors presented transformed assessment results on a scale of 0–100. As a result, significant differences in functioning were determined (67.7 ± 22.8 in main group and 94.2 ± 9.0 in control group; p < 0.001), in physical role (77.4 ± 33.0 and 92.9 ± 20.1; p = 0.001), social functioning (81.5 ± 22.0 and 89.6 ± 15.9; p = 0.014) and physical component summary (43.8 ± 6.5 un 52.8 ± 5.9; p < 0.001). In the first three components (Akasaka, et al., 2003) transformed SF-36 assessment on the scale of 0–100 was presented.

Comparing the available data with results of the present study, it can be concluded that the present study participants had significantly lower indicators in physical role (37.67 ± 29.85), while other indicators were on the same level – physical functioning 70.66 ± 26.17, social functioning 74.50 ± 17.12, physical component summary 45.30 ± 25.16.

Based on the results of several studies, developers of the questionnaire present SF-36 reference data for people with impairment on the level of upper and/or lower limbs. The arithmetic mean on scales are 38.93 ± 11.49 for
physical health summary indicators and 46.73 ± 12.15 for mental health summary indicators (Ware, Kosinski, & Bjorner, 2007). Respectively, the physical component is on a level that is statistically significantly below the norm which is 50 points. Comparing these reference data for people with arm and/or leg impairment and sitting volleyball players, it is confirmed that sitting volleyball players have statistically significantly higher (p < 0.05) physical health summary indicator (45.30 ± 25.16). Mental health summary indicator is relatively lower (41.02 ± 19.53) for sitting volleyball players.

Among separate reference scales, physical functioning (39.00 ± 12.47) demonstrated the lowest indicators, while mental health (46.13 ± 11.57) showed the highest indicators. Sitting volleyball players, meanwhile, have better physical functioning (44.69 ± 11.01), and mental health data are on a similar level (44.81 ± 9.17).

The emotional role component was on a significantly lower level (28.56 ± 14.84) for sitting volleyball players, the average indicator for people with arm and/or leg impairment was 43.58 ± 13.47. This component was significantly (p < 0.05) lower for sitting volleyball players. The emotional role component consists of three questions that reflect the limitations to person’s mental health aspects. They describe time that the person spends at work or performing other usual activities, the amount and quality of the performed activities. Lower results reflect limitations when performing work or other activities due to emotional problems.

In total, sitting volleyball players compared to the average population data have lower physical component summary results and considerably lower (p < 0.05) mental component summary results. Compared to patients who have the respective disorders and diagnosis, it can be seen that sitting volleyball players have higher physical health summary indicators (45.30 ± 25.16), while mental health summary indicators are lower (41.02 ± 19.53).
3.2 Testing of physical work capacity and physiological characteristics of sitting volleyball players

3.2.1 Cycle test

According to literature sources, cycle tests for people with amputated lower limbs are complicated from the technical point of view (Chin, et al., 2002b). Cycle test was offered with a removed prosthesis, additionally fixing the person to the chair, using chairs of different construction, with the back support, etc. Our task was not to determine the correlation of the work capacity of the athletes with their sports achievements. Still, taking into account that volleyball is a technical game and depends less on the players’ cardiorespiratory capacity, also in the classical volleyball there is no direct correlation between the athlete’s work capacity and sports results. In other kinds of sports for people with disabilities, results are at least partly related to cardiorespiratory capacity indicators. Such correlation has been determined in wheelchair basketball, wheelchair rugby, wheelchair tennis, track and field athletics (Beckman & Tweedy, 2009; O’Riordan, 2009; Edwards, 2008).

Comparing the present study results with the men sitting volleyball team PWC170 data (Виноградов & Катощук, 1988), which ranged from 85.25W to 170.5W, it can be seen that the average cycle test results also fall into this range (absolute work capacity for the main group is 104,5 ± 22,7 W). Still, from the point of view of methodology, these studies cannot be compared because cycle tests were not conducted in the study of Vinogradov. In their study hypotonic reaction to exercise prevailed among the sitting volleyball players, while in the present study, hypertonic reaction prevailed.
3.2.2 Arm ergometry test

The biggest oxygen consumption while performing the arm ergometry test usually is about 70% of results on a sliding ergometer.

Like in studies of other authors (Tropp, Samuelsson, & Jorfeldt, 1997), also in this study the arm ergometry from the technical point of view is more appropriate for people with amputated lower limbs. Still, we can agree with Myrthe Vesterling and colleagues (Vesterling, Schoppen, Dekker, Wempe, & Geertzen, 2005), who believe that during arm ergometry tests patients often need additional encouragement because, compared to cycle tests, the workload is perceived as higher.

Compared to V. Vinogradov’s testing data (Виноградов & Катощук, 1988), the VO2max results obtained in our study are significantly lower. V.Vinogradov presented testing results depending on the amputation level – from 3.95 ± 0.21 l/min (unilateral amputation below knee) to 3.38 ± 0.10 l/min (bilateral amputation) and 4.64 ± 0.20 l/min for control group. In the present study the obtained results are considerably lower 2.07 ± 0.37 l/min. Partly it might be related to the fact that the contingent involved in the present study was younger and participated in a specialized rehabilitation programme that included also special muscle strength and endurance exercises.

Comparing data of Takaaki Chin and colleagues with the data obtained during the present study, it can be concluded that the VO2max results are similar. The average VO2max for patients with one amputated leg before starting the rehabilitation course was 18 ml/kg/min. The relative maximum oxygen consumption for sitting volleyball players was 29 ml/kg/min.

Heart rate monitoring during the exercise shows a relatively low or medium intensity cardiorespiratory load. The average pulse during exercise was 61.7% of the calculated maximum cardiac frequency. Thus, sitting volleyball
could be rated among sports with relatively low or medium intensity by the
level of cardiorespiratory intensity.

Sitting volleyball players with amputated legs removed their prosthesis
during the exercise, and that reduces the overall work amount and energy
consumption.

3.3 Assessment of specific sports skills in Paralympic sports
depending on medical and functional classification

Classification in Paralympic sports is based on several possibly
objective examination methods. Those are different skill tests specific for the
particular kinds of sports, technical (biomechanical) tests, games efficiency
(efﬁciency of the speciﬁc sports movements performed by players), aerobic and
anaerobic work capacity tests, etc.

In the present study, no correlation was found between skills of sitting
volleyball players and their medical classiﬁcation group.

Bartosz Molik in his studies of anthropometry and efﬁciency of the
speciﬁc moves and sitting volleyball players in 2006, 2009 and 2014 concluded
that there is no statistical relation between the athlete’s speciﬁc skills and
classiﬁcation group (existing impairments) (Molik, Kosmol, & Skucas, 2008;
Molik, Laskin, Kosmol, Skucas, & Bida, 2010; Molik et al., 2008). There is
a correlation between the athlete’s speciﬁc skills in sitting volleyball and the
athlete’s anthropometric indicators.

A large number of examined players potentially allows to statistically
conﬁrm the number of necessary sports groups in sitting volleyball. The results
of the present study suggest that there is no correlation between the basic skills
of sitting volleyball players and their medical classiﬁcation group. Still, there is
a correlation between anthropometric data of particular persons and the basic
sitting volleyball skills.
The study did not find statistically reliable relation between the athlete’s functional disorders and limitations of specific sports activities for sitting volleyball. In total, assessment of specific sports activities for player with classification status disabled, minimally disabled and able was similar.

This confirmed the hypothesis of the study that, while being seated and playing sitting volleyball, athletes with functional disorders are in the same functional initial position as athletes without functional disorders. This further confirms the statement that the existing classification system in sitting volleyball is objective and there is no need to add an additional group to it from the point of view of functionality.

Results of the present study confirmed the primary hypothesis that specific sports work capacity of sitting volleyball players (people with impairment of lower limbs) does not depend on the kind and severity of the impairment.

### 3.4 Analysis of predisposed factors of sports traumas and myoskeletal complaints in sitting volleyball

During the Beijing Olympic Games, 1 055 traumas were recorded with the overall incidence at 6.1 per 1 000 registered athletes (Junge, et al., 2009). Still, the study does not mention the frequency of traumas in relation to the number of exercise hours. Half of the traumas (49.6 %) was a potential reason for skipping further exercises or competitions. Most often diagnoses included damage of the foot joint tendons and muscle strain (partial tear) in the upper leg. The most common diagnoses in the present study were lumbago, contusions of fingers and palms, shoulder joint cuff syndrome. Considering the definition of traumas that limit participation of athletes in sports, only those traumas that cause athletes to stop participation in exercises or games for a while were recorded. The majority of traumas during the Olympic games
occurred during competitions (72.5 %). In the present study it is not possible to clearly distinguish whether the trauma occurred during the competition or exercise. During the Olympic games, the most common trauma mechanism was a contact with another athlete, and as a result a cumulative trauma occurred (22 %), and the non-contact mechanism (20 %). In the present study, cumulative traumas occurred more often – 70–80 % of all traumas.

During the Olympic games, the medics determined that 33 % of traumas will cause athletes to interrupt exercising for up to one week, 11.2 % – for one to four weeks, 4.9 % – for more than four weeks. In the present study, after most of the traumas, the non-exercise period lasted for up to one week, but there were huge differences between the genders. For women, sitting volleyball traumas more often ended with non-exercise period longer than one week. Therefore, even though trauma incidence among sitting volleyball men and women practically does not differ – 1.11 traumas among men, and 1.01 traumas among women, still women had longer rehabilitation periods. In surveys of the present study, respondents often found it difficult to relate the start of the complaints with a particular move or exercise episode. The main symptom was pain, often of unclear nature (sometimes respondents associated them with the usual post-exercise pain), that is hard to be localized and is gradually increasing. It is clear that pain can be considered a marker of trauma, it is an unpleasant feeling and emotional experience that is related to current or potential damage of tissues, and can be divided into acute and chronic components.

In several countries and several kinds of sports different programmes for prevention of sports traumas are being used for a long time already. Most often different stretching techniques, strength exercises, body stability, balance and other physiotherapeutic methods are used.
Such exercise routines are used by athletes who belong to the respective disability groups (for example, athletes with spinal cord damage), there are exercise programmes developed specifically for particular kinds of sports (track and field athletics, swimming, basketball, volleyball and other Olympic sports).

As the study shows, the longer the disability period (for example, the time after amputation), the higher the trauma risks and the number of myoskeletal complaints among sitting volleyball players (Mustafins, Landor, Vetra, & Scibrja, 2008). It was especially characteristic of people with unilateral lower limb amputation, irrespective of its level. This contingent had a typical lumbago syndrome. It has been confirmed earlier that this syndrome is largely related to specific imbalance of postural muscles. *m. iliopsoas, m. quadratus lumborum* have been shortened in the side of amputation. Also, lower back extensors and *m. quadriceps femoris* (in the opposite side of the amputation) have been shortened. *m. gluteus maximus* and abdominal muscles are weakened. Such imbalance of muscles was the cause of lumbago, even though as the patient is standing, the pelvis is in a symmetrical position. It means that for the particular patient with an amputated leg, not only the length of the prosthesis should be measured, but also the respective groups of muscles. Usually such athletes had increased lumbar lordosis and frontal inclination of pelvis. Players who had had their amputation a longer period ago (more than ten years) more often had spondylosis, spondyloarthrosis, intervertebral disc protrusion or herniation.

In the observations of the present study, lumbago prevailed in 47.4 % of cases among all traumas and complaints of Latvian sitting volleyball players (men and women, n = 32), and in 40.8 % of cases among foreign players (men and women, n = 188) (Mustafins, Landor, Vetra, & Scibrja, 2008). The presently obtained data suggest that lumbago is the most common myoskeletal complaint among sitting volleyball players.
As the number of traumas caused by overload in sitting volleyball is higher than in classical volleyball, preventive exercise programmes and other preventive measures play a big role and should be definitely included in the exercise programme.
Conclusions

1. Sitting volleyball players most often are people with traumatic amputated lower limbs because of the military conflicts or traffic accidents.
2. Sitting volleyball players have higher relative cardiorespiratory work capacity and higher absolute physical work capacity (PWC\textsubscript{170}) compared with people who have functioning limitations, but who are not engaged into sports.
3. Both physical component summary (PCS) and mental component summary (MCS) for sitting volleyball players are lower than average in the population. The physical health aspect of the quality of life for sitting volleyball players is statistically significantly higher than for people who have limb functioning limitations, but who are not engaged into any sports.
4. The specific sports skills in sitting volleyball do not depend on the medical classification group, the functioning limitations of players do not directly influence sports results in sitting volleyball.
5. The overall occurrence of traumas in sitting volleyball is low and does not differ from classical volleyball. Traumas most often are localized in the area of shoulders, lower back, fingers and palms.

Practical significance of the present study

- The data obtained in the study can be used by coaches, sports medicine doctors, rehabilitation specialists, physiotherapists, and other specialists in their practices for safe exercise and competition planning and prophylaxis of secondary health disorders.
- Results of the study can be used in development of players’ medical database and evidence-based medical classification system that will promote following fair game principles and ensure organization of objective competitions.
Further directions of the study

Considering the following facts: 1) the rapidly growing number of Paralympic athletes, 2) intensification of exercises, 3) increase of the number of competitions, 4) people with more severe disabilities are engaged in the Paralympic movement, it is important to collect data on further sports traumas and complaints on the locomotor system and localisation and study the predisposing factors. The predisposing factors should be divided into sports-specific (external) and specific to the organism or the particular disability group (internal). Both external and internal modified risk factors can be influenced using preventing measures. A good-quality study would be necessary on this topic. Further studies aimed at the process assessment are also necessary to develop the Paralympic classification. The classification should be objective and strict, still, it should allow a broad range of athletes to participate in sports activities, including persons with distinctive impairment.

Further studies are necessary on the quality of life of athletes with disabilities that would allow to objectivise the influence of sports activities on the person’s health and respectively modify the environment of exercising.

Further studies on cardiorespiratory work capacity of athletes are necessary. Testing should be specially adapted for people with disabilities – in the same way the specific cardiorespiratory work capacity testing is done in sports. One of the possible solutions would be use of combined arm and leg ergometric method. Cardiorespiratory testing also allows to objectivise outcome of rehabilitation.

So far there has not been any reliable study conducted in Latvia on inclusion of people with disabilities in sports programmes, the real situation in regions has not been studied, which, to a large extent, lays obstacles to development and implementation of comprehensive and appropriate programmes and methodological material. Development of inclusive education
largely depends on initiatives of the sports teachers in particular schools, technical equipment, the existing materials that have not been updated for years. There is often a situation that a child or youth with a disability is automatically excused from sports classes without proper assessment of the person’s real capabilities and the necessity of sports activities for improvement of the person’s physical health (earlier, for example, there were classes held in special groups). School sports teachers, social teachers, rehabilitation specialists, sports medicine doctors and physiotherapists need updated practical information so that they would be able to provide good quality recommendations to people with disabilities on the workload of physical activities, etc.
Publications and reports on the topic of the study

Publications in reviewed journals:


Presentations, published thesis or expanded thesis:


Bibliography


41. Виноградов, В. И., & Катощук, Г. И. 1988. Толерантность к физическим нагрузкам у первично протезируемых инвалидов с культями нижних конечностей. Сб. тр." Протезирование и протезостроение".—М.: ЦНИИПП, 79
Acknowledgements

The author would like to express his gratitude to those people who for many years in different ways have encouraged and supported the present study.

I would like to thank the Paralympic athletes who with their dedication, vigorous performance and positive attitude inspired me to start this work and continue it.

I would like to express my gratitude to the European Committee Volleyball for Disabled and the World Organization Volleyball for Disabled (ECVD, later ParaVolley Europe) for moral and technical assistance, WOVD (later World ParaVolley) medical commission representatives, team medical staff – for their practical contribution in collection and analysis of the data.

I would like to thank the scientific advisors – Professor Per Renstrom (Stockholm) and Associate Professor Anatoly Landor (Tartu) – for a number of methodological recommendations and knowledge.

I would like to acknowledge the supervisor of the present Doctoral Thesis, Professor Aivars Vētra – for the sensitivity to the topic and significant recommendations, especially regarding rehabilitation issues, and also for the patient and professional polishing work on the present study.

I would like to thank the RSU for the grant issued under the ESF project “Support for Doctoral Students in Acquiring Study Programme and Acquisition of the Scientific Degree in Rīga Stradiņš University” in 2009–2010.

FINALLY – I would like to thank my family – my wife Irīna, and daughter Jeļizaveta – who have been supporting my work for several years with great patience and practical assistance.