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Rīga Stradiņš University

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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

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

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Table of Contents

Abbreviations used in the Thesis

BP	Bodily 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_{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 PARAVOLLEY*.

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 $27.1 \pm 5,0$ 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 ± 7.96 un MCS 41.02 ± 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 ± 14.84 and role-physical 32.43 ± 11.70 sections. The highest score was registered in the sections of vitality 50.55 ± 7.30 and general health 49.95 ± 8.60 (see Table 2.1).

Table 2.1

Assessment of separate health components in SF 36v2 survey (transformed assessment) on a scale of 0–100

Parameters	Scales							
	PF	**RP**	**BP**	**GH**	**V**	**SF**	**RE**	**MH**
Arithmetic mean	70.6	37.6	59.6	70.7	59.4	74.5	41.4	65.7
25 percentiles	55.0	18.7	41.0	57.0	50.0	62.5	16.6	55.0
50 percentiles (median)	79.9	25.0	62.0	72.0	56.2	75.0	25.0	70.0
75 percentiles	95.0	62.5	74.0	87.0	68.5	87.5	75.0	75.0
Standard deviation	26.1	29.8	24.0	18.0	14.6	17.1	31.8	16.2
Min.	0.0	0.0	0.0	35.0	12.5	37.5	0.0	25.0
Max.	100.0	100.0	100.0	100.0	87.50	100.0	100.0	95.0
N	75	75	75	75	75	75	75	75

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)

Contingent	Heart rate at particular exercise load (× min)			PWC_{170}	PWC_{170}/kg
	50 W	75 W	100 W		
Participants (n = 20)	118.0 ± 14.5	141.7 ± 8.1	168.4 ± 7.7	104.5 ± 22.7	1.45 ± 0.31
Control group (n = 20)	127.6 ± 20.0	150.0 ± 11.9	177.8 ± 9.8	88.5 ± 30.1	1.11 ± 0.41

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)

Indicator	Result
Absolute maximum oxygen consumption (VO_2max)	2.07 ± 0.37 l/min
Relative maximum oxygen consumption	29.0 ml/kg/min

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)

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

Table 2.5

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

Traumas and complaints, localization	Number of occurrences (player / team / year)	Period of athlete's absence after trauma (player / trauma)
Sprains, strains, contusions of tendons, ligaments in area of fingers, palm	4.4 ± 1.0	< one week
Shoulder joint rotator cuff (tendinitis, enthesitis, myositis, sprain)	2.3 ± 0.6	> one week
Lumbago	6.0 ± 1.2	> one week
Contusions, sprains, strains (different areas)	2.0 ± 0.7	> one week

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 Vestering and colleagues (Vestering, 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 VO_2max 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 VO_2max results are similar. The average VO_2max 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_{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:

1. Molik, B., Morgulec-Adamowicz, N., Marszalek, J., Kosmol, A., Rutkowska, I., Jakubicka, A., Kaliszewska, E., Kozlowski, R., Kurowska, M., Ploch, E., Mustafins, P., Gomez, M.-A. 2017. Evaluation of Game Performance in Elite Male Sitting Volleyball Players. *Adapted Physical Activity Quarterly*. *Human Kinetics.* 34, 104–124.

2. Mustafins, P., Renstrom, P., Vetra, A., Scibrja, I. 2013. Injuries in volleyball for athletes with a disability – a prospective long-term study. *Polish Journal of Rehabilitation Research*., 5, 6–11.

3. Mustafins, P., Landor, A., Vetra, A., Scibrja I. 2008. Rate and type of participation limiting health disorders in sitting volleyball players. *Papers on Anthropology*. 17, 223–247.

4. Mustafins, P., Ščibrja, I. 2006. Enthesopathy and juvenile osteochondritis as an overuse injury in young athletes. *Proceedings of the Latvian Academy of Sciences*. 60(5/6), 210–214.

5. Asser, T. Mustafin, P. 1994. Quantitative Determination of Muscle Tone Changes in Neurologically Impaired Patients. *Acta Universitatis Tartuensis*.

Presentations, published thesis or expanded thesis:

1. Mustafins, P. 1998. *The typical injuries in sitting volleyball.* Abstract plus oral presentation in: Proceedings of the International symposium on adapted physical activity and rehabilitation. Kaunas, Lithuania, 42.

2. Mustafins, P. 2000. *The most usual trauma and complaints in sitting volleyball.* Abstract plus oral presentation in: Proceedings of the 5th Annual Congress of the European College of Sport Sciences. Jyvaskyla, Finland, 519.

3. Mustafins, P. 2005. *Some principles of the medical coverage in sport for the persons with a disability.* Abstract plus oral presentation in: Proceedings of the 2nd International Congress Sport and Health. St. Petersburg, Russia, 360–361.

4. Mustafins, P. 2003. *Medical coverage in sport*. Abstract plus oral presentation in: Materials of the International symposium The fine art of adapted coaching. Roermond, the Netherlands, 1–12.

5. Mustafins, P. 2001. *The most usual injury and complaints in sitting volleyball, some comparisons between the disabled and "normal" sport.* Abstract plus oral presentation in: Abstract book of the 3rd International Congress on Sports Medicine. Riga, Latvia, 21.

6. Mustafins, P., Scibrja, I. 2008. *The most common injury and musculoskeletal complaints in sitting volleyball: a long-term study.* Abstract no. 142 plus poster presentation in: British Journal of Sports Medicine. June 2008, 42(6), 534.

7. Morres, I., Papaioannou, G., Mustafins, P. 2004 *Analysis of sitting volleyball tasks and the relationship between the classification status and performance amongst male elite sitting volleyball athletes; a pilot study.* Abstract O.313 and oral presentation in: Abstracts of the Pre-Olympic Congress, Thessaloniki, Greece.

8. Morres, I., Papaioannou, G., Mustafins, P., Fotiadis, D. I. 2005. *Sitting-Volleyball: Antropometry, sport performance and classification status – a preliminary report.* Abstract and oral presentation in: Abstracts of the 4th International Baltic Sports medicine congress, Riga, Latvia, 33–34.

9. Morres, I., Mustafins, P., Katsis, C., Koutsi, E., Milanese, C., Papaioannou, G. 2006. *Sitting Volleyball Medical Classification System – Contradictions and Recommendations Toward the Sports-Specific Classification Principles.* Abstract and oral presentation in: Abstract booklet of the VISTA 2006 conference "Classification: solutions for the future", Bonn, Germany, 17.

10. Mustafins, P., Ščibrja, I. 2007. *Risk factors for the enthesopathy and juvenile osteochondrosis as the overuse injuries in young athletes.* Thesis in: Eeesti arst, Estonia, 8, 583–584.

11. Mustafins, P., Ščibrja, I. 2005. *Enthesopathies in young athletes*. Thesis and oral presentation in: Abstracts of the 4th International Baltic Sports medicine congress, Riga, Latvia.

12. Mustafins, P., Ščibrja, I. 2002. *Enthesopathies in the young athletes*. Poster presentation and abstract in: Abstracts of the 7th Annual Congress of European College of Sport Science. Athens, Greece.

13. Mustafins, P., Vetra, A. 2009. *The most often injuries and musculoskeletal complaints in Paralympic volleyball athletes with a disability, comparing to the Olympic one*. Abstract plus oral presentation in: Thesis of the RSU Scientific conference, Riga, Latvia.

14. Mustafins, P., Vetra, A. 2009. *SF-36v2 Health survey data of the international Paralympic volleyball players.* Abstract plus oral presentation in: Thesis of the International symposium Curative gymnastics in rehabilitation of the musculoskeletal disorders, Riga, Latvia.

15. Mustafins, P., Vetra, A., Scibrja, I. 2009. *The sport participation limiting injuries, musculoskeletal complaints and the SF-36v2 health survey data in international Paralympic volleyball players.* Abstract plus poster presentation in: International Journal of Rehabilitation Research. Proceedings of the 10th Congress of the European Federation for Research in Rehabilitation, Riga, Latvia.

16. Mustafins, P., Vetra, A., Schibrja, I. 2009. *The sport participation limiting injuries, musculoskeletal complaints and the SF-36v2 health survey data in Paralympic volleyball players. A long-term survey*. Extended thesis in: Proceedings of the 10th EFRR Congress, Medimond, Bologna, Italy, 63–67.

17. Mustafins, P., Vetra, A., Scibrja, I. 2009. *The most common injury and musculoskeletal complaints in sitting volleyball: a long-term survey.* Abstract plus oral presentation in: Proceedings of the international seminar on the methodological and medical aspects of sitting volleyball "Spirit in Coaching", Elblag, Poland.

18. Mustafins, P., Vetra, A., Scibrja, I. 2009. *SF-36v2 Health survey data of the international Paralympic volleyball players.* Abstract plus oral presentation in: Proceedings of the international seminar on the methodological and medical aspects of sitting volleyball "Spirit in Coaching", Elblag, Poland.

19. Mustafins, P. 2009. *Medical aspects of the Paralympic sport*. Joint conference of the European Federation of Adapted Physical Activity and Latvian Association of Rehabilitation Physicians, Riga, Latvia, November 2009.

20. Mustafins, P., Renström, P., Vetra, A., Schybria, I. 2010. *Injury incidence and prevalence in sitting and standing volleyball for athletes with a disability - a long term prospective study*. Abstract plus oral presentation in: European Congress on Adapted Physical Activity, Jyvaskyla, Finland, May 2010.

21. Mustafins, P. 2011. Paralympic volleyball athlete (keynote lecture). FIVB Medicine world congress. Bled, Slovenia, January 2011.

22. Molik, B., Morgulec-Adamowicz, N., Mustafins, P. 2013. *Evaluation of game performance elite male sitting volleyball players.* Poster presentation in: ISAPA Congress, Istanbul, Turkey, July 2013.

23. Mustafins, P. 2013. *Health indexes in Paralympic Volleyball*. Conference of the Norwegian Society for Physical Medicine and Rehabilitation. Tromso, Norway, November 2013.

Bibliography

1. Akasaka, K. T., Okuma, O., Kusano, S., Suyama, T., Yamamoto, M., & Kunisawa, Y. 2003. SF-36 health survey in disabled sitting volleyball players in japan. *Journal of Physical Therapy Science, 15*(2), 71–73.

2. Beebe, K., Song, K. J., Ross, E., Tuy, B., Patterson, F., & Benevenia, J. 2009. Functional outcomes after limb-salvage surgery and endoprosthetic reconstruction with an expandable prosthesis: a report of 4 cases. *Archives of physical medicine and rehabilitation, 90*(6), 1039–1047.

3. Bekkers, J. E., de Windt, T. S., Raijmakers, N. J., Dhert, W. J., & Saris, D. B. 2009. Validation of the Knee Injury and Osteoarthritis Outcome Score (KOOS) for the treatment of focal cartilage lesions. *Osteoarthritis and cartilage*, *17*(11), 1434–1439.

4. Bennett, R. M., Schein, J., Kosinski, M. R., Hewitt, D. J., Jordan, D. M., & Rosenthal, N. R. 2005. Impact of fibromyalgia pain on health-related quality of life before and after treatment with tramadol/acetaminophen 5. *Arthritis Care & Research*, *53*(4), 519–527.

5. Bjorner, J. B., Kosinski, M., & Ware, J. E. 2005. Computerized adaptive testing and item banking. *Assessing quality of life in clinical trials*, 95–112.

6. Brandes, M., Schomaker, R., Möllenhoff, G., & Rosenbaum, D. 2008. Quantity versus quality of gait and quality of life in patients with osteoarthritis. *Gait & posture, 28*(1), 74–79.

7. Cerin, E., Leslie, E., Sugiyama, T., & Owen, N. 2009. Associations of multiple physical activity domains with mental well-being. *Mental Health and Physical Activity, 2*(2), 55–64.

8. Chin, T. S., Fujita, H., Nakajima, S., Oyabu, H., Nagakura, Y., & Nakagawa, A. 2002b. Physical fitness of lower limb amputees. *American journal of physical medicine & rehabilitation, 81*(5), 321–325.

9. Engelhardt, M., B. H., Scharmer, C., Wohlgemuth, W. A., Willy, C., & Wölfle, K. D. 2008. Prospective 2-years follow-up quality of life study after infrageniculate bypass surgery for limb salvage: lasting improvements only in non-diabetic patients. *European Journal of Vascular and Endovascular Surgery, 36*(1), 63–70.

10. Fernández-Fairen, M., Sala, P., Ramírez, H., & Gil, J. 2007. A prospective randomized study of unilateral versus bilateral instrumented posterolateral lumbar fusion in degenerative spondylolisthesis. *Spine, 32*(4), 395–401.

11. Ferrara, M. S., & Peterson, C. 2000. Injuries to athletes with disabilities. *Sports Medicine, 30*(2), 137–143.

12. Ferrara, M. S., Buckley, W. E., Mccann, B. C., Limbird, T. J., Powell, J. W., & Robl, R. O. 1992. The injury experience of the competitive athlete with a disability: prevention implications. *Medicine and science in sports and exercise, 24*(2).

13. Hafner, B. J., Willingham, L. L., Buell, N. C., Allyn, K. J., & Smith, D. G. 2007. Evaluation of function, performance, and preference as transfemoral amputees transition from mechanical to microprocessor control of the prosthetic knee. *Archives of physical medicine and rehabilitation, 88*(2), 207–217.

14. Hemsley, K., Sitler, M., Moyer, R., & Oatis, C. 2010. Neuromuscular and psychological influences on range of motion recovery in anterior cruciate ligament reconstruction patients. *Journal of Electromyography and kinesiology, 20*(4), 684–692.

15. Hoogendoorn, J. M., & van der Werken, C. 2001. Grade III open tibial fractures: functional outcome and quality of life in amputees versus patients with successful reconstruction. *Injury, 32*(4), 329–334.

16. Howe, D. 2006. Injury in Paralympic Sport. L. S, S. B, & W. I., *Pain and Injury in Sport: Social and Ethical Analysis*. London: Taylor & Francis, 211–224.

17. Hu, J., Gruber, K. J., & Hsueh, K. H. 2010. Psychometric properties of the Chinese version of the SF-36 in older adults with diabetes in Beijing, China. *Diabetes research and clinical practice, 88*(3), 273–281.

18. International Paralympic Committee. (2007). *Classification Code and International Standards.* Bonn.

19. Junge, A., Engebretsen, L., Mountjoy, M. L., Alonso, J. M., Renström, P. A., Aubry, M. J., & Dvorak, J. 2009. Sports injuries during the summer Olympic games 2008. *The American journal of sports medicine, 37*(11), 2165–2172.

20. Karachalios, T., R. N., Giotikas, D., Bargiotas, K., Varitimidis, S., & Malizos, K. N. 2009. A mid-term clinical outcome study of the Advance Medial Pivot knee arthroplasty. *The Knee, 16*(6), 484–488.

21. Lahti, J., Laaksonen, M., L. E., & Rahkonen, O. 2010. The impact of physical activity on physical health functioning–a prospective study among middle-aged employees. *Preventive medicine, 50*(5–6), 246–250.

22. Lustig, S., Leray, E., Boisrenoult, P., Trojani, C., Laffargue, P., Saragaglia, D., & Neyret, P. 2009. Dislocation and bicruciate lesions of the knee: epidemiology and acute stage assessment in a prospective series. *Orthopaedics & Traumatology: Surgery & Research, 95*(8), 614–620.

23. Molik, B., Kosmol, A., & Skucas, K. 2008. Sport-specific and general sporting physical fitness of sitting volleyball athletes. *Physiotherapy, 16*(4), 68–75.

24. Molik, B., Laskin, J. J., Kosmol, A., Skucas, K., & Bida, U. 2010. Relationship between functional classification levels and anaerobic performance of wheelchair basketball athletes. *Research Quarterly for Exercise and Sport, 81*(1), 69–73.

25. Molik, B., Lubelska, E., Kosmol, A., Bogdan, M., Yilla, A. B., & Hyla, E. 2008. An examination of the international wheelchair rugby federation classification system utilizing parameters of offensive game efficiency. *Adapted Physical Activity Quarterly, 25*(4), 335–351.

26. Muhsen, K., Garty-Sandalon, N., Gross, R., & Green, M. S. 2010. Psychological distress is independently associated with physical inactivity in Israeli adults. *Preventive medicine, 50*(3), 118–122.

27. Mustafins, P., Landor, A., Vetra, A., & Scibrja, I. 2008. Rate and type of participation limiting health disorders in sitting volleyball players. *Papers on Anthropology, 17*, 223–247.

28. Patel, B. P., & Hamadeh, M. J. 2009. Nutritional and exercise-based interventions in the treatment of amyotrophic lateral sclerosis. *Clinical Nutrition, 28*(6), 604–617.

29. Rameh, C., & Magnan, J. 2010. Quality of life of patients following stages III–IV vestibular schwannoma surgery using the retrosigmoid and translabyrinthine approaches. *Auris Nasus Larynx, 37*(5), 546–552.

30. Reeser, J. C. 2003. The disabled volleyball athlete. *Handbook of Sports Medicine and Science: Volleyball*, 175–182.

31. Rhebergen, D., Beekman, A. T., de Graaf, R., Nolen, W. A., Spijker, J., Hoogendijk, W. J., & Penninx, B. W. 2010. Trajectories of recovery of social and physical functioning in major depression, dysthymic disorder and double depression: a 3-year follow-up. *Journal of affective disorders, 124*(1), 148–156.

32. Rogliani, M., Gentile, P., Labardi, L., Donfrancesco, A., & Cervelli, V. 2009. Improvement of physical and psychological symptoms after breast reduction. *Journal of Plastic, Reconstructive & Aesthetic Surgery, 62*(12), 1647–1649.

33. Salzmann, G. M., Paul, J., Bauer, J. S., Woertler, K., Sauerschnig, M., Landwehr, S., & Schöttle, P. B. 2009. T2 assessment and clinical outcome following autologous matrix-assisted chondrocyte and osteochondral autograft transplantation. *Osteoarthritis and cartilage, 17*(12), 1576–1582.

34. Taft, C., Karlsson, J., & Sullivan, M. 2000. Assessing Changes in SF-36 Version 2.0-Results from a Swedish Population Survey. *Quality of Life Research*, 305–305.

35. Tomey, K., Sowers, M., Zheng, H., & Jackson, E. A. 2009. Physical functioning related to C-reactive protein and fibrinogen levels in mid-life women. *Experimental gerontology, 44*(12), 799–804.

36. Vestering, M. M., Schoppen, T., Dekker, R., Wempe, J., & Geertzen, J. H. 2005. Development of an exercise testing protocol for patients with a lower limb amputation: results of a pilot study. *International journal of rehabilitation research, 28*(3), 237–244.

37. Ware, J., Kosinski, M., & Bjorner, J. 2007. *User's Manual for the SF-36v2 (patent pending) Health Survey* (2nd ed.). Lincoln, USA: Quality Metric Incorporated.

38. Webborn, N., Willick, S., & Reeser, J. C. 2006. Injuries among disabled athletes during the 2002 Winter Paralympic Games. *Medicine & Science in Sports & Exercise, 38*(5), 811–815.

39. Wylie, J. D., Bershadsky, B., & Iannotti, J. P. 2010. The effect of medical comorbidity on self-reported shoulder-specific health related quality of life in patients with shoulder disease. *Journal of shoulder and elbow surgery*, *19*(6), 823–828.

40. Zidarov, D., Swaine, B., & Gauthier-Gagnon, C. 2009. Quality of life of persons with lower-limb amputation during rehabilitation and at 3-month follow-up. *Archives of Physical Medicine and Rehabilitation*, *90*(4), 634–645.

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*

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