UHASSELT

Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

The relationship between psychological outcomes and quantitative and qualitative movement outcomes during return to sport testing after anterior cruciate ligament reconstruction

Lindsay Jacobs
Nele Van Craesbeek
Scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie,

afstudeerrichting revalidatiewetenschappen en kinesitherapie bij musculoskeletale aandoeningen

PROMOTOR :

dr. Bart DINGENEN

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Acknowledgement

Research context

This master thesis fits into the research domain of musculoskeletal rehabilitation and is specifically targeting athletes who underwent a primary anterior cruciate ligament (ACL) reconstruction. After getting an ACL injury, athletes often choose for reconstruction. After this surgery, it takes months to return to their previous level of sports, and in many cases athletes do not even return to sports on the same level as before the injury. There is still no consensus about when it seems safe for athletes to return and the decision-making process is too often a solely time-based approach. A lot of physical tests (hop tests, strength tests of lower extremity, balance tests etc.) are used in clinical practice to determine if an athlete is ready to return to sport but psychological measurements are often overlooked. It has been frequently observed that athletes who return to sport seems to be physically ready to do so, but still sustain a second injury. Growing evidence exists that other influencing factors, including psychological factors, may play a role.

This master thesis consists of two parts, dived over two consecutive years. Last year, a literature research about psychological factors concerning rehabilitation and return to sport decision making after ACL reconstruction was executed. This year, an observational study was performed. During both years, this research took place at the University of Hasselt, in Diepenbeek. Participants participating in the observational study were tested at REVAL, the Department of Rehabilitation Sciences and Physiotherapy. This master thesis is part of an ongoing research project executed by dr. Bart Dingenen: 'Optimization of clinical testing in the evaluation of return to sport after ACL reconstruction'.

The research question and predetermined hypothesis of this observational study were developed in cooperation with promoter dr. Bart Dingenen. Because this study is part of an ongoing study, a global study protocol existed in advance but had to be rewrite and complement with recent evidence to correspond fully with the aim of this research. The students were considered to assist physical measurements of participants included in the study, respectively at six and 12 months post-operative. These measurements were scheduled by the promoter and took place in both master years. Data-analysis and academic writing was fully implemented by the two master-thesis students.

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1 Abstract

Background: Previous research has shown the importance of the psychological response in chances to return to sport and re-injury after ACL reconstruction. Little is already known about relationships between psychological factors and objective movement outcomes after rehabilitation.

Objectives: The aim of this cross-sectional study was to examine possible relationships between psychological outcomes and quantitative and qualitative movement outcomes six months after ACL reconstruction.

Participants: 34 Participants (30M) were recruited from January 2017 until July 2018 after primary ACL reconstruction.

Measurements: Participants completed the Anterior Cruciate Ligament Return to Sport after Injury (ACL-RSI) questionnaire, Knee Self-Efficacy Scale (K-SES) and study-specific questionnaire about motivation and expectations. Quantitative movement tests included the single and triple hop for distance, Y balance and dynamic reaction speed test using Smartgoals®. Qualitative movement tests included 2D-video-analysis of bipodal drop vertical jump (BDVJ), single leg drop vertical jump (SLDVJ), single leg squat (SLS) and tuck jump. Frontal and sagittal plane kinematics and an overall scoring were calculated. Spearman correlations were used to examine relationships, linear regression to examine which variables explained an outcome measure.

Results: ACL-RSI showed most significant (p<0.05) moderate-large correlations with quantitative (hop tests, Y balance test, reaction speed test) and qualitative (hip adduction during SLDVJ, knee valgus during SLS) outcomes. K-SES present and future showed significant correlations with quantitative movement outcomes (hop tests, Y balance test). The study-specific questionnaire showed significant correlations with quantitative (hop tests) and qualitative (SLS-scoring, knee valgus during BDVJ) movement outcomes. The ACL-RSI explained some variance of quantitative (Y balance test posteromedial and posterolateral) and qualitative movement outcomes (hip abduction during SLDVJ, knee valgus during SLS), the K-SES explained some variance of the hop tests.

Conclusion: Multiple relationships could be demonstrated between psychological measurements and both quantitative and qualitative movement outcomes during return to sport testing six months after ACL reconstruction.

2 Introduction

Rupture of the anterior cruciate ligament (ACL) is a serious injury common in athletes involved in sports that contain cutting, pivoting and twisting movements (Ardern, Taylor, Feller, & Webster, 2012). The incidence of an ACL injury is variable but has been estimated on 0.9-2.0 injuries per 10 000 athletic exposures (Montalvo et al., 2018) and seems to increase because of participation in higher-risk sports like football, handball, volleyball and basketball (Schub & Saluan, 2011). While most injuries are diagnosed in males, female athletes are at higher risk to sustain an ACL injury (Agel, Arendt, & Bershadsky, 2005) and show a higher rate of injury per athletic exposure (Hootman, Dick, & Agel, 2007; Montalvo et al., 2018).

Athletes who wish to return to sport often undergo an ACL reconstruction. After this operation, the main goal of the athlete is to return to sport as quick as possible and to achieve the same pre-injury level (Ardern, Taylor, Feller, & Webster, 2014; Kyritsis, Bahr, Landreau, Miladi, & Witvrouw, 2016). However, rates of return to the previous sport level are relatively low, especially in older athletes and females (Brophy et al., 2012). According to one review (Ardern, Taylor, et al., 2014), 81% of the athletes return to sport again, 65% achieve their previous level of sport, but only 55% return to a competitive level of sport. Regardless the variety in return to sport rates across different studies, this shows a quite negative image about the rehabilitation and return to sport after ACL reconstruction in athletes.

Until now, the decision to return to sport is often based on time after reconstruction and knee-impairments (Barber-Westin & Noyes, 2011; Burgi et al., 2019), but it has been suggested to consider other factors as well (Dingenen & Gokeler, 2017). Previous research has shown that the psychological response of an athlete after ACL reconstruction as well as on the rehabilitation seems to play an important role in the chances to return to sport and in the chances to sustain a second ACL injury after return to sport (Ardern, Taylor, Feller, Whitehead, & Webster, 2013; McPherson, Feller, Hewett, & Webster, 2019; Webster, Nagelli, Hewett, & Feller, 2018). An association between a positive psychological response and the rate of returning to sport can be made, and was already shown by several studies (Ardern, Taylor, Feller, & Webster, 2013; Ardern, Taylor, Feller, Whitehead, et al., 2013; Langford, Webster, & Feller, 2009).

In this regard, fear of re-injury seems to be one of the most reported reasons for not returning to sport (Ardern, Osterberg, et al., 2014; Faltstrom, Hagglund, & Kvist, 2016; Tjong, Murnaghan, Nyhof-Young, & Ogilvie-Harris, 2014). Multiple other psychological factors described in literature like self-efficacy, motivation and expectations may play a role in the psychological status of the patient and may influence the decision to return to sport (Ardern, Osterberg, et al., 2014; Ardern, Taylor, Feller, Whitehead, et al., 2013; Faltstrom et al., 2016; Gobbi & Francisco, 2006; Hamrin Senorski et al., 2017; Rodriguez-Roiz et al., 2015; Ross, Clifford, & Louw, 2017; Sonesson, Kvist, Ardern, Osterberg, & Silbernagel, 2017).

Despite the important influence of psychological factors on the decision to return to sport, other more objective or physical factors cannot be forgotten. Both quantitative, like muscle strength or hop tests as well as qualitative movement outcomes should be considered when determining whether a patient is ready to return to sport (Dingenen & Gokeler, 2017; Gokeler, Dingenen, Mouton, & Seil, 2017). Following latest evidence, only seven percent of included studies used quality of motion criteria to clear athletes to return to sport (Burgi et al., 2019).

Little is already known about the possible relationship between psychological factors and objective movement outcomes after ACL rehabilitation. Paterno et al (2018) showed that patients with a higher level of fear were more likely to have a single-leg hop symmetry index lower than 95% and an isometric quadriceps strength symmetry lower than 90%. Several studies confirmed this relationship, whereby an association seems demonstrable between a decreased quadriceps strength, a higher level of pain and the psychological response (Lepley & Kuenze, 2018) as well as a weak correlation between the results on the 'Anterior Cruciate Ligament Return to Sport after Injury questionnaire' ACL-RSI and neuromuscular testing (Raoul et al., 2019). Finally, Zarzycki et al. (2018) indicated that lower scores on the ACL-RSI were related to a higher gait asymmetry. It is possible that other relationships between patient reported outcomes and movement outcomes, as described above, exist between psychological factors and objective outcome measures. Because most relationships between psychological factors and physical outcome measures are investigated using only the ACL-RSI and strength or hop tests, the aim of this study is to investigate relationships between several psychological measurements and both quantitative and qualitative movement outcomes.

3 Methods

3.1 Study design

This research, which was a cross-sectional study of all patients who complied with the predefined in- and exclusion criteria between January 2017 and January 2019, was approved by the Medical Ethics Committee of the University of Hasselt and the Medical Ethics Committee of the hospital ZOL (Ziekenhuis Oost-Limburg). Approval included patient information, the informed consent as well as the predefined protocol of this study (Appendix 1). The code of the study was B371201731092.

3.2 Participants

Recruitment of subjects was done in collaboration with two orthopaedic surgeons of the hospital ZOL in Genk, Belgium from January 2017 until July 2018. The study and the possibility to participate was presented to every patient undergoing an ACL reconstruction by one of the two surgeons meeting the in- and exclusion criteria. Interested patients were brought in contact with the local researcher whereby the following in- and exclusion criteria were checked.

Inclusion criteria were: the patient underwent a unilateral ACL reconstruction using a hamstring autograft (1), was equal or between 18 and 45 years old (2), was willing to sign the predefined informed consent (3) and had the possibility to use a PC or laptop at home (4). Exclusion criteria applied in this study were: the patient underwent a revision ACL reconstruction (1), the surgery contained a meniscectomy including more than 1/3 of the entire meniscus present in the knee with the ACL reconstruction (2), the presence of a cartilage injury as a result of the ACL injury (3), a history of a grade three PCL injury, collateral ligament injury or an injury of the posterolateral angle in the knee with the ACL reconstruction (4), a history of a grade three sprain in the contralateral knee (e.g. injury of ACL, PCL, collateral ligaments, posterolateral angle) (5), a history of a major trauma and/or major orthopedic surgery at the lumbar spine, pelvis or lower extremity (6) and a presence of one of the following conditions: neurological or vestibular disorders and pregnancy (7).

3.3 Procedure

When patients confirmed their participation in this study, the local researcher contacted them to make an appointment for the movement tests and the informed consent was signed (Appendix 2). Participants could start their rehabilitation in the meantime with a self-selected physical therapist.

For measuring the psychological response at six months post-operative, the participants were sent an email to fill in the questionnaires via a secured online form (Google Forms). The movement tests, measured six months after reconstruction, took place in the movement lab of the University of Hasselt. Participants were wearing a T-shirt, short and their usual sport shoes. All tests were executed under supervision of the same researcher to minimize detection bias. Prior to the testing a measurement of height, weight and leg length was done as well as an acquisition of patient characteristics like age, type of sport before injury, injury mechanism and score on questionnaires like the 'International Knee Documentation Committee' (IKDC) and the 'Knee Injury and Osteoarthritis Outcome Score' (KOOS).

Before the execution of the movement tests, all participants received the same standard warming up protocol. They performed a warm-up designed by Stensrud et al (2011) and already used by several other authors (Dingenen, Malfait, Nijs, et al., 2015; Dingenen, Malfait, Vanrenterghem, Verschueren, & Staes, 2014; Malfait et al., 2014). This warm-up consisted of two series of two-leg squats (8 repetitions) and two-leg maximum jumps (5 repetitions) (Stensrud et al., 2011). Movement tests included in this research contained both quantitative and qualitative movement tests. The order of execution of the movement tests was predetermined.

3.4   Outcome measures

An overview of all included patient reported outcome measures and outcomes of movement tests are listed up in table one, Appendix 3. The full questionnaires patient needed to fill in can be found in Appendix 4.

3.4.1   Primary outcome measures

3.4.1.1   Patient reported outcome measures (PROM)

Anterior Cruciate Ligament Return to Sport after Injury (ACL-RSI) Scale

This questionnaire, developed by Webster et al (2008) and validated in Dutch (Slagers, Reininga, & van den Akker-Scheek, 2017) was used to assess psychological responses to ACL injury in relation to return to sport. It contained 12 questions about fear of re-injury and confidence in knee-function. The answers on these questions were scored on an 11-point numeric rating scale from zero till ten (completely unsure - completely sure). There was no clear cut-off value, but it was accepted that athletes with higher scores on this questionnaire were more likely to return to sport (Webster et al., 2008). The final score on this questionnaire was the average score of the 12 items (/100).

Knee Self-Efficacy Scale (K-SES)

The K-SES was developed by Thomee et al. (2006) and contained 22 questions of daily living, sport and leisure time and physical activities. This questionnaire was considered valid and reliable for athletes who sustained an ACL injury and was used by several authors in previous studies (Ardern, Osterberg, et al., 2014; Hamrin Senorski et al., 2017). The questionnaire contained questions about several real-life situations and asked participants to score them on an 11-grade Likert scale (completely uncertain - very certain). The main purpose of this questionnaire was to evaluate beliefs of an athlete in their own possibilities and knee function, whereby higher mean scores indicated higher self-efficacy (Thomee et al., 2006). The final score was calculated by making the sum of the scores and then dividing them by the number of questions, so a mean score was obtained (/10). Since the K-SES was divided in a part questioning the beliefs of patients in their own possibilities and knee function now and a part questioning what they expected in the future, two outcome scores were become.

Study-specific questionnaire

Because the ACL-RSI and K-SES did not contain questions about motivation or expectations, a short study-specific questionnaire was developed to assess these psychological aspects. Participants were asked to rate their motivation ("How much time and effort do you want to put into rehabilitation?") and expectations ("Do you think it is possible to return to your previous level of sport?") on a numeric rating scale from zero till ten. Several authors already used additional questions to survey the motivational aspect of returning to sport together with some questions about expectations (Ardern, Taylor, Feller, Whitehead, & Webster, 2015; Gobbi & Francisco, 2006; Kvist, Ek, Sporrstedt, & Good, 2005; Sonesson et al., 2017).

3.4.1.2 Quantitative movement tests

Hop tests

Two different hop tests were included in the testing protocol, the single hop for distance test and the triple hop for distance test (Noyes, Barber, & Mangine, 1991). (Figure 1) All hop tests were performed on one leg, starting with the non-operated leg. Comparison in jump length between the two legs was believed as a predictor of dynamic knee stability (Fitzgerald, Lephart, Hwang, & Wainner, 2001). Three performances of each hop test were executed preceded by two jumps as exercise. If the third jump was the furthest, an additional fourth jump was performed. The instruction to the patient was to jump as far as possible on one leg while keeping balance during the landing. The order of the different hop tests was randomized to minimize a risk of bias due to fatigue. The outcome measure of each hop test was maximum distance, expressed in centimetres. Further a comparison between the two legs was made so a limb symmetry index (LSI) expressed as a percentage was obtained.
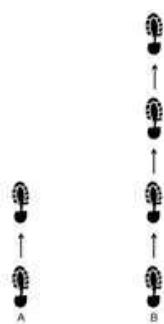

Figure 1 A) Single hop for distance test; B) Triple hop for distance test

Dynamic reaction speed

To test dynamic reaction speed, two agility tests using Smartgoals® were implemented. For both tests, participants were placed in the centre of a square (three goals) or pentagon (five goals). When the test started the goals lighted up alternately after which the participant had to cross the goal line with one leg to extinguish the lights. For the test with three goals, participants were free to choose which leg crossed the goal line. For the test with five goals, participants had to react on the colour that lighted up. If a blue light turned on, participants had to cross the goal line with their left leg. If an orange light turned on, participants had to cross the goal line with their right leg. Participants had to cross the goal line and return to the centre 20 times. Each trial was performed three times after one familiarization trial. The outcome measure was the minimum time of the three repetitions, expressed in seconds, for each dynamic reaction speed test (three goals and pentagon).

Postural control: Y balance test

The Y balance test was an adapted version of the star excursion balance test (Linek, Sikora, Wolny, & Saulicz, 2017). Participants stood on one foot on a central point with eyes closed (Dingenen, Janssens, Claes, Bellemans, & Staes, 2015; Okuda et al., 2005) and hands placed on the iliac crest. The instruction was to move the leg opposite to the supporting leg in three directions: anterior, posteromedial and posterolateral. Each limb was tested three times, starting with the non-operated side as supporting leg, preceded by one trial with eyes open and three trials with eyes closed since stabilization of results was achieved after the second measurement (Linek et al., 2017). The outcome measure was the furthest leg excursion of three trials for both legs compared to the leg length (distance SISA-medial malleolus) of the participant and a limb symmetry index.

3.4.1.3 Qualitative movement tests

Bipodal drop vertical jump (BDVJ)

Participants stood with both feet on a 30 cm high box. The course of this test was to jump off the box with both feet at the same time, land with both feet on the ground and jump up as high as possible moving their two arms to the ceiling. Landing occurred on the same place as where the last jump for height took place. Participants were filmed using iPads® from a frontal and sagittal view (ACL reconstruction side). Cameras were placed 3.5m away from the participant and, using a fixed tripod, at 60cm height.

Two-dimensional video-analysis was done with a software (Kinovea®) by applying 11 reflective markers on different body parts (acromion, sternum, SISA, greater trochanter, lateral femoral condyle, lateral malleolus) (Figure 2). This measurement method seemed appropriate since previous research approved two-dimensional frontal and sagittal plane video analysis offered opportunities to identify less optimal landing patterns (Dingenen, Malfait, Vanrenterghem, et al., 2015).

Trials whereby the participants didn't move their both arms in the air, lost their balance during the jump or landing, watched the ground or landed too much forward were excluded from analysis. In total four correctly executed jumps from each participant were considered and analysed. Analysis of each BDVJ included a two-dimensional video-analysis of the landing movement whereby knee valgus angle, hip flexion angle and knee flexion angle were calculated (Figure 3) and a scoring on the 'Landing Error Scoring System' (LESS) (Appendix 5) (Padua et al., 2009).

Figure 2 Placement of the 11 reflective markers. (Dingenen, Malfait, Vanrenterghem, et al., 2015)

Single-leg drop vertical jump (SLDVJ)

Participants stood on one leg on a 10 cm high box. The course of this test was to drop off the box on one foot, land with one foot on the ground and jump up as high as possible moving their two arms to the ceiling (Dingenen et al., 2014). Landing occurred on the same place as where the last jump for height took place. Participants were filmed again using iPads® from a frontal and sagittal view. The position of the cameras as well as of the 11 reflective markers was the same as during the bipodal vertical drop jump. Performances were not valid if the participant jumped off the box instead of dropping, if the other leg touched the ground, if the participant lost balance or landed too much forward (Stensrud et al., 2011). Each leg was tested four times, starting with the non-operated side, so eight correct jumps were two-dimensional analysed using Kinovea®. Participants were allowed to practice the performance two or three times. Analysis included two-dimensional video-analysis whereby knee valgus angles, lateral trunk motion angles, hip adduction angles, hip flexion angles and knee flexion angles were calculated (Figure 3) and a scoring on the 'Single-Leg Landing Error Scoring System' (SL-LESS) (Appendix 6) (O'Connor, 2015).

Single-leg squat

Participants stood on one foot with crossed arms. The instruction was to bend the knee as far as possible while watching forward, performing a squat movement (Munro, Herrington, & Carolan, 2012). Thereafter, patients returned to the starting position. The velocity of the performance of one squat was controlled by a metronome (60 bpm). Participants had to squat during two beats and had to rise up during the next two beats. Both legs were tested four times, starting with the non-operated side. Participants were filmed using iPads® from a frontal and sagittal view. The position of the cameras as well as of the 11 reflective markers was the same as during the drop vertical jumps. Participants were allowed to practice the performance two or three times until they felt comfortable (Dingenen et al., 2014; Munro et al., 2012). Analysis included two-dimensional video-analysis whereby lateral trunk motion angles, hip adduction and knee valgus were calculated (Figure 3) and a scoring based on the scoring of Crossley et al (2011) (Appendix 7).

Tuck jump

Participants stood on both feet (ca. 35 cm apart) while watching forward. The instruction was to jump for height as much as possible for 10 seconds. Knees had to be lifted to hip height and landing had to occur on the same place. Prior to the test, participants performed three to five subsequent practice jumps to become familiar with the test and to make an accurate interpretation possible. Participants were filmed using iPads® from a frontal and sagittal view whereby position of the cameras was the same as during the drop vertical jumps. Scoring was based on the 'Modified Tuck Jump Assessment' (Appendix 8) (Fort-Vanmeerhaeghe, Montalvo, Lloyd, Read, & Myer, 2017; Gokeler & Dingenen, 2019).
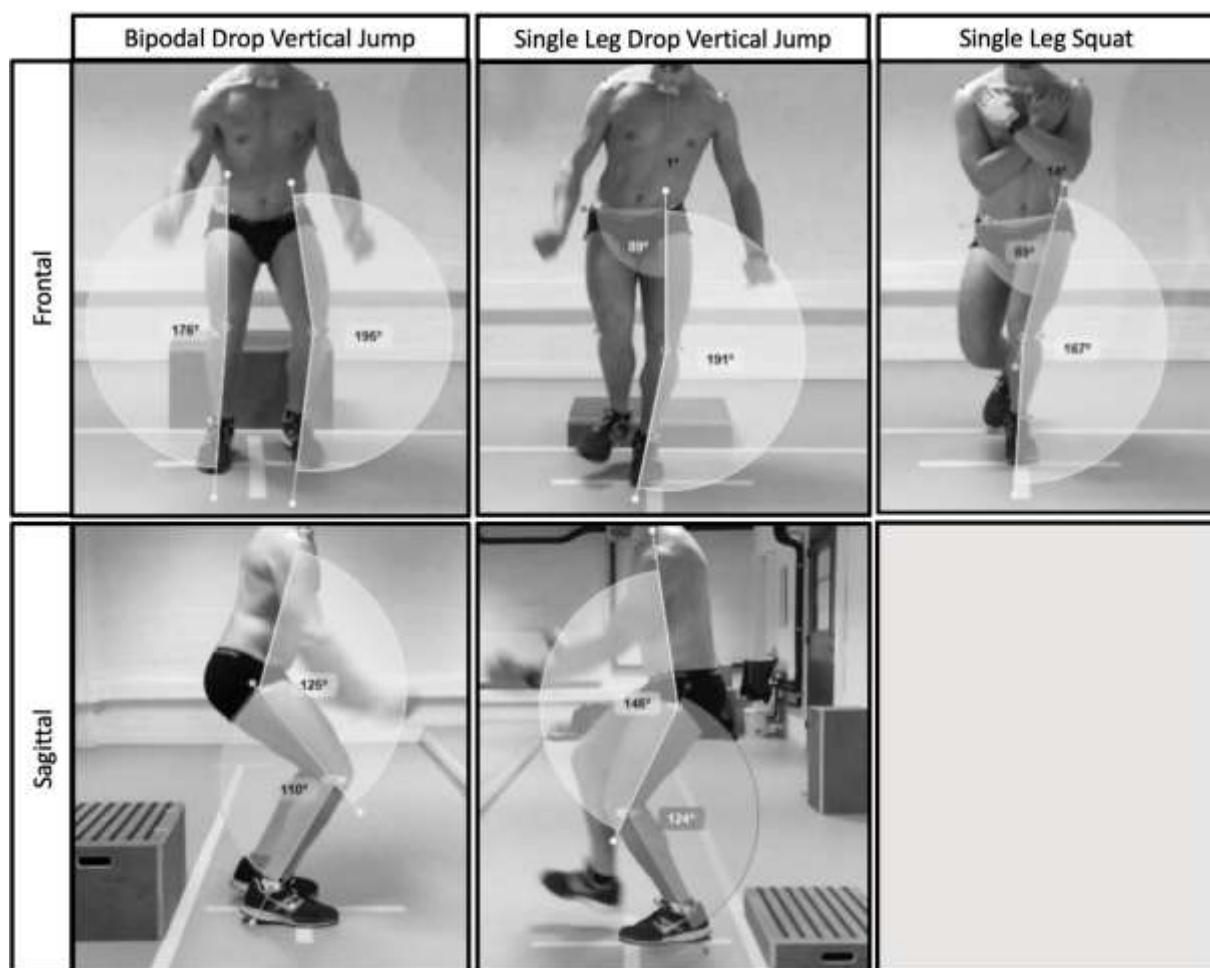
Figure 3 Two-dimensional video analysis

3.4.2 Secondary outcome measures

Demographic information

Information about gender, sport before injury, operated side, etiology of the injury and body mass index (BMI) was collected at six months postoperative. Further a subjective clinical evaluation of the patients' knee was obtained from the 'Knee Injury and Osteoarthritis outcome Score' (KOOS) and 'International Knee Documentation Committee' questionnaire (IKDC) (Appendix 9).

3.5 Data-analyses

All analyses were completed using SAS JMP Pro 14.1 whereby a list-wise deletion approach was used to deal with missing data. Sample descriptive statistics were calculated including means and standard deviations. All data were evaluated for normality and equality of variances, which were conditions for the use of Pearson correlation. Pearson or Spearman correlations were performed to evaluate relationships between assessed psychological factors (patient-reported outcome measures) and qualitative and quantitative movement outcomes. In the case of a non-normal distribution of data, a Spearman correlation, which was a non-parametrical variant, was calculated. A p-value of ≤0.05 was set a priori for all statistical tests. For interpretation of the correlation coefficient the approach of Hopkins et al (Hopkins, Marshall, Batterham, & Hanin, 2009) was followed. Thereby a coefficient from |0.1|was considered as small, from |0.3| as moderate, from |0.5| as large, from |0.7| as very large and from |0.9| as extremely large.

If statistically significant correlations could be demonstrated, a multiple linear regression model was applied on those data. Therefore, data had to meet criteria like linearity, normality, homoscedasticity and independence. In this way, it was possible to consider to what extent certain movement outcomes could predict the psychological response of participants and vice-versa.

4 Results

4.1 Demographic factors

A total of 34 participants were recruited (30M, 4F) after reconstruction (Appendix 10, Table 6). They were all operated in the same hospital by one of two cooperating surgeons, using a hamstring autograft (right side: n=20, 58.82%). Of these participants, 31 were injured while playing sports and the most prominent injury mechanism was non-contact (n=30, 88.3%). Other injury mechanisms were: contact (n=1) and fall or accident (n=3). Most of the participants played football before their injury (n=25, 73.5%). Other sports included basketball (n=3), running (n=2) and tennis, handball, badminton or fitness (n=1).

Mean BMI was calculated and resulted in a mean of 24.65 (SD 2.81) kg/m². The mean score on the IKDC was 77.71 (SD 12.86), while the mean score on the KOOS was divided into five subcategories: symptoms (75.95, SD 16.71), pain (83.78, SD 13.11), daily living (70.46, SD 10.90), sports/recreation (70.46, SD 20.55) and quality of life (62.53, SD 17.04).

4.2 Correlations

Because not all data met the predefined criteria of a normal distribution and equal variance, the non-parametric calculation of the correlation coefficient using Spearman correlation was performed for all data.

4.2.1 Correlations between patient-reported outcomes and quantitative movement outcomes

Data regarding patient-reported outcomes and quantitative movement outcomes demonstrated several statistically significant correlations (Appendix 11, Table 7). A higher score on the ACL-RSI was correlated to a further distance on the single hop for distance test (operated side, non-operated side and limb symmetry index) (r=0.51, p=0.003; r=0.40, p=0.022; r=0.55, p<0.001) and on the triple hop for distance test (operated side, non-operated side and limb symmetry index) (r=0.51, p=0.002; r=0.38, p=0.03; r=0.49, p=0.004).

The ACL-RSI also correlated to the Y balance test in posteromedial (operated and non-operated side) (r=0.43, p=0.012; r=0.42, p=0.015) and posterolateral direction (operated and non-operated side) (r=0.49, p=0.004; r=0.35, p=0.045). A higher score on the ACL-RSI also correlated to a significant lower time on both tests using Smartgoals® (three goals and pentagon) (r=-0.38, p=0.032; r=-0.39, p=0.028). All above described correlations could be interpreted as moderate to large correlations.

A higher score on the K-SES present subscale correlated largely to very largely to a further distance on the single hop for distance test (operated side and limb symmetry index) (r=0.62, p<0.001; r=0.74, p<0.001) and correlated moderately to largely to a further distance on the triple hop for distance test (operated side, non-operated side, limb symmetry index) (r=0.64, p<0.001; r=0.37, p=0.032; r=0.63, p<0.001) and moderately to a higher limb symmetry index of the Y balance test in anterior direction (r=0.37, p=0.033). The score on the K-SES future subscale correlated moderately to largely with a better score on the single hop for distance test (operated side and limb symmetry index) (r=0.44, p=0.01; r=0.69, p<0.001) and triple hop for distance test (operated side and limb symmetry index) (r=0.44, p=0.01; r=0.50, p=0.003).

Finally, a better score on the study-specific questionnaire, specifically on the question about expectations of the patient, correlated largely with a better limb symmetry index of the single hop for distance test (r=0.50, p=0.003). No correlations could be demonstrated between the study-specific questionnaire questioning the motivation of the patient and any quantitative movement outcome.

4.2.2 Correlations between patient-reported outcomes and qualitative movement outcomes

Only four statistically significant correlations could be demonstrated between patient-reported outcome measures and qualitative movement outcomes (Appendix 11, Table 8). A higher score on the ACL-RSI positively correlated to a higher hip adduction angle on the operated side during the single-leg drop vertical jump (r=0.38, p=0.037) and to a higher knee valgus angle on the operated side during the single-leg squat (r=0.48, p=0.005).

The score on the study specific questionnaire about motivation correlated significantly with the objective scoring of the single-leg squat (operated side) based on the method of Crossley et al (2011) (r=0.40, p=0.022). And finally, the score on the study-specific questionnaire about expectations showed a significant positive correlation with knee valgus angle on the operated side during a bipodal drop vertical jump (r=0.38, p=0.031). All these correlations were of moderate size. No correlations could be demonstrated between the outcomes on the K-SES subscales and any qualitative movement outcome.

4.3   Regression

Before linear regression could be executed, model assumptions needed to be checked. Depending on these model assumptions, regression was executed. The explaining variables within the first model in JMP (*fit model*) consisted of all the significant Spearman correlations (p<0.05). Not all of these explaining variables were also significant within the regression model, so they were deleted to simplify this model.

4.3.1   Patient-reported outcome measures: regression model of quantitative and qualitative outcomes

The 34 participants filled in five different questionnaires (ACL-RSI, K-SES present and future, study-specific questionnaire motivation and expectations). Of these questionnaires, the study specific questionnaire (both motivation as expectations) had unequal variance of the residuals, so no regression model could be made. The other questionnaires all had normal distributions, linearity and variance. PROM were not included in each other's model, because this study does not aim to examine the relationship between the PROM mutually (Appendix 12, Table 9).

The ACL-RSI had several correlations with other PROM, qualitative and quantitative movement outcomes. The significant correlations between the ACL-RSI and 11 qualitative and quantitative outcome measures were used to put into the regression model. Together, they predicted 49.50% of the total variance of the score on this questionnaire. After deleting the non-significant ones, only two explaining variables remained, predicting 38.23% of the variance: the Y balance test in posterolateral direction of the non-operated side (p=0.01) and knee valgus of the operated leg during the single leg squat (p<0.001).

Of the K-SES present the regression model consisted of three significant correlations with quantitative movement outcomes: the single hop for distance (operated) and triple hop for distance test (operated and non-operated). They predicted 41.47% of the total variance of the final score. After simplification of these model, only the single hop test operated remained significant (p<0.0001) and explained 39.75%. The regression model of the K-SES future had two significant correlations. Together they explained 18.14% of the total variance. The only variable remaining in the final model was the single hop for distance test operated (p=0.015) and explained 17.60%. The variance of the total score on the K-SES present and future can be partially explained by the score on the single hop test (operated side).

4.3.2 Quantitative movement outcomes: regression model of PROM

The model assumptions of all different quantitative movement outcomes were checked before executing linear regression. Regression could not be performed in case of the outcome measures single and triple hop for distance (non-operated) and Y balance test in anterior direction (operated and non-operated). In these cases the variance was unequal and/or the residuals were not normal distributed (Appendix 12, Table 10).

The single hop for distance test (operated) had a normal distribution and variance. This test correlated with three different PROM: the ACL-RSI, K-SES present and future. Altogether, they explained 49.06% of the total variance. After deleting the non-significant variables, one variable remained significant, predicting 39.75%: the K-SES present (p<0.001). Such as the single hop for distance test (operated), the triple hop for distance test (operated) correlated with the ACL-RSI, K-SES future and present. These three significant correlations explained 42.96% of the total variance of the score on this test. Again, the non-significant ones within the first regression model were deleted and only the K-SES present remained significant in the final model (p<0.001). This variable explained 35.57% of the total variance. Because of doubt about the variance of the residuals, these results need to be interpret with caution. The Y balance test of the operated leg in posteromedial and posterolateral direction only correlated with one PROM: the ACL-RSI (PM: p=0.008, explaining 20.38% and PL: p=0.01, explaining 19.70%). The balance test of the non-operated leg also correlated with the ACL-RSI. In posteromedial direction the p-value was 0.014 and explained 17.84%, in posterolateral direction the p-value was 0.015, explaining 17.79%.

4.3.3 Qualitative movement outcomes: regression model of PROM

Only four qualitative movement outcomes of the operated leg correlated with some PROM. The movement outcomes were: knee valgus during bipodal drop vertical jump and single leg squat, hip abduction during the single leg drop vertical jump and the Crossley scoring of the single leg squat performance. Because of the insignificance of the model of the Crossley scoring and knee valgus during bipodal drop vertical jump, only two regression models were made (Appendix 12, Table 11).

The total variance of the score on the hip abduction during single leg drop vertical jump and knee valgus during single leg squat can be partially predicted by the score on the ACL-RSI. For the hip abduction the ACL-RSI predicts 15.69% (p=0.027) and for the knee valgus 22.65% (p=0.006).

5 Discussion

The purpose of this study was to examine possible relationships between psychological outcomes and quantitative and qualitative movement outcomes six months after ACL reconstruction. A better score on the ACL-RSI questionnaire, indicating less fear and more confidence, was correlated to a better score on the single hop for distance test on both operated and non-operated side and limb symmetry index, to a better score on the triple hop for distance test also both on operated and non-operated side and limb symmetry index, and to a better score on the Y balance test in posteromedial and posterolateral direction on both operated and non-operated side. A better score on the ACL-RSI also correlated to a lower time on both dynamic reaction speed tests using Smartgoals®.

The positive statistically significant correlations between the ACL-RSI and the single hop for distance test and triple hop for distance test were in line with the results of Raoul et al (2019). This study shows a positive and significant correlation between the ACL-RSI and a single and triple hop for distance test on the operated side. The only difference in the results is the strength of the correlations, whereby our study showed a moderate to large correlation in contrast to Raoul et al (2019) who shows a weak correlation. In addition, our results regarding the positive correlation between the ACL-RSI and the limb symmetry index for the single hop for distance test seemed to be in line with the results of Paterno et al (2018). An important difference is that Paterno et al (2018) used the Tampa Scale of Kinesiophobia (TSK-11) whereby our study used the ACL-RSI to get an idea of the patient's level of fear. The ACL-RSI is a much more specific questionnaire for patients after ACL reconstruction than the TSK which is useful in a broader range of pathologies. This might be the reason why our study revealed a statistically significant correlation between the ACL-RSI-score and the limb symmetry index for triple hop for distance test whereby this correlation is non-existent following the study of Paterno et al (2018).

The results of our study show multiple clear correlations between the K-SES subscales or the study-specific questionnaire and quantitative movement outcomes. It is remarkable, given the strength of a number of correlations, that questionnaires like these have never been used in previous research to examine possible correlations between the psychological response and quantitative movement outcomes. Therefore, the results of this study cannot be compared with previous studies.

The same applies to all the results regarding correlations between psychological outcomes and balance measures or reaction speed because these movement tests were never included in previous research.

A better score on the ACL-RSI correlated with a greater hip adduction angle during single-leg drop vertical jump and a greater knee valgus angle during a single-leg squat, both on the operated side. Because of the way of drawing the two-dimensional angles, the interpretation of the hip adduction angle and knee valgus angle deserves special attention. For the knee valgus angle, the outer angle of the knee was measured. In general, an angle of more than 180 degrees equals a varus position of the knee and an angle less than 180 degrees equals a valgus position. For the hip adduction angle, the inner angle was measured, so a bigger angle equals less hip adduction whereas a smaller angle equals more hip adduction.

Our findings regarding the positive correlations between the response on the ACL-RSI and the angles of knee valgus and hip adduction during movement tasks were not completely in line with the results of respectively Zarzycki and Trigsted (Trigsted et al., 2018; Zarzycki et al., 2018). The study of Zarzycki et al (2018) investigated the relationship between the ACL-RSI-score and sagittal plane kinematic asymmetry during gait after rehabilitation after ACL reconstruction. The results show a significant negative correlation between the ACL-RSI and knee kinematic asymmetry during knee flexion angle at initial contact and peak knee flexion angle.

Participants with less fear and more confidence show a more symmetric gait pattern whereas patients with more fear and less confidence exhibit greater side-to-side differences in knee kinematics, as characterized by less knee flexion in the surgical limb at both initial contact and peak knee flexion. It is unclear to what extent gait is comparable to drop landings or squats. However, one could also expect to see sagittal plane kinematics like reduced knee and hip flexion in less controllable and more dynamical movements like drop landings or single-leg squats. Trigsted et al (2018) confirmed this hypothesis by demonstrating significant negative correlations between fear of re-injury (TSK-11) and knee, hip and trunk flexion during a bipodal drop vertical jump in women.

Our results did not show any statistically significant correlation between psychological outcomes and sagittal plane kinematics during movement tasks. In frontal plane however, a significant positive correlation was demonstrable between the ACL-RSI and the hip adduction angle during a single-leg drop vertical jump. This result was in line with the study of Trigsted et al (2018), who shows that patients with less fear of re-injury demonstrate less hip adduction during a bipodal drop vertical jump.

Findings in our research that deserve special attention are the relationships between the score on the ACL-RSI and frontal plane knee and hip kinematics during movement tasks. There was a moderate correlation between a higher score on the ACL-RSI and less knee valgus on the operated side during a single-leg squat and less hip adduction on the operated side during a single-leg drop vertical jump. In conclusion, participants with more confidence and less fear moved less to knee valgus and hip adduction during dynamic activities like single-leg squat or single-leg drop vertical jump. Knee valgus is often described as a body position in which the knee joint collapses medially, representing a combination of hip adduction, hip internal rotation, knee flexion, knee abduction and tibial rotation (Hewett et al., 2005; Paterno et al., 2010). In this regard, our study describes a negative correlation between the ACL-RSI and both knee valgus and hip adduction whereby hip adduction can be seen as a contributing factor to knee valgus. Latest evidence based on in vitro and in vivo study models reveals knee valgus, often in combination with internal knee rotation, as a risk factor for an ACL injury. (Kiapour et al., 2014; Shin, Chaudhari, & Andriacchi, 2009, 2011; Withrow, Huston, Wojtys, & Ashton-Miller, 2006). Further, Paterno et al (2010) shows neuromuscular control, specifically an increase in total frontal plane knee valgus movement, as a predictor of a second ACL injury.

Based on our results, it seemed that participants who were more confident and experienced less fear of re-injury had more control about their knee and hip movements and could better avoid risky movements like knee valgus. Based on this result, one would expect that patients with more confidence and less fear are less suspected to sustain a second ACL injury. This hypothesis is confirmed by the study of McPherson et al. (2019) who showed that people who sustain a second ACL injury trend toward lower psychological readiness at 12 months after ACLR. However, it remains unclear if patients have more confidence because of their experience of neuromuscular control during movements or if patients show more control because of a feeling of confidence in their knee function. Based on the study methods of this study, we are not able to conclude the causality.

This study revealed two significant positive correlations between the study-specific questionnaire about motivation and expectations and qualitative movement outcomes. No previous studies used such a questionnaire to investigate relationships between psychological outcomes and movement outcomes so the results of our research cannot be compared with previous research. Our study-specific questionnaire was not very extensive and consisted of only one question about motivation and one question about expectations. It is possible that the use of a more extensive questionnaire, eventually mapping a broader view of the motivational component and the expectations of the patient, would result in more correlations with quantitative and qualitative movement outcomes.

A multiple linear regression model was made when significant correlations were found between PROM and movement outcomes. The variance of the ACL-RSI could be partially explained by the Y balance test in posterolateral direction and the amount of knee valgus on de SLS, while the variance of the K-SES (present and future) was explained by the score on the single hop test. The other PROM were not included into these models. We only wanted to investigate the degree of explaining capacity of the physical outcomes. Because of the exclusion of other PROM in our model, the R^2 remained rather low. The same procedure was done for the quantitative and qualitative movement outcomes: the K-SES present explained some of the variance of the single and triple hop test, while the ACL-RSI did so for the Y balance test PM and PL, SLDVJ-HA and SLS-KV. Also in this case, the R^2 could be larger when including other physical movement outcomes.

Some other authors used multivariate regression models in their research, but none of them had the same research purposes. In this study, we searched for explaining quantitative and qualitative movement outcomes in case of patient reported outcome measures and vice versa. One study (Lentz et al., 2009) searched for explaining variables of the IKDC subjective form score and single hop test, while other ones (Thomee et al., 2007; Webster et al., 2018) tried to explain the variance of the ACL-RSI (Webster et al., 2018) or K-SES scale (Thomee et al., 2007). None of them solely looked after explaining movement outcomes for these patient reported outcome measures. Also, these articles highlight the importance of self-reported outcome measures to predict return to sport outcomes, which is important to keep in mind. Our study did not search for a relationship between these outcomes and return to sport.

Because the results of our study revealed multiple correlations between psychological outcomes and movement outcomes, it seems necessary to follow up the psychological representation of patients, just as the physical representation, during rehabilitation and to implement them into the decision whether to return to sport. Taking the biopsychosocial framework in mind, it seems to us that the return to sport decision during the rehabilitation process seems to be determined by both movement outcomes as well as psychological outcomes (Dingenen & Gokeler, 2017). Recent evidence reveals a dominant focus on time and to a lesser extent on physical criteria to determine the patient's status after ACL reconstruction and rehabilitation whereby psychological criteria are rarely investigated (Burgi et al., 2019). Sadeqi et al. (2018) demonstrates a regular and gradual improvement of the ACL-RSI score during two years after ACL reconstruction, whereby the greatest increase occurs between preoperatively and four months postoperatively and between six months and one year of follow-up. It seems reasonable that other psychological outcomes, like self-efficacy, motivation and expectations, show a similar evolution pattern over time. A regular assessment of these factors, if possible starting preoperative, seems convenient.

Our results made clear that the ACL-RSI and K-SES present and future show the most significant correlations with both quantitative and qualitative movement outcome measures. The study specific questionnaire correlated to a lesser extent. When practitioners assess the psychological response of their patients, we recommend giving priority to the ACL-RSI and K-SES. Even though the questionnaires about expectations and motivation correlated to a lesser extent, assessing these psychological factors can be necessary to get a broader view on the psychological status of the patient. Higher motivation during rehabilitation leads to a higher chance of returning to sport, according to Sonesson et al. (2017). Physiotherapists can enhance the motivational aspect of their patients by setting goals, repeating testing and giving education, whereby they influence the amount of rehabilitation and the success rate (Grindem, Risberg, & Eitzen, 2015). Adherence to rehabilitation does not directly change the relationship between psychological factors and the rehabilitation outcome, but when a patient is more self-motivated, he seems to attend rehabilitation sessions more strictly and complete a home exercise program more systematically, which are predictors of a better functional recovery (Brewer et al., 2000).

As mentioned above, during the rehabilitation of patients after ACL reconstruction a biopsychosocial conceptual framework should be kept in mind. Relationships between the biological and psychological component of this framework seems clear after the results of our study. The social aspect of this model is not discussed in this study. A recent qualitative research reveals social support as a key factor influencing the rehabilitation outcome after ACL reconstruction (Paterno et al., 2019). Future research should further investigate this social component and its possible relationships with the other components of the biopsychosocial framework.

The psychological response of patients seemed to play a role during the rehabilitation period, based on our results. The next step to improve the rehabilitation and possibly the rehabilitation outcome is to implement interventions aiming to improve this psychological response. In this regard, Rodriguez et al (2019) describes in a systematic review mental imagery as a therapy as an effective intervention, in combination with traditional physical therapy, in reducing fear of reinjury and confidence building in first-time ACL reconstruction. Mental imagery can be described as a process of performing a skill in one's mind using senses (touch, feel, smell, vision) without executing any movement (Maddison et al., 2012; Rodriguez et al., 2019). Specifically, one can mentally imagine rehabilitation exercises and sports activities, but also goal setting, controlling arousal levels and increasing self-confidence and even tissue-healing or other physiological processes (Maddison et al., 2012). It is unclear to what extent physical therapists are trained to integrate mental imagery in their treatment plan, which is mainly focused on physical rehabilitation. Many physical therapists may feel uncomfortable or uncertain to perform such treatments or to take the psychological status of the patient into account during the rehabilitation. In general, the first step in this process is the acknowledgement of the presence of psychological factors, like fear, confidence, motivation and expectations, during the rehabilitation process.

This study aims to contribute to this by showing relationships between the psychological and physical status of the patient. Next, physical therapists should recognize patients whereby this psychological status is suboptimal. Regularly taking questionnaires throughout the rehabilitation period like the ACL-RSI, K-SES and asking about motivation and expectations can serve as a tool to get an idea of this. The final step is to set up a rehabilitation program that prepares the patient both physically as well as mentally to return to sport.

Some limitations of this current study have to be mentioned. First, it is unclear if the sample of this research fully corresponds to the population of ACL-patients. Only four female participants were included in this research, accounting for 12% of the total studied population and 75% of the included population consisted of football players what makes this subgroup overrepresented. Reasons for this overrepresentation remain unclear, but it has to be kept in mind that the results of this study are mainly applicable on male football players and to a lesser extent on athletes, specifically females, of other different sports. Second, patients were allowed to choose their physical therapist to follow the rehabilitation. Therefore, there was no control over the followed rehabilitation protocol. A possible influence of a performance bias could not be ruled out. It is possible that participants scored better on certain movement tasks or on psychological tests because more attention was paid to it during their rehabilitation period in contrast to patients who performed certain movement tasks for the first time.

Third, the reaction speed test using Smartgoals® is not yet described in literature so information about descriptive statistics does not exist. Therefore, this test cannot be seen as valid nor reliable and inclusion of this test in the research protocol is debatable. The reaction speed test distinguishes itself from other tests because this is a very open, dynamic and performance-based task and consequently very functional. Patients cannot predict the course of the test and prepare their movements and therefore this test gives information about the participant's capacity to deal with multiple physical and mental demands of playing sports. According to Gokeler et al. (2019), consciously focussing on controlling knee movements during exercises seems inappropriate to acquire complex motor skills. In this way, the reaction speed test is supposed to better reflect in-game movements and associated biomechanics. According to Collings et al. (2019) this type of testing with a very low experimental control seems to have a higher external validity so inclusion of this test seems justified although one must keep in mind some limitations may exist and further clarification is required.

Fourth, this study has a cross-sectional study design so based on these correlations nothing can be said about cause and effect. However, this is a very interesting consideration whether because of a psychological less optimal outcome a patient creates less optimal movement patterns or vice versa. Future research, consisting of randomized clinical trials with interventions directed at psychological factors or movement factors, is recommended to declare this causality.

Finally, there were some missing data in our study. In terms of demographic factors, two participants did not fill in the IKDC questionnaire whereby one of them did also not fill in the KOOS questionnaire. Multiple participants didn't fill in some questions of this last questionnaire. One participant did not fill in all questions about pain and sports/recreation, another one didn't fill in all questions about daily life and one participant didn't fully fill in the questions about QoL. Why these questions were not answered remains unclear. Possibly because participants did not understand the question or because of oblivion. These incomplete scores were not included in the calculations of mean and standard deviation, so effects of these incompleteness were minimized. There were also some missing data of the quantitative and qualitative movement outcomes. One participant did not execute the reaction speed test, one participant did not perform a SLDVJ on the non-operated leg, so no LESS-score was calculated, one participant did not perform the SLDVJ tests (both operated and non-operated) and one participant did not perform a SLS of the non-operated leg, so there was no Crossley score. One participant was unable to execute any qualitative movement test. In terms of patient-reported outcome measures, one participant didn't fill in any questionnaire so these data were lacking.

One strength of this study is the extensive research protocol, including multiple psychological outcome measures as well as multiple quantitative and qualitative movement outcomes. To our knowledge no previously published literature demonstrates a similar research protocol and is consequently able to show such extensive results based on the same study population. Also, this study used both correlations and regression analysis to analyse the results. There was a large amount of data from PROM, qualitative and quantitative movement outcomes. Despite this large amount, this study succeeded to make a clear overview of all the significant correlations and made a clear analysis. To get an even broader view, the significant correlations were put into a multiple regression model to predict the variance of some scores.

Although this study already reveals several correlations between psychological and physical movement outcomes (both quantitative and qualitative), further research could explore more correlations, using even more outcomes (strength, more questions about movation and self-efficacy, ROM …). Also, our study population was rather small, consisting almost solely of male football players, so further research should use a more varied group of participants (many different sports, female players). It may also be interesting to extend these correlations to return to sport ratio's.

6 Conclusion

The ACL-RSI showed most significant moderate to large correlations with quantitative (hop tests, balance test and reaction speed test) and qualitative (SLDVJ-HA and SLS-KV operated) outcomes. In the regression models of these movement outcomes, the ACL-RSI most frequently explained the variance of the end score of the quantitative and qualitative movement outcomes. This test can be seen as the most important questionnaire to assess psychological factors in relation to physical outcomes. The K-SES present and future also showed multiple significant correlations with quantitative movement outcomes (hop tests and balance test). In contrast, the study-specific questionnaire about motivation and expectations showed only a limited number of correlations with quantitative and qualitative movement outcomes (hop tests, SLS and BDVJ-KV operated).

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8 Appendices

Appendix 1: Approval medical ethics committee ZOL

Comité Medische Ethiek
Schiepse Bos 6
B-3600 Genk
Tel: 089-32 15 09 (secretariaat)
ec.submission@zol.be (secretariaat)

Graag wijzen wij u op de verplichtingen van de hoofdonderzoeker/opdrachtgever t.o.v. het Comité Medische Ethiek:

- De hoofdonderzoeker moet de inclusie van de eerste patiënt melden aan het Comité Medische Ethiek. Het definitief gunstig advies vervalt één jaar na datum van de definitieve goedkeuring wanneer er geen enkele patiënt geïncludeerd is.
- Eenmaal per jaar verstrekt de opdrachtgever aan het bevoegde Ethisch Comité een lijst van alle vermoedens van ernstige bijwerkingen die zich in die periode hebben voor gedaan evenals een rapport betreffende de veiligheid van de deelnemers.
- *Bij medicatiestudies* dient men in geval van een ernstig ongewenst voorval uiterlijk 7 dagen nadat de opdrachtgever van het geval kennis heeft gekregen het bevoegde Ethisch Comité te verwittigen.
  Bij onderzoeken met medische hulpmiddelen dient de rapportering te gebeuren conform de GCP-principes (ISO 14155 : 2011)
  Bij elke andere studie gebeurt de rapportering volgens ICH-GCP, met als prioriteit de veiligheid van de patiënt
- De hoofdonderzoeker/opdrachtgever bezorgt de documenten van een goedgekeurd amendement aan alle betrokken ethische comités. Opgelet: protocolwijzigingen die belang hebben voor de patiënt moet men in de patiënteninformatie opnemen.

Indien aan deze verplichtingen niet voldaan wordt, of de veiligheid van de patiënt in het gedrang komt, is het Comité Medische Ethiek wettelijk verplicht om op te treden.

Tenslotte verzoeken wij u ons mee te delen indien een studie wordt afgesloten of vroegtijdig onderbroken (met opgave van eventuele reden).

Met vriendelijke groeten

Dr. P. NOYENS
Voorzitter Ethisch Comité
Ziekenhuis Oost-Limburg
Schiepse Bos 6, 3600 Genk

dr. P. Noyens
Voorzitter Comité Medische Ethiek
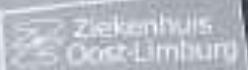
Commissie Medische Ethiek
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Titel studie: Onderzoek naar een optimalisatie van klinische testen ter evaluatie van de terugkeer tot sport na een voorste kruisband reconstructie

Ledenlijst Comité Medische Ethiek

Prof. dr. Kris Dierickx, ethicus
Dr. Gilbert Hoogmartens, huisarts
Mevr. Greet Onkelinx, juriste

Dr. Martine Burin, geriater
Dr. Pascal Vanelderen, anesthesist
Dr. Ward Schrooten, epidemioloog
Dr. Wim Arts, pediater
Dr. Joris Penders, klinisch bioloog
Dr. Patrick Noyens, cardioloog – voorzitter CME
Dr. Jan Vandevenne, radioloog
Dr. Nathalie Dhont, gynaecologe
Dr. Leen Schrooten, psychiater
Mevr. Lacluyse Kathleen, psychologe
Mevr. Ellen Gielen, onderzoeksmedewerker
Dhr. Pierrot Smets, hoofdverpleegkundige
Mevr. Kirsten Cardone, dietiste
Mevr. Sarah De Sy, ziekenhuis-apotheker
Mevr. Griet Wyers, ziekenhuis-apotheker

Vervanger / Expert

Dr. David Verhaert, cardioloog
Mevr. Uschi Colemonts, verpleegkundige
Mevr. Karla Briers, zorgcoördinator

Cc: FAGG
    Victor Hortaplein 40 bus 40, 1060 Brussel

Cc: Dr. Bart Dingenen, UHasselt

Appendix 2: Patient information and informed consent

Informatiebrochure en toestemmingsformulier patiënten

Titel van de studie:

Onderzoek naar een optimalisatie van klinische testen ter evaluatie van de terugkeer tot sport na een voorste kruisband reconstructie

Opdrachtgever:

In opdracht van Universiteit Hasselt, Martelarenlaan 42, 3500 Hasselt

Onderzoeksinstelling:

REVAL – Studiecentrum voor revalidatieonderzoek, Agoralaan gebouw A, 3590 Diepenbeek

Ziekenhuis Oost-Limburg, Schiepse Bos 6, 3600 Genk

Ethische comités:

Comité Medische Ethiek Ziekenhuis Oost-Limburg Comité

voor Medische Ethiek UHasselt

Plaatselijke artsen-onderzoekers:

dr. Bart Dingenen	REVAL, UHasselt
Prof. dr. Johan Bellemans	REVAL, UHasselt; Ziekenhuis Oost-Limburg, Genk
dr. ir. Stijn Quanten	Online Tools for Human Organizations - Othor ®
dr. Alli Gokeler	Universiteit Groningen
Prof. dr. Jan Truijen	Morfologie, UHasselt; Ziekenhuis Oost-Limburg, Genk

Geachte heer / mevrouw,

U wordt uitgenodigd om deel te nemen aan een interventionele studie, die door de Universiteit Hasselt wordt uitgevoerd, in samenwerking met het Ziekenhuis Oost-Limburg (ZOL), Genk. Het betreft een studie naar de beslissing of iemand klaar is om terug te gaan sporten na een voorste kruisband reconstructie. Hiervoor worden een heel aantal metingen uitgevoerd, die ons in staat zullen stellen een beter beeld te vormen over het functioneren van personen na een voorste kruisband reconstructie. Het doel van deze studie is uiteindelijk de beslissing om terug te keren tot sport na een voorste kruisband reconstructie te verbeteren in de klinische praktijk. Voordat u akkoord gaat om aan deze studie deel te nemen, vragen wij u om kennis te nemen van wat deze studie zal inhouden op het gebied van organisatie, zodat u een welbewuste beslissing kunt nemen.

Dit wordt een "geïnformeerde toestemming" genoemd. Wij vragen u de volgende pagina's met informatie aandachtig te lezen. Heeft u vragen, dan kan u terecht bij de arts-onderzoeker of zijn of haar vertegenwoordiger.

Dit document bestaat uit 3 delen: 1. de noodzakelijke informatie die u nodig heeft voor het nemen van uw beslissing of u wel of niet zal deelnemen, 2. uw schriftelijke toestemming en 3. aanvullende informatie waarin u meer details terugvindt over bepaalde onderdelen van de basisinformatie.

I**. Noodzakelijke informatie voor uw beslissing om deel te nemen**
Als u aan deze studie deelneemt, moet u weten dat:

➢ De behandeling die de arts-onderzoeker u in overeenstemming met de huidige aanbevelingen heeft voorgesteld niet zal veranderen door uw deelname aan deze studie.

➢ Deze klinische studie opgesteld is na evaluatie door één of meerdere ethische comités.

➢ Uw deelname is vrijwillig; er kan op geen enkele manier sprake zijn van dwang. Voor deelname is uw ondertekende toestemming nodig. Ook nadat u hebt getekend, kan u de arts-onderzoeker laten weten dat u uw deelname wilt stopzetten.

➢ De gegevens die in het kader van uw deelname worden verzameld, zijn vertrouwelijk. Bij de publicatie van de resultaten is uw anonimiteit verzekerd.

➢ Er is een verzekering afgesloten voor het geval dat u schade zou oplopen in het kader van uw deelname aan deze klinische studie.

➢ Indien u extra informatie wenst, kan u altijd contact opnemen met de arts-onderzoeker of een medewerker van zijn of haar team.

Aanvullende informatie over uw "Rechten als deelnemer aan een klinische studie" vindt u in bijlage.

Doelstellingen en verloop van de studie
Een voorste kruisband (VKB) ruptuur is een knieblessure die een langdurige revalidatie met zich meebrengt. De meeste patiënten ondergaan een VKB reconstructie na een VKB ruptuur. Wetenschappelijk gezien bestaan er de dag van vandaag nog veel vragen over de meest optimale criteria waaraan een sporter moet voldoen om veilig terug te keren tot sport (in het Engels return to sport). Dit kan minder optimale resultaten op lange termijn na een VKB reconstructie in de hand werken.

Het doel van deze studie is uiteindelijk de beslissing om terug te keren tot sport na een voorste kruisband reconstructie te verbeteren in de klinische praktijk. Om dit doel te bereiken, zal u gevraagd worden verschillende testen uit te voeren en vragenlijsten in te vullen. Deze metingen zullen 6 maanden en 12 maanden na de operatie gebeuren. Enkel de vragenlijsten en de neurocognitieve testen (zie later) zullen op 0, 3, 6, 9 en 12 maanden worden uitgevoerd. Deze testen nemen slechts een minimale tijd in beslag (20 minuten) en kunnen thuis online worden uitgevoerd op een computer.

Na het verzamelen van de data wordt u 2 jaar opgevolgd naar sportparticipatie en blessures toe. Dit zal gebeuren door u terug te contacteren 1 en 2 jaar na de laatste metingen. Voor deze opvolging dient u enkel en alleen enkele vragenlijsten in te vullen, welke digitaal worden verstuurd via een online platform waarmee vragenlijsten in een beveiligde omgeving kunnen afgenomen worden (www.surveymonkey.com). De resultaten van dit onderzoek zouden ons toelaten te bestuderen of sommige testen meer of minder geschikt zullen zijn om te integreren binnen een return to sport beslissing. De doelstelling is dat de testen die in dit project gebruikt worden makkelijk toepasbaar zijn in de klinische praktijk. Op deze manier kan de return to sport beslissing in de toekomst met een bredere wetenschappelijk ondersteuning gebeuren. Verder kunnen de resultaten bijdragen tot een optimalisatie van preventieve maatregelen om de kans om een nieuwe VKB of andere blessure te krijgen in de toekomst te verkleinen.

Wij stellen u voor om aan deze studie deel te nemen omdat uw arts bij u een voorste kruisband reconstructie heeft uitgevoerd in het kader van uw klinische situatie. Aan deze klinische studie zouden 50 patiënten moeten deelnemen en 50 controle proefpersonen.

Om te toetsen of u kunt deelnemen aan deze studie, hebben wij enkele in- en exclusiecriteria opgesteld, waaraan u moet voldoen voordat wij u kunnen toelaten in de studie.

Inclusiecriteria:

1. Aanwezigheid van een VKB reconstructie aan 1 knie, met een hamstrings autogreffe.
2. Leeftijd van de patiënt gelijk of groter dan 18 jaar en jonger dan 45 jaar.
3. Bereid zijn om het informed consent te tekenen.
4. Thuis een PC of laptop ter beschikking hebben.

Patiënten worden geëxcludeerd indien aan één of meer van de volgende criteria wordt voldaan:

1. Revisie VKB chirurgie (meer dan een 1-malige VKB reconstructie).
2. Meniscectomie die meer dan 1/3 van de meniscus behelzen in de knie met de VKB reconstructie.
3. Traumatische kraakbeenletsels ten gevolge van het VKB letsel.
4. Een voorgeschiedenis van een graad 3 letsel van de achterste kruisband of collaterale gewrichtsbanden, of letsel van de posterolaterale hoek, in de knie met de VKB reconstructie.
5. Een voorgeschiedenis van een graad 3 ligamentair letsel in de contralaterale knie (i.e. letsel van de VKB, achterste kruisband, lateraal collateraal ligament, mediaal collateraal ligament of posterolaterale hoek).
6. Voorgeschiedenis van een majeur trauma en/of majeure orthopedische chirurgie ter hoogte van de lumbale wervelkolom, bekken of het onderste lidmaat (buiten de VKB reconstructie).
7. Aanwezigheid van één van volgende aandoeningen of constituties: neurologische of vestibulaire stoornissen, zwangerschap.

De duur van uw deelname aan deze studie bestaat uit 7 meetmomenten (0, 3, 6, 9 en 12 maanden na de voorste kruisband reconstructie, en de online opvolging via de vragenlijsten op 1 en 2 jaar na de laatste meting, wat wil zeggen 24 en 36 maanden na de operatie). Tijdens deze studie zal uw arts-onderzoeker u vragen om alle voor de studie noodzakelijke gegevens en informatie te verzamelen - zoals uw demografische gegevens (leeftijd, gewicht, lengte, geslacht).

Uw arts-onderzoeker zal u ook vragen om verschillende vragenlijsten in te vullen die kniespecifieke symptomen, functie, sportactiviteiten, motivatie en tevredenheid evalueren.

Het invullen van deze vragenlijsten zal ongeveer 20 minuten van uw tijd in beslag nemen tijdens elk meetmoment. Naast deze vragenlijsten, wordt er tijdens de metingen op 0, 3, 6, 9 en 12 maanden ook een set van neurocognitieve testen afgenomen. Dit zijn testen die verschillende soorten van reactietijden zullen evalueren. Deze testen worden uitgevoerd op een computer via een online platform, waarvoor u een login zal krijgen en deze testen thuis kan uitvoeren. Het uitvoeren van deze testen duurt ook slechts een 10-tal minuten. Op 6 maanden en 12 maanden na de voorste kruisband reconstructie zullen er ook verschillende andere testen uitgevoerd de volgende aspecten evalueren:

- Sprongafstand, spronghoogte (bewegingskwantitatieve testen)
- Snelheid van richtingsveranderingen (dynamische reactiesnelheid)
- De manier van bewegen wordt tijdens enkele functionele taken zoals het buigen door 1 been en het springen op 2 benen, het springen op 1 been en het evenwicht bewaren geëvalueerd (bewegingskwalitatieve testen)
- Kracht van de heup, knie en kuitspieren

Al deze metingen zijn niet-invasief en worden uitgevoerd in het Studiecentrum voor Revalidatieonderzoek REVAL aan de Universiteit Hasselt (Agoralaan, gebouw A, 3590 Diepenbeek). Deze metingen in het labo zullen ongeveer 2 uur in beslag nemen. In onderstaande tabel worden de metingen binnen dit onderzoeksproject schematisch en chronologisch weergegeven:

Tijdstip na de operatie	Metingen	Locatie
0 maanden	Vragenlijsten	Thuis op pc
	Fundamentele neurocognitieve testen	
3 maanden	Vragenlijsten	Thuis op pc
	Fundamentele neurocognitieve testen	
6 maanden	Vragenlijsten	Labo UHasselt
	Fundamentele neurocognitieve testen	
	Dynamische reactiesnelheid testen	
	Bewegingskwantitatieve testen	
	Bewegingskwalitatieve testen	
	Krachttesten	
9 maanden	Vragenlijsten	Thuis op pc
	Fundamentele neurocognitieve testen	
12 maanden	Vragenlijsten	Labo UHasselt
	Fundamentele neurocognitieve testen	
	Dynamische reactiesnelheid testen	
	Bewegingskwantitatieve testen	
	Bewegingskwalitatieve testen	
	Krachttesten	
24 maanden	Vragenlijsten	Thuis op pc
36 maanden	Vragenlijsten	Thuis op pc

Wat moet ik meenemen naar het onderzoekslabo?

Wanneer u een afspraak heeft in het Studiecentrum voor Revalidatieonderzoek REVAL aan de Universiteit Hasselt (Agoralaan, gebouw A, 3590 Diepenbeek) om uw testen op 6 en 12 maanden uit te voeren, wordt gevraagd een short, nauw aansluitend T-shirt en sportschoenen mee te nemen.

Beschrijving van de risico's en van de voordelen

Er zijn geen bijkomende risico's verbonden aan de deelname aan bovengenoemde experimentele metingen ten opzichte van de standaardprocedure die gevolgd wordt bij een voorste kruisband ruptuur. Er wordt voldoende rust gelaten tussen de verschillende testen. Het onderzoeksteam zal al het mogelijke doen om een aangename sfeer te creëren tijdens het onderzoek. Het voordeel voor u is dat er tijdens de meetmomenten ook feedback kan geformuleerd worden, binnen de mate waarin dit wetenschappelijk op dit moment reeds kan.

U moet begrijpen dat de resultaten van het onderzoek zullen bijdragen tot een verhoogd inzicht in de return to sport beslissing na een voorste kruisband reconstructie waardoor in de toekomst een meer optimale opvolging kan worden uitgewerkt. De deelname aan dit onderzoek brengt geen kosten voor u mee. Er wordt geen extra vergoeding voorzien voor de medewerking aan het onderzoek.

Intrekking van uw toestemming
U neemt vrijwillig deel aan deze studie en u hebt het recht om uw toestemming voor gelijk welke reden in te trekken. U hoeft hiervoor geen reden op te geven.

Als u uw toestemming intrekt, zullen de gegevens bewaard blijven die tot op het ogenblik van uw stopzetting werden verzameld. Dit om de geldigheid van de studie te garanderen. Er zal geen enkel nieuw gegeven aan de opdrachtgever worden gegeven.

De opdrachtgever/verantwoordelijke van de studie zou ook kunnen beslissen om de studie te stoppen indien:

➢ U zich niet houdt aan de instructies voor deelname aan de studie
➢ Verdere deelname aan de studie schadelijk blijkt te zijn voor u
➢ Er na inclusie wordt ontdekt dat u niet aan de studievoorwaarden voldoet
➢ De opdrachtgever de studie stopzet wegens andere (onbekende) redenen

Als u aan deze studie deelneemt, vragen wij om:

➢ Tenvolle mee te werken voor een correct verloop van de studie.
➢ Geen informatie over uw gezondheidstoestand of de symptomen die u ervaart te verzwijgen.
➢ Uw arts-onderzoeker op de hoogte te brengen als men u voorstelt om aan een andere studie deel te nemen zodat u met hem/haar kan bespreken of u aan deze studie kunt deelnemen en of uw deelname aan de huidige klinische studie moet worden stopgezet.

Contact
Als u bijkomende informatie wenst, maar ook ingeval van problemen of als u zich zorgen maakt, kan u contact opnemen met de arts-onderzoeker (dr. Bart Dingenen) via het e-mail adres bart.dingenen@uhasselt.be of het telefoonnummer +32495607519.
Als u vragen hebt met betrekking tot uw rechten als deelnemer aan de studie, kan u contact opnemen met de ombudsdienst in uw ziekenhuis op het telefoonnummer +3289321521. Indien nodig kan de ombudsdienst u in contact brengen met het Ethisch Comité.

II.   Aanvullende informatie
Aanvullende informatie over de bescherming en de rechten van de deelnemer aan een klinische studie.

Ethisch comité
Na raadpleging van het Comité Medische Ethiek van UHasselt heeft het Comité Medische Ethiek van ZOL Genk zijn goedkeuring gegeven voor deze studie. Een ethische comité heeft de taak om personen die aan klinische studies deelnemen te beschermen. Ze controleren of uw rechten als patiënt en als deelnemer aan een studie gerespecteerd worden, of de studie wetenschappelijk relevant en ethisch verantwoord is.
Hierover brengen de ethische comités een advies uit in overeenstemming met de Belgische wet van 7 mei 2004. U dient het positief advies van de Ethische Comités in geen geval te beschouwen als een aansporing om deel te nemen aan deze studie.

Vrijwillige deelname

Aarzel niet om alle vragen te stellen die u nuttig vindt voordat u tekent. Neem de tijd om er met een vertrouwenspersoon over te praten, als u dit wenst. U heeft het recht om niet deel te nemen aan deze studie of met deze studie te stoppen zonder dat u hiervoor een reden hoeft te geven, zelfs al hebt u eerder toegestemd om aan deze studie deel te nemen. Als u aanvaardt om aan deze studie deel te nemen, ondertekent u het toestemmingsformulier. De onderzoeker zal dit formulier ook ondertekenen en zal zo bevestigen dat hij u de noodzakelijke informatie voor deze studie heeft gegeven. U zult het voor u bestemde exemplaar ontvangen.

Kosten in verband met uw deelname

Uw deelname zal echter voor u geen bijkomende kosten met zich meebrengen.

Vertrouwelijkheidgarantie

Uw deelname aan de studie betekent dat u ermee akkoord gaat dat de onderzoeker gegevens over u verzamelt en dat de opdrachtgever van de studie die gebruikt voor onderzoek en in het kader van wetenschappelijke en medische publicaties. U hebt het recht om aan de onderzoeker te vragen welke gegevens hij/zij over u heeft verzameld en waarvoor ze gebruikt worden in het kader van de studie. Deze gegevens hebben betrekking op uw huidige (klinische) situatie. U hebt het recht om deze gegevens in te kijken en om verbeteringen te laten aanbrengen indien ze foutief zouden zijn[1].

De onderzoeker is verplicht om deze verzamelde gegevens vertrouwelijk te behandelen. Dit betekent dat hij zich ertoe verbindt om uw naam nooit bekend te maken in het kader van een publicatie of een conferentie en dat hij uw persoonlijke gegevens zal coderen (uw identiteit zal worden vervangen door een identificatiecode in de studie). De onderzoeker en zijn team zullen gedurende de volledige klinische studie de enige personen zijn die een verband kunnen leggen tussen de overgedragen gegevens en uw medisch dossier[2]. De overgedragen persoonlijke gegevens omvatten geen combinatie van elementen waarmee het mogelijk is u te identificeren[3].

Om de kwaliteit van de studie te controleren, kan uw medisch dossier worden ingekeken door personen die gebonden zijn aan het beroepsgeheim zoals vertegenwoordigers van de ethische comités, van de opdrachtgever van de studie of een extern auditbureau. Dit kan enkel gebeuren onder strikte voorwaarden, onder de verantwoordelijkheid van de onderzoeker en onder zijn/haar toezicht (of van één van zijn/haar onderzoeksmedewerkers). De (gecodeerde) onderzoeksgegevens kunnen doorgegeven worden aan Belgische of andere regelgevende instanties, aan de ethische comités, aan andere artsen en/of instellingen die samenwerken met de opdrachtgever.

Uw toestemming om aan deze studie deel te nemen betekent dus ook dat u akkoord gaat dat uw gecodeerde medische gegevens gebruikt worden voor doeleinden die in dit informatieformulier staan beschreven en dat ze worden overgedragen aan bovenvermelde personen en/of instellingen. De opdrachtgever verbindt zich ertoe om de verzamelde gegevens enkel in het kader van deze studie te gebruiken.

---

[1] Deze rechten zijn bepaald door de wet van 8 december 1992 tot bescherming van de persoonlijke levenssfeer ten opzichte van de verwerking van persoonsgegevens en door de wet van 22 augustus 2002 betreffende de rechten van de patiënt.

[2] De wet verplicht om voor klinische studies dit verband met uw dossier gedurende 20 jaar te bewaren.

[3] De database met de resultaten van de studie zal dus geen elementen bevatten zoals uw initialen, uw geslacht en uw volledige geboortedatum (dd/mm/jjjj).

Indien u uw toestemming tot deelname aan de studie intrekt, zullen de gecodeerde gegevens die al verzameld waren vóór uw terugtrekking, bewaard worden. Hierdoor wordt de geldigheid van de studie gegarandeerd. Er zal geen enkel nieuw gegeven aan de opdrachtgever worden doorgegeven.

Verzekering

In een interventionele studie is het enige mogelijke risico een probleem met de maatregelen die werden genomen om de vertrouwelijkheid van uw persoonsgegevens te beschermen. De opdrachtgever is, ook indien er geen sprake is van fout, aansprakelijk voor de schade die u als deelnemer - of in geval van overlijden uw rechthebbenden - oplopen en die rechtstreeks of onrechtstreeks te wijten is aan de deelname aan deze studie. Hiervoor heeft de opdrachtgever een verzekeringscontract afgesloten[4].

Gegevens van de verzekeringsmaatschappij:

Ethias - Zetel voor Vlaanderen
Prins-Bisschopssingel 73
3500 Hasselt
Tel. 011 28 21 11
Polisnummer: 45.197.381

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[4] Conform artikel 29 van de Belgische wetgeving inzake experimenten op de menselijke persoon (7 mei 2004)

III. Geïnformeerde toestemming

Deelnemer

- ✓ Ik verklaar dat ik geïnformeerd ben over de aard, het doel, de duur, de eventuele voordelen en risico's van de studie en dat ik weet wat van mij wordt verwacht. ✓ Ik heb kennis genomen van het informatiedocument en de bijlagen ervan.
- ✓ Ik heb voldoende tijd gehad om na te denken en met een door mij gekozen persoon, zoals mijn huisarts of een familielid, te praten.
- ✓ Ik heb alle vragen kunnen stellen die bij me opkwamen en ik heb een duidelijk antwoord gekregen op mijn vragen.
- ✓ Ik begrijp dat mijn deelname aan deze studie vrijwillig is en dat ik vrij ben mijn deelname aan deze studie stop te zetten zonder dat dit mijn relatie schaadt met het therapeutisch team dat instaat voor mijn gezondheid.
- ✓ Ik begrijp dat er tijdens mijn deelname aan deze studie gegevens over mij zullen worden verzameld en dat de arts-onderzoeker en de opdrachtgever de vertrouwelijkheid van deze gegevens verzekeren overeenkomstig de Belgische wetgeving ter zake.
- ✓ Ik stem in met de verwerking van mijn persoonlijke gegevens volgens de modaliteiten die zijn beschreven in de rubriek over het verzekeren van de vertrouwelijkheid (bijlage XX).
- ✓ Ik ga ermee akkoord dat de studiegegevens die voor de hier vermelde studie worden verzameld, later zullen worden verwerkt, op voorwaarde dat deze verwerking beperkt blijft tot de context van de hier vermelde studie voor een betere kennis van de ziekte en de behandeling ervan.
- ✓ Ik heb een exemplaar ontvangen van de informatie aan de deelnemer en de geïnformeerde toestemming.

Naam   Datum   Handtekening deelnemer

Arts-Onderzoeker

- ✓ Ik verklaar de benodigde informatie inzake deze studie mondeling te hebben verstrekt evenals een exemplaar van het informatiedocument aan de deelnemer te hebben verstrekt.
- ✓ Ik bevestig dat geen enkele druk op de deelnemer is uitgeoefend om hem/haar te doen toestemmen met deelname aan de studie en ik ben bereid om op alle eventuele bijkomende vragen te antwoorden.
- ✓ Ik bevestig dat ik werk in overeenstemming met de ethische beginselen zoals vermeld in de "Verklaring van Helsinki", de "Goede klinische praktijk" en de Belgische wet van 7 mei 2004 inzake experimenten op de menselijke persoon.

Naam   Datum   Handtekening onderzoeker

Appendix 3: Overview outcome measures

Table 1

Outcome measures

	Measuring scale/ questionnaire	Components	Outcome
Patient reported questionnaires	ACL-RSI		Score /100
	K-SES	K-SES present	Score /10
		K-SES future	Score /10
	Study-specific questionnaire	Motivation	Score /10
		Expectations	Score /10
	Movement test	**Subdivision**	**Outcome**
Quantitative movement	Hop tests	Single hop for distance test	Maximum distance (cm) & LSI (%)
		Triple for distance hop test	Maximum distance (cm) & LSI (%)
	Y balance test		Maximum distance corrected for leg length (%) & LSI (%)
	Smartgoals®	Three goals	Minimum time (sec)
		Pentagon	Minimum time (sec)
	Movement test	**Measurement**	**Outcome**
Qualitative movement tests	BDVJ	Knee valgus, hip flexion, knee flexion	Angles (°)
		LESS	Score
	SLDVJ	Knee valgus, lateral trunk motion, hip adduction, knee flexion, hip flexion	Angles (°)
		SL-LESS	Score
	Single-leg squat	Knee valgus, lateral trunk motion, hip adduction	Angles (°)
		Scoring based on Crossley	Score /15
	Tuck jump	Scoring based on Fort-Vanmeerhaeghe	Score /20

Appendix 4: patient reported outcome measures

1. <u>ACL-RSI (Slagers et al., 2017)</u>

ACL-RSI-vragenlijst

<u>Instructies</u>: Beantwoord de volgende vragen met betrekking tot uw hoofdsport die u voorafgaand aan uw blessure beoefende. Kruis bij elke vraag een vakje aan tussen de twee beschrijvingen om aan te geven hoe u zich op dit moment voelt ten opzichte van de twee uitersten.

1. Bent u er zeker van dat u weer op uw oude niveau uw sport kunt beoefenen?

Helemaal niet zeker	0	10	20	30	40	50	60	70	80	90	100	Helemaal zeker
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

2. Denkt u dat u waarschijnlijk uw knie opnieuw zal blesseren bij het beoefenen van uw sport?

Heel erg waarschijnlijk	0	10	20	30	40	50	60	70	80	90	100	Helemaal niet waarschijnlijk
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

3. Bent u zenuwachtig over het beoefenen van uw sport?

Heel erg zenuwachtig	0	10	20	30	40	50	60	70	80	90	100	Helemaal niet zenuwachtig
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

4. Weet u zeker dat u niet door uw knie gaat tijdens uw sportbeoefening?

Helemaal niet zeker	0	10	20	30	40	50	60	70	80	90	100	Helemaal zeker
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

5. Weet u zeker dat u uw sport kan beoefenen zonder bezorgd te zijn over uw knie?

Helemaal niet zeker	0	10	20	30	40	50	60	70	80	90	100	Helemaal zeker
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

6. Vindt u het frustrerend rekening te moeten houden met uw knie in uw sport?

Heel erg frustrerend	0	10	20	30	40	50	60	70	80	90	100	Helemaal niet frustrerend
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

7. Bent u bang opnieuw geblesseerd te raken aan uw knie door het beoefenen van uw sport?

Heel erg bang   Helemaal niet

	0	10	20	30	40	50	60	70	80	90	100	bang
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

8. Bent u er zeker van dat uw knie belasting aan kan?

Helemaal   Helemaal

niet zeker

0	10	20	30	40	50	60	70	80	90	100	zeker
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

9. Bent u bang voor het per ongeluk blesseren van uw knie door het beoefenen van uw sport?

Heel erg bang   Helemaal   niet

0	10	20	30	40	50	60	70	80	90	100	bang
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

10. Houden de gedachten aan het weer opnieuw moeten ondergaan van een operatie en revalidatie u tegen om weer uw sport te beoefenen?

Altijd

0	10	20	30	40	50	60	70	80	90	100	Nooit
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

11. bent u zeker van uw vermogen om goed te presteren in uw sport?

Helemaal   Helemaal zeker

niet zeker

0	10	20	30	40	50	60	70	80	90	100
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

12. Voelt u zich ontspannen over het beoefenen van uw sport?

Helemaal   Helemaal

niet   ontspannen

ontspannen

0	10	20	30	40	50	60	70	80	90	100
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

2. <u>K-SES (Thomee et al., 2006)</u>

Knee Self-Efficacy Scale (Thomee et al. 2006)

Voornaam: _____

Achternaam: _____

Datum: _____

Deze vragenlijst bestaat uit 4 delen. In deel A, B en C wordt gevraagd aan te duiden hoe zeker je bent over het uitvoeren van verschillende activiteiten op dit moment. Deel D refereert naar de activiteiten in de toekomst.

Gelieve de vragen zorgvuldig te lezen en het antwoord aan te duiden dat passend is voor u.

Deel A. Dagelijkse activiteiten

<u>Hoe zeker ben je NU over de volgende activiteiten?</u>

0 = Ik voel me totaal niet zeker om deze activiteit uit te voeren.

10 = Ik voel me helemaal zeker om deze activiteit uit te voeren.

	0	1	2	3	4	5	6	7	8	9	10
1. Wandelen in het bos	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Op en af gaan op een trap of helling	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Uitgaan en dansen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Aan wal springen vanuit een boot	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Achter kleine kinderen aanlopen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Lopen richting een trein of bus	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7. Werken in de tuin	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Deel B. Sport en vrije tijd activiteiten

Hoe zeker ben je NU over de volgende activiteiten?

0 = Ik voel me totaal niet zeker om deze activiteit uit te voeren.

10 = Ik voel me helemaal zeker om deze activiteit uit te voeren.

	0	1	2	3	4	5	6	7	8	9	10
1. Een lange rit fietsen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Skiën	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Paardrijden	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Zwemmen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Rondtrekken in de bergen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Deel C. Fysieke activiteiten

Hoe zeker ben je NU over de volgende activiteiten?

0 = Ik voel me totaal niet zeker om deze activiteit uit te voeren.

10 = Ik voel me helemaal zeker om deze activiteit uit te voeren.

	0	1	2	3	4	5	6	7	8	9	10
1. Squatten (door de knieën buigen)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Zijdelings springen van het ene been naar het andere	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Hard te trainen voor een korte tijd	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Eénbenige sprongen uitvoeren op het geopereerde been	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Bewegen in een kleine bewegende boot	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Snel draaien	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Deel D. Je knie functie in de TOEKOMST

0 = Ik voel me totaal niet zeker.

10 = Ik voel me helemaal zeker.

	0	1	2	3	4	5	6	7	8	9	10
1. Hoe zeker voel je je dat je kan terugkeren tot hetzelfde fysieke activiteitsniveau als voor de blessure	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Hoe zeker voel je je dat je geen nieuwe knie blessure zal oplopen?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Hoe zeker voel je je dat je knie het niet gaat begeven?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Hoe zeker voel je je dat je knie er niet slechter aan toe zal zijn dan voor de operatie?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3. Study-specific questionnaire

Study-specific questionnaire

Voornaam: _____

Achternaam: _____

Datum: _____

Pre-operatieve sport: _____

De volgende vragen gaan over uw motivatie en verwachtingen. Gelieve de vragen zorgvuldig te lezen en het antwoord aan te duiden dat passend is voor u.

1. Denk je dat het mogelijk is o terug te keren tot je voorgaand sportniveau?
    - o   1   Ik geloof niet dat het mogelijk is.
    - o   2
    - o   3
    - o   4
    - o   5
    - o   6
    - o   7
    - o   8
    - o   9
    - o   10   Ik geloof heel sterk dat het mogelijk is.

2. Hoeveel tijd en moeite wil je investeren om terug te keren tot je voorgaande sportniveau?
    - o   1   Zo weinig mogelijk
    - o   2
    - o   3
    - o   4
    - o   5
    - o   6
    - o   7
    - o   8
    - o   9
    - o   10   Zo veel mogelijk

Appendix 5: LESS (Padua et al., 2009)

Table 2

Landing Error Scoring System

LESS-item	Operational Definition of Error	Scoring
Knee flexion: initial contact	The knee is flexed less than 30° at initial contact	0 = Absent 1 = Present
Hip flexion: initial contact	The thigh is in line with the trunk at initial contact.	0 = Absent 1 = Present
Trunk flexion: initial contact	The trunk is vertical or extended on the hips at initial contact.	0 = Absent 1 = Present
Ankle plantar flexion: initial contact	The foot lands heel to toe or with a flat foot at initial contact.	0 = Absent 1 = Present
Medial knee position:	The centre of the patella is medial to the midfoot at initial contact.	0 = Absent 1 = Present
Lateral trunk flexion: initial contact	The midline of the trunk is flexed to the left or the right side of the body at initial contact.	0 = Absent 1 = Present
Stance width: wide	The feet are positioned greater than shoulder width apart (acromion processes) at initial contact.	0 = Absent 1 = Present
Stance width: narrow	The feet are positioned less than shoulder width apart (acromion processes) at initial contact.	0 = Absent 1 = Present
Foot position: external rotation	The foot is externally rotated more than 308 between initial contact and maximum knee flexion.	0 = Absent 1 = Present
Foot position: internal rotation	The foot is internally rotated more than 308 between initial contact and maximum knee flexion.	0 = Absent 1 = Present
Symmetrical initial foot contact: initial contact	One foot lands before the other foot or 1 foot lands heel to toe and the other foot lands toe to heel.	0 = Absent 1 = Present
Knee flexion displacement	The knee flexes less than 458 between initial contact and maximum knee flexion.	0 = Absent 1 = Present
Hip flexion displacement	The thigh does not flex more on the trunk between initial contact and maximum knee flexion.	0 = Absent 1 = Present

Trunk flexion displacement	The trunk does not flex more between initial contact and maximum knee flexion.	0 = Absent 1 = Present
Medial knee displacement	At the point of maximum medial knee position, the center of the patella is medial to the midfoot.	0 = Absent 1 = Present
Joint displacement	Soft: the participant demonstrates a large amount of trunk, hip, and knee displacement. Average: the participant has some, but not a large amount of, trunk, hip, and knee displacement. Stiff: the participant goes through very little, if any, trunk, hip, and knee displacement.	0 = Soft 1 = Average 2 = Stiff
Overall impression	Excellent: the participant displays a soft landing with no frontal-plane or transverse plane motion. Average: all other landings. Poor: the participant displays large frontal-plane or transverse-plane motion, or the participant displays a stiff landing with some frontal-plane or transverse-plane motion.	0 = Excellent 1 = Average 2 = Poor

Appendix 6: SL-LESS (O'Connor, 2015)

Table 3

SL-LESS Itemized Description

		Item	Error (1)	Good (0)
S A G I T T A L P L A N E	1	Forward Trunk Flexion at IC	At IC the trunk is vertical or extended on the hips	The trunk is flexed on the hips
	2	Knee Flexion at IC	At IC the knee is flexed more than 30°	The knee is not flexed more than 30°
	3	Ankle plantarflexion at IC	The foot lands heel to toe or with a flat foot	The foot of the test leg lands toe to heel
	4	Forward Trunk Flexion Displacement	Between IC and MKF there is no additional trunk flexion	There is additional trunk flexion
	5	Knee Flexion Displacement	Between IC and MKF the knee does not flex an additional 30°	The knee flexes an additional 30°
	6	Ankle Dorsiflexion Displacement	Between IC and MKF the heel does not touch the ground or the ankle does not move into a dorsiflexed position during landing	The heel touches the ground and the ankle becomes dorsiflexed during landing
F R O N T A L	7	Knee Valgus at IC	At IC, a line drawn straight down from the centre of the patella is medial to the midfoot	The line goes through the midfoot
	8	Lateral Trunk Flexion at IC	At IC, the midline of the trunk is flexed to the left or the right side of the body	The trunk is not flexed to the left or right side of the body

PLANE	9	Knee Valgus Displacement	At MKV a line drawn straight down from the centre of the patella runs through the great toe or is medial to the great toe	The line is lateral to the great toe
	10	Pelvic Drop	During landing the contralateral pelvis positioned lower than the ipsilateral pelvis	Both sides of the pelvis remain level
	11	Tibial rotation (toe pointed in/out)	Between IC and MKF the foot is internally/externally rotated more than 30°	If the foot is not internally/externally rotated more than 30°

IC, initial contact; ROM, range of motion; MKF, maximum knee flexion; MKV, maximum knee valgus

Appendix 7: Single-leg squat scoring (Crossley et al., 2011)

Table 4

Clinical rating criteria determined by consensus panel (Crossley)

	Criterion	To Be Rated "Good" (1)
A	Overall impression across the 5 trials	
	Ability to maintain balance	Participant does not lose balance
	Perturbations of the person	Movement is performed smoothly
	Depth or the squat	The squat is performed to at least 60° of knee flexion
	Speed of the squat	Squat is performed at approximately 1 per 2 seconds
B	Trunk posture	
	Trunk/thoracic lateral deviation or shift	
	Trunk/thoracic rotation	
	Trunk/thoracic lateral flexion	
	Trunk/thoracic forward flexion	
C	The pelvis "in space"	
	Pelvic shunt or lateral deviation	No pelvic shunt or lateral deviation
	Pelvic rotation	No pelvic rotation
	Pelvic tilt (take note of depth of squat)	No pelvic tilt
D	Hip joint	
	Hip adduction	No hip adduction
	Hip (femoral) internal rotation	No hip (femoral) internal rotation
E	Knee joint	
	Apparent knee valgus	No apparent knee valgus
	Knee position relative to foot position	Center of the knee remains over the center of the foot

Appendix 8: Modified Tuck Jump Assessment (Fort-Vanmeerhaeghe et al., 2017)

Table 5

Modified Tuck Jump Assessment

Phase of jump		Criterion	View	None (0)	Small (1)	Large (2)
Knee and thigh motion	1.	Lower extremity valgus at landing	Frontal (F)	No valgus	SLight valgus	Obvious valgus: both knees touch
	2.	Thighs do not reach parallel (peak of jump)	Lateral (L)	The knees are higher or at the same level as the hips	The middle of the knees are at a lower level than the middle of the hips	The whole knees are under the entire hips
	3.	Thighs not equal side-to-side during flight	F	Thighs equal side-to-side	Thighs slightly unequal side-to-side	Thighs completely unequal side-to-side (one knee is over the other)
Foot position during landing	4.	Foot placement not shoulder width apart	F	Foot placement exactly shoulder width apart	Foot placement mostly shoulder width apart	Both feet fully together and touch at landing
	5.	Foot placement not parallel (front to back)	L	Foot (the end of the feet) placement parallel	Foot placement mostly parallel	Foot placement obviously unparalleled (one foot is over half the distance of the other foot/leg)
	6.	Foot contact timing not equal (asymmetrical landing)	F	Foot contact timing equal side-to-side	Foot contact timing slightly unequal	Foot contact timing completely unequal
	7.	Excessive landing contact noise	F/L	Subtle noise at landing (landing on the balls of their feet)	Audible noise at landing (heels almost touch the ground at landing)	Loud and pronounced moise at landing (contact of the entire foot and heel on the ground between jumps)

Plyometric technique	8. Pause between jumps	F/L	Reactive and reflex jumps	Small pause between jumps	Large pause between jumps (or double contact between jumps)
	9. Technique declines prior seconds	F/L	No decline in technique	Technique declines after five seconds	Technique declines before five seconds
	10. Does not land in same foot print (consistent point of landing)	F/L	Lands in same footprint	Does not land in same footprint, but inside the shape	Lands outside the shape

Appendix 9: Subjective knee scoring

1. <u>KOOS (de Groot, Favejee, Reijman, Verhaar, & Terwee, 2008)</u>

Knee injury and Osteoarthritis Outcome Score (KOOS)

Groot IB de, Favejee M, Reijman M, Verhaar JAN, Terwee CB.

Instructies:

Instructies: Deze vragenlijst stelt vragen in verband met uw visie betreffende uw knie. Deze informatie helpt ons te achterhalen hoe u zich voelt en in hoeverre het mogelijk is voor u om uw dagelijkse activiteiten uit te voeren. Beantwoord de onderstaande vragen door **één** antwoord aan te vinken dat voor u van toepassing is. Als u niet geheel zeker bent van uw antwoord, graag toch het best mogelijke antwoord geven.

Symptomen

Deze vragen dienen te worden beantwoord met betrekking tot de knie symptomen gedurende de afgelopen week.

	Nooit (0)	Bijna nooit (1)	Soms (2)	Vaak (3)	Altijd (4)
S-1	*Is uw knie gezwollen?*				
	☐	☐	☐	☐	☐
S-1	*Voelt u knarsen in uw knie of hoort u uw knie klikken of een ander geluid als u uw*				
	☐	☐	☐	☐	☐
S-3	*Blijft uw knie steken of schiet uw knie op slot bij bewegen?*				
	☐	☐	☐	☐	☐

	Altijd (0)	Vaak (1)	Soms (2)	Bijna nooit (3)	Nooit (4)
S-4	*Kan u uw knie volledig strekken?*				
	☐	☐	☐	☐	☐
S-5	*Kan u uw knie volledig buigen?*				
	☐	☐	☐	☐	☐

Stijfheid

De volgende vragen betreffen de hoeveelheid <u>gewrichtsstijfheid</u> die u ervaren heeft in uw knie gedurende de **afgelopen week.** Stijfheid is een gevoel van restrictie of traagheid in de gemakkelijkheid waarmee u uw kniegewricht kan bewegen.

	Niet (0)	Mild (1)	Gemiddeld (2)	Ernstig (3)	Extreem (4)
S-6	*Hoe ernstig is de stijfheid van uw kniegewricht als u wakker wordt 's morgens?*				
	☐	☐	☐	☐	☐

S-7   *Hoe ernstig is de stijfheid van uw kniegewricht nadat u gezeten, gelegen of gerust heeft later op de dag?*

Pijn

De volgende vragen betreffen de hoeveelheid <u>pijn</u> die u ervaren heeft in uw knie gedurende de **afgelopen week.**

Nooit (0)	**Maandelijks (1)**	**Wekelijks (2)**	**Dagelijks (3)**	**Altijd (4)**

P-1   *Hoe vaak ervaart u kniepijn?*

Niet (0)	**Mild (1)**	**Gemiddeld (2)**	**Ernstig (3)**	**Extreem (4)**

P-2   *Draaien/roteren van uw knie*

P-3   *Volledig strekken van de knie*

P-4   *Volledig buigen van de knie*

P-5   *Lopen op een vlak oppervlak*

P-6   *Op- en neer lopen van een trap*

P-7   *'s Nachts in bed*

P-8   *Zitten of liggen*

P-9   *Rechtop staan*

Functioneren, dagelijkse bezigheden

De volgende vragen betreffen uw fysieke functioneren. Hierbij wordt bedoeld de mogelijkheid om u te bewegen en voor uzelf te zorgen. Voor de volgende activiteiten graag aangeven wat de moeilijkheidsgraad is die u ervaren heeft gedurende de afgelopen week als gevolg van uw knie.

Niet (0)	**Mild (1)**	**Gemiddeld (2)**	**Ernstig (3)**	**Extreem (4)**

A-1   *Trap aflopen*

A-2   *Trap oplopen*

☐   ☐   ☐   ☐   ☐

A-3   *Opstaan nadat u gezeten heeft*

☐   ☐   ☐   ☐   ☐

A-4   *Staan*

☐   ☐   ☐   ☐   ☐

A-5   *Bukken naar de grond/iets oppakken van de grond*

☐   ☐   ☐   ☐   ☐

A-6   *Lopen op een vlakke ondergrond*

☐   ☐   ☐   ☐   ☐

A-7   *Instappen/uitstappen uit een auto*

☐   ☐   ☐   ☐   ☐

A-8   *Winkelen*

☐   ☐   ☐   ☐   ☐

A-9   *Sokken/kousen aantrekken*

☐   ☐   ☐   ☐   ☐

	Niet (0)	**Mild (1)**	**Gemiddeld (2)**	**Ernstig (3)**	**Extreem (4)**

A-10   *Opstaan vanuit bed*

☐   ☐   ☐   ☐   ☐

A-11   *Sokken/kousen uittrekken*

☐   ☐   ☐   ☐   ☐

A-12   *In bed liggen (draaien)*

☐   ☐   ☐   ☐   ☐

A-13   *In/uit bad gaan*

☐   ☐   ☐   ☐   ☐

A-14   *Zitten*

☐   ☐   ☐   ☐   ☐

A-15   *Gaan zitten/opstaan van het toilet*

☐   ☐   ☐   ☐   ☐

A-16   *Zware huishoudelijke activiteiten (zware dozen tillen, de vloer schrobben etc)*

☐   ☐   ☐   ☐   ☐

A-17   *Lichte huishoudelijke werkzaamheden (koken, stoffen etc)*

☐   ☐   ☐   ☐   ☐

Functioneren in vrije tijd en sport

De volgende vragen gaan over uw lichamelijke gesteldheid tijdens recreatieve/ sportieve activiteiten. De vragen dienen te worden beantwoord naar aanleiding van de moeilijkheidsgraad die u ervaart door uw knie gedurende de **afgelopen week**.

		Niet (0)	Mild (1)	Gemiddeld (2)	Ernstig (3)	Extreem (4)
Sp-1	*Op uw hurken zitten*	☐	☐	☐	☐	☐
Sp-2	*Hardlopen*	☐	☐	☐	☐	☐
Sp-3	*Springen*	☐	☐	☐	☐	☐
Sp-4	*Draaien/roteren van uw geblesseerde knie*	☐	☐	☐	☐	☐
Sp-5	*Knielen – Bukken*	☐	☐	☐	☐	☐

Kwaliteit van leven

		Nooit (0)	Maandelijks (1)	Wekelijks (2)	Dagelijks (3)	Altijd (4)
Q-1	*Hoe vaak wordt u aan uw knie herinnerd?*	☐	☐	☐	☐	☐

		Niet (0)	Mild (1)	Gemiddeld (2)	Ernstig (3)	Extreem (4)
Q-2	*Heeft u uw manier van leven veranderd om uw knie te ontzien?*	☐	☐	☐	☐	☐

		Totaal (0)	Grotendeels (1)	Matig (2)	Iets (3)	Totaal niet (4)
Q-3	*In welke mate kunt u op uw knie vertrouwen?*	☐	☐	☐	☐	☐

		Geen (0)	Gering (1)	Matig (2)	Veel (3)	Erg veel (4)
Q-4	*In het algemeen, hoeveel hinder ervaart u door uw knie?*	☐	☐	☐	☐	☐

Scoreberekening:

Scoring: elk item wordt gescoord tussen 0 en 4 en de ruwe score van elke sectie is de som van de item scores. De score wordt daarna omgezet in een 0-100 schaal. Een hogere score indiceert minder problemen.

Schaal	Ruwe score	Herberekende score	MDC90
Pijn	/36		12 punten
Symptomen	/28		8 punten
ADL	/68	100 - Actueel ruwe score x 100: Mogelijke ruwe score range	10 punten
Sport/Rec	/20		19 punten
QvL	/16		13 punten

2. IKDC (Haverkamp et al., 2006)

200 IKDC SUBJECTIEF KNIE EVALUATIE FORMULIER

Naam _____

Huidige datum: _____/ _____/ _____ Datum van letsel: _____/ _____/ _____

Symptomen*:

*Beoordeel de symptomen op het hoogste niveau van activiteiten waarop u kunt functioneren zonder significante klachten of symptomen, ook al voert u geen activiteiten uit op dit niveau.

1. Wat is het hoogste niveau van activiteiten dat u kunt bereiken zonder aanzienlijke pijn in uw knie.
   - ☐ Erg inspannende activiteiten dat u kunt bereiken zonder aanzienlijke pijn in uw knie.
   - ☐ Inspannende activiteiten, zoals zwaar lichamelijk werk, skiën of tennis.
   - ☐ Matige activiteiten, zoals matig lichamelijk werk, rennen of joggen
   - ☐ Lichte activiteiten zoals lopen, huishoudelijk werk of werken in de tuin.
   - ☐ Geen van de bovengenoemde activiteiten door pijn in de knie.

2. Hoe vaak hebt u in de laatste 4 weken, of sinds uw ongeval, pijn gehad?

	0	1	2	3	4	5	6	7	8	9	10	
Nooit	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Constant
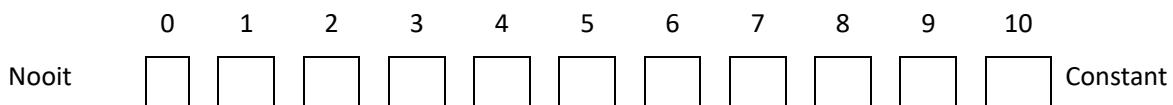
3. Als u pijn heeft, hoe erg is deze dan?

												Ergst
Geen	0	1	2	3	4	5	6	7	8	9	10	voorstelbare
pijn	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	pijn
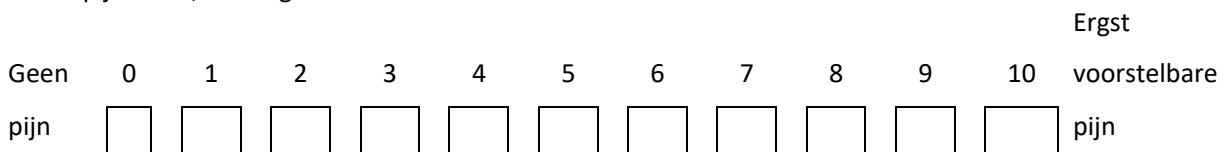
4. Hoe stijf of gezwollen was uw knie in de laatste 4 weken, of sinds uw ongeval?
   - ☐ Niet
   - ☐ Mild
   - ☐ Matig
   - ☐ Erg
   - ☐ Zeer erg

5. Wat is het hoogste niveau van activiteiten dat u kunt bereiken zonder een aanzienlijke zwelling van uw knie?
   - ☐ Erg inspannende activiteiten, zoals springen, of draaibeweging zoals in basket of voetbal.
   - ☐ Inspannende activiteiten, zoals zwaar lichamelijk werk, skiën of tennis
   - ☐ Matige activiteiten, zoals matig lichamelijk werk, rennen of joggen.
   - ☐ Lichte activiteiten zoals lopen, huishoudelijk werk of werken in de tuin.
   - ☐ Geen van de bovengenoemde activiteiten vanwege zwelling van de knie.

6. Heeft u in de laatste 4 weken, of sinds uw ongeval, last gehad van slot en/of zwikklachten?
   - ☐ Ja ☐ Nee

7. Wat is het hoogste niveau van activiteiten dat u kunt bereiken zonder dat u door uw knie zwikt?
   - ☐ Erg inspannende activiteiten, zoals springen, of draaibeweging zoals in basket of voetbal.
   - ☐ Inspannende activiteiten, zoals zwaar lichamelijk werk, skiën of tennis
   - ☐ Matige activiteiten, zoals matig lichamelijk werk, rennen of joggen.
   - ☐ Lichte activiteiten zoals lopen, huishoudelijk werk of werken in de tuin.
   - ☐ Geen van de bovengenoemde activiteiten vanwege zwelling van de knie.

SPORT ACTIVITEITEN:

8. Wat is het hoogste niveau van activiteiten waaraan u regelmatig kunt deelnemen?

- ☐ Erg inspannende activiteiten, zoals springen, of draaibeweging zoals in basket of voetbal.
- ☐ Inspannende activiteiten, zoals zwaar lichamelijk werk, skiën of tennis
- ☐ Matige activiteiten, zoals matig lichamelijk werk, rennen of joggen.
- ☐ Lichte activiteiten zoals lopen, huishoudelijk werk of werken in de tuin.
- ☐ Geen van de bovengenoemde activiteiten door de knie.

9. Hoe moeilijk zijn de volgende activiteiten voor u, door uw knieklachten?

	Niet moeilijk	Iets moeizaam	Moeilijk	Erg moeilijk	Onmogelijk
a. Trap oplopen	☐	☐	☐	☐	☐
b. Trap aflopen	☐	☐	☐	☐	☐
c. Op uw knieën zitten	☐	☐	☐	☐	☐
d. Hurken	☐	☐	☐	☐	☐
e. Zitten	☐	☐	☐	☐	☐
f. Opstaan uit een stoel.	☐	☐	☐	☐	☐
g. Rechtdoor hardlopen	☐	☐	☐	☐	☐
h. Springen en neerkomen op het aangedane been	☐	☐	☐	☐	☐
i. Snel starten en stoppen bij lopen	☐	☐	☐	☐	☐

FUNCTIE

10. Hoe wilt u de functie van u knie beoordelen op een schaal van 0 tot 10, als 10 normaal/perfecte functie betekent, en 0 betekent dat uw kniefunctie ervoor zorgt dat u geen van uw normale activiteiten kunt uitvoeren (inclusief sport).

FUNCTIE VOOR UW KNIELETSEL:

Kan geen dagelijkse activiteiten uitvoeren	0	1	2	3	4	5	6	7	8	9	10	Geen beperking in dagelijkse activiteiten
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

HUIDIGE FUNCTIE VAN UW KNIE:

Kan geen dagelijkse activiteiten uitvoeren	0	1	2	3	4	5	6	7	8	9	10	Geen beperking in dagelijkse activiteiten
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Appendix 10: Participants characteristics

Table 6

Participant characteristics

Variables	N (%) or Mean (SD)
Gender	
Male, n (%)	30 (88.24%)
Female, n (%)	4 (11.76%)
Age at testing, mean (SD), y	24.70 (4.49)
Type of sport before injury (n)	Football (25) Basketball (3) Running (2)
	Tennis (1) Handball (1) Badminton (1)
	Fitness (1)
Time post-op (SD), months	6.26 (0.29)
Operated side	
Right, n (%)	20 (58.82%)
Left, n (%)	14 (41.18%)
Injury mechanism (n)	Non-contact (30) Contact (1)
	Fall (2) Motor accident (1)
BMI, mean (SD), kg/m²	24.64 (2.81)
Score IKDC, mean (SD) **	77.14 (15.67)
Score KOOS, mean (SD) *	
Symptoms	75.95 (16.71)
Pain *	83.78 (13.11)
Daily living *	92.83 (10.90)
Sports/Recreation *	70.46 (20.55)
QoL *	62.66 (17.04)

Appendix 11: Correlation coefficients

Table 7

Correlations between patient reported outcomes and quantitative movement outcomes

	ACL-RSI[#]	K-SES present[#]	K-SES future[#]	Study-specific questionnaire - Motivation[#]	Study-specific questionnaire - Expectations[#]
Single hop test (max. operated)	0.51* (p=0.003)	0.62* (p<0.001)	0.44* (p=0.01)	0.23 (p=0,197)	0.32 (p=0.071)
Single hop test (max. non- operated)	0.40* (p=0.022)	0.31 (p=0.084)	0.17 (p=0.345)	0.21 (p=0.242)	0.16 (p=0.38)
Single hop test (LSI %)	0.56* (p<0.001)	0.74* (p<0.001)	0.69* (p<0.001)	0.18 (p=0.312)	0.50* (p=0.003)
Triple hop test (max. operated)	0.51* (p=0.002)	0.64* (p<0.001)	0.44* (p=0.01)	0.28 (p=0.111)	0.33 (p=0.064)
Triple hop test (max. non-operated)	0.38* (p=0.03)	0.37* (p=0.032)	0.18 (p=0.308)	0.23 (p=0.189)	0.20 (p=0.268)
Triple hop test (LSI %)	0.49* (p=0.004)	0.63* (p<0.001)	0.50* (p=0.003)	0.14 (p=0.431)	0.34 (p=0.056)
Y balance test - Distance (operated) Ant.	0.27 (p=0.127)	0.18 (p=0.304)	0.08 (p=0.655)	0.21 (p=0.252)	0.12 (p=0.508)
Y balance test - Distance (operated) PM.	0.43* (p=0.012)	0.17 (p=0.339)	0.14 (p=0.435)	0.18 (p=0.309)	0.23 (p=198)
Y balance test - Distance (operated) PL.	0.49* (p=0.004)	0.17 (p=0.345)	0.28 (p=0.12)	0.24 (p=0.185)	0.33 (p=0.06)

Y balance test - Distance (non-operated) Ant	0.14 (p=0.439)	-0.01 (p=0.968)	0.07 (p=0.684)	0.08 (p=0.672)	0.09 (p=0.607)
Y balance test - Distance (non-operated) PM.	0.42* (p=0.015)	0.15 (p=0.395)	0.25 (p=0.157)	0.29 (p=0.097)	0.31 (p=0.083)
Y balance test - Distance (non-operated) PL.	0.35* (p=0.045)	0.04 (p=0.808)	0.18 (p=0.329)	0.18 (p=0.319)	0.23 (p=0.202)
Y balance test - LSI% Ant.	0.34 (p=0.052)	0.37* (p=0.033)	0.04 (p=0.811)	0.21 (p=0.249)	0.13 (p=0.465)
Y balance test - LSI% PM.	0.16 (p=0.371)	0.26 (p=0.138)	0.02 (p=0.928)	-0.04 (p=0.808)	0.07 (p=0.712)
Y balance test - LSI% PL.	0.14 (p=0.447)	0.19 (p=0.295)	0.05 (p=0.787)	0.07 (p=0.670)	0.09 (p=0.606)
Smartgoals - 3 goals[#]	-0.38* (p=0.032)	-0.19 (p=0.307)	-0.20 (p=0.270)	-0.05 (p=0.770)	-0.14 (p=0.446)
Smartgoals - Pentagon[#]	-0.39* (p=0.028)	-0.18 (p=0.328)	-0.25 (p=0.168)	-0.20 (p=0.277)	-0.25 (p=0.169)

* $p < 0.05$
# Missing data of one participant

Table 8

Correlations between patient reported outcomes and qualitative movement outcomes

	ACL-RSI[#]	K-SES Present[#]	K-SES Future[#]	Study-specific questionnaire – Motivation[#]	Study-specific questionnaire – Expectations[#]
BDVJ - LESS[#]	-0.05 (p=0.774)	-0.09 (p=0.628)	-0.09 (p=0.627)	-0.11 (p=0.551)	-0.27 (p=0.136)
BDVJ - KV (operated)[#]	0.19 (p=0.303)	0.34 (p=0.055)	0.27 (p=0.135)	0.07 (p=0.692)	0.38* (p=0.031)
BDVJ - KV (non-operated)[#]	-0.02 (p=0.926)	0.21 (p=0.241)	-0.09 (p=0.611)	-0.07 (p=0.724)	-0.05 (p=0.780)
BDVJ - HF (operated)[#]	0.14 (p=0.442)	-0.01 (p=0.956)	-0.20 (p=0.282)	0.01 (p=0.937)	-0.29 (p=0.106)
BDVJ - KF (operated)[#]	0.08 (p=0.652)	0.05 (p=0.795)	-0.08 (p=0.671)	-0.02 (p=0.927)	-0.17 (p=0.361)
SLDVJ- SL-LESS (operated)[§]	-0.01 (p=0.972)	-0.05 (p=0.778)	0.10 (p=0.591)	-0.10 (p=0.587)	0.15 (p=0.421)
SLDVJ- LTM (operated)[§]	-0.25 (p=0.176)	-0.17 (p=0.369)	-0.19 (p=0.297)	-0.35 (p=0.054)	-0.23 (p=0.219)
SLDVJ- HA (operated)[§]	0.38* (p=0.037)	0.29 (p=0.117)	0.18 (p=0.342)	0.29 (p=0.118)	0.31 (p=0.091)
SLDVJ- KV (operated)[§]	0.17 (p=0.370)	0.07 (p=0.723)	-0.01 (p=0.955)	0.13 (p=0.484)	0.09 (p=0.643)
SLDVJ- HF (operated)[#]	-0.01 (p=0.953)	< -0.01 (p=0.998)	-0.20 (p=0.272)	-0.16 (p=0.382)	-0.33 (p=0.065)
SLDVJ- KF (operated)[#]	-0.3 (p=0.095)	-0.21 (p=0.259)	-0.28 (p=0.114)	-0.01 (p=0.940)	-0.24 (p=0.187)
SLDVJ- SL-LESS (non-operated)[¶]	0.09 (p=0.644)	0.19 (p=0.312)	0.09 (p=0.653)	-0.12 (p=0.529)	-0.02 (p=0.918)
SLDVJ- LTM (non-operated)[§]	0.31 (p=0.094)	0.01 (p=0.945)	0.20 (p=0.273)	-0.06 (p=0.739)	0.28 (p=0.132)

SLDVJ- HA (non-operated)§	-0.22 (p=0.225)	0.06 (p=0.752)	-0.19 (p=0.310)	0.19 (p=0.297)	-0.15 (p=0.412)
SLDVJ- KV (non-operated)§	-0.16 (p=0.389)	0.13 (p=0.496)	-0.21 (p=0.247)	0.08 (p=0.670)	-0.16 (p=0.375)
SLDVJ- HF (non-operated)#	0.07 (p=0.718)	0.01 (p=0.946)	-0.22 (p=0.225)	-0.12 (p=0.515)	-0.23 (p=0.196)
SLDVJ- KF (non-operated)#	0.15 (p=0.417)	0.30 (p=0.097)	0.05 (p=0.783)	-0.01 (p=0.945)	0.08 (p=0.682)
SLS - Scoring (Crossley) (operated)#	0.30 (p=0.1)	0.18 (p=0.326)	0.15 (p=0.398)	0.40* (p=0.022)	0.12 (p=0.528)
SLS- LTM (operated)#	-0.09 (p=0.635)	0.12 (p=0.498)	0.19 (p=0.301)	-0.10 (p=0.578)	0.12 (p=0.5)
SLS- HA (operated)#	0.31 (p=0.084)	0.28 (p=0.117)	0.02 (p=0.901)	0.32 (p=0.077)	0.01 (p=0.963)
SLS- KV (operated)#	0.48* (p=0.005)	0.29 (p=0.111)	0.27 (p=0.139)	0.05 (p=0.797)	0.17 (p=0.342)
SLS- Scoring (Crossley) (non-operated)#	0.16 (p=0.389)	0.11 (p=0.562)	0.22 (p=0.218)	0.26 (p=0.149)	0.14 (p=0.460)
SLS- LTM (non-operated)#	0.04 (p=0.845)	0.08 (p=0.682)	0.28 (p=0.121)	0.14 (p=0.433)	0.24 (p=0.188)
SLS- HA (non-operated)#	0.10 (p=0.574)	0.19 (p=0.296)	-0.08 (p=0.669)	0.05 (p=0.796)	-0.03 (p=0.856)
SLS- KV (non-operated)#	0.09 (p=0.621)	0.30 (p=0.096)	< -0.01 (p=0.992)	-0.07 (p=0.687)	-0.07 (p=0.694)
Tuck Jump§	-0.22 (p=0.246)	-0.20 (p=0.282)	-0.04 (p=0.813)	0.03 (p=0.889)	-0.05 (p=0.788)

* $p < 0.05$

Missing data of one participant

§ Missing data of two participants

¶ Missing data of three participants

Appendix 12: Regression models

Table 9

Regression model of PROM

	ACL-RSI	K-SES present	K-SES future
First model			
Correlations	11	3	2
R²	49.49%	41.47%	18.14%
Final model			
Correlations	2	1	1
R²	38.23%	39.75%	17.59%

Table 10

Regression model of quantitative movement outcomes

	Single Hop operated	Triple Hop operated	Y balance PM Operated	Y balance PL Operated	Y balance PM Non-op	Y balance PL Non-op
First model						
Correlations	3	3	1	1	1	1
R²	49.06%	42.96%	20.38%	19.70%	17.84%	17.79%
Final model						
Correlations	1	1	/	/	/	/
R²	39.75%	35.57%	/	/	/	/

Table 11

Regression model of qualitative movement outcomes

	SLDVJ-HA Operated	SLS-KV Operated
Model		
Correlations	1	1
R^2	15.69%	22.65%

Appendix 13: Common used abbreviations

Table 12	
List of common abbreviations	
ACL	Anterior Cruciate Ligament
ACL-RSI	ACL-Return to Sport after Injury scale
ACLR	Anterior Cruciate Ligament Reconstruction
BDVJ	Bipodal Drop Vertical Jump
BMI	Body Mass Index
HA	Hip Abduction
IKDC	International Knee Documentation Committee
KOOS	Knee Injury and Osteoarthritis Outcome Score
K-SES	Knee Self-Efficacy Scale
KV	Knee Valgus
LSI	Limb Symmetry Index
PCL	Posterior Cruciate Ligament
PROM	Patient Reported Outcome Measure
PM	Postero-Medial
PL	Postero-Lateral
RTS	Return To Sport
(SL) LESS	(Single-Leg) Landing Error Scoring System
SLDVJ	Single Leg Drop Vertical Jump
SLS	Single leg squat
TSK	Tampa Scale of Kinesiophobia

Voortgangsformulieren

UHASSELT

INVENTARISATIEFORMULIER WETENSCHAPPELIJKE STAGE DEEL 2

DATUM	INHOUD OVERLEG	HANDTEKENINGEN
11/09/'18	Overleg aanpak MP II	Promotor: Copromotor/Begeleider: Student(e): Student(e):
27/11/'18	Overleg data-verwerking en resultaten	Promotor: Copromotor/Begeleider: Student(e): Student(e):
07/02/'19	Overleg statistische verwerking, structuur resultaten en discussie	Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):
		Promotor: Copromotor/Begeleider: Student(e): Student(e):

In te vullen door de promotor(en) en eventuele copromotor aan het einde van MP2:

Naam Student(e): Nele Van Craesbeek .... Datum: 24/05/2019 ....

Titel Masterproef: The relationship between psychological outcomes and quantitative and qualitative movement outcomes during return to sport testing after anterior cruciate ligament reconstruction

1) Geef aan in hoeverre de student(e) onderstaande competenties zelfstandig uitvoerde:
   - NVT: De student(e) leverde hierin geen bijdrage, aangezien hij/zij in een reeds lopende studie meewerkte.
   - 1: De student(e) was niet zelfstandig en sterk afhankelijk van medestudent(e) of promotor en teamleden bij de uitwerking en uitvoering.
   - 2: De student(e) had veel hulp en ondersteuning nodig bij de uitwerking en uitvoering.
   - 3: De student(e) was redelijk zelfstandig bij de uitwerking en uitvoering
   - 4: De student(e) had weinig tot geringe hulp nodig bij de uitwerking en uitvoering.
   - 5: De student(e) werkte zeer zelfstandig en had slechts zeer sporadisch hulp en bijsturing nodig van de promotor of zijn team bij de uitwerking en uitvoering.

Competenties	NVT	1	2	3	4	5
Opstelling onderzoeksvraag	O	O	O	O	✓	O
Methodologische uitwerking	O	O	O	O	✓	O
Data acquisitie	O	O	O	✓	O	O
Data management	O	O	O	O	O	✓
Dataverwerking/Statistiek	O	O	O	O	O	✓
Rapportage	O	O	O	O	O	✓

2) <u>Niet-bindend advies</u>: Student(e) krijgt toelating/~~geen toelating~~ (schrappen wat niet past) om bovenvermelde Wetenschappelijke stage/masterproef deel 2 te verdedigen in bovenvermelde periode. Deze eventuele toelating houdt geen garantie in dat de student geslaagd is voor dit opleidingsonderdeel.

3) Deze wetenschappelijke stage/masterproef deel 2 mag wel/~~niet~~ (schrappen wat niet past) openbaar verdedigd worden.

4) Deze wetenschappelijke stage/masterproef deel 2 mag wel/niet (schrappen wat niet past) opgenomen worden in de bibliotheek en docserver van de UHasselt.

Datum en handtekening Student(e)

24/05/2019

Datum en handtekening promotor(en)

Datum en handtekening Co-promotor(en)

24/05/2019

In te vullen door de promotor(en) en eventuele copromotor aan het einde van MP2:

Naam Student(e): Lindsay Jacobs	**Datum:** 24/05/2019
Titel Masterproef: The relationship between psychological outcomes and quantitative and qualitative movement outcomes during return to sport testing after anterior cruciate ligament reconstruction	

1) Geef aan in hoeverre de student(e) onderstaande competenties zelfstandig uitvoerde:
   - NVT: De student(e) leverde hierin geen bijdrage, aangezien hij/zij in een reeds lopende studie meewerkte.
   - 1: De student(e) was niet zelfstandig en sterk afhankelijk van medestudent(e) of promotor en teamleden bij de uitwerking en uitvoering.
   - 2: De student(e) had veel hulp en ondersteuning nodig bij de uitwerking en uitvoering.
   - 3: De student(e) was redelijk zelfstandig bij de uitwerking en uitvoering
   - 4: De student(e) had weinig tot geringe hulp nodig bij de uitwerking en uitvoering.
   - 5: De student(e) werkte zeer zelfstandig en had slechts zeer sporadisch hulp en bijsturing nodig van de promotor of zijn team bij de uitwerking en uitvoering.

Competenties	NVT	1	2	3	4	5
Opstelling onderzoeksvraag	O	O	O	O	✓	O
Methodologische uitwerking	O	O	O	O	✓	O
Data acquisitie	O	O	O	✓	O	O
Data management	O	O	O	O	O	✓
Dataverwerking/Statistiek	O	O	O	O	O	✓
Rapportage	O	O	O	O	O	✓

2) <u>Niet-bindend advies</u>: Student(e) krijgt toelating/~~geen toelating~~ (schrappen wat niet past) om bovenvermelde Wetenschappelijke stage/masterproef deel 2 te verdedigen in bovenvermelde periode. Deze eventuele toelating houdt geen garantie in dat de student geslaagd is voor dit opleidingsonderdeel.

3) Deze wetenschappelijke stage/masterproef deel 2 mag wel/~~niet~~ (schrappen wat niet past) openbaar verdedigd worden.

4) Deze wetenschappelijke stage/masterproef deel 2 mag wel/~~niet~~ (schrappen wat niet past) opgenomen worden in de bibliotheek en docserver van de UHasselt.

Datum en handtekening
Student(e)
24/05/2019

Datum en handtekening
promotor(en)

Datum en handtekening
Co-promotor(en)
24/05/2019