Fontys Paramedic University of Applied Sciences
Physiotherapy English Stream

Relationship between Y Balance Test and single-leg hop performance measures

Name Student: Nina Goedert
Student number: 2204511
Name Supervisor: Steven Onkelinx
Version: 1.0
Date: 05.01.2016
Preface

This report regards quantitative research performed at the Fontys University of Applied Sciences Sports Education with first year physical education teacher education students. It is a graduation project conducted within the scope of the Physiotherapy Bachelor program at the Fontys Paramedic University of Applied Sciences in Eindhoven (NL).

Throughout the realization process of this project, I received support from a variety of people, without whom it would not have been possible to conduct this research.

Firstly, I wish to express my sincere gratitude to my supervisor, Steven Onkelinx, for the continuous feedback, support, patience, and guidance throughout the research and writing processes of this bachelor thesis. I would also like to thank René van Saan, a teacher at the Fontys Paramedic University of Applied Sciences, for his inspiration for my research topic, and his feedback on my project plan.

I would like to thank Hans van Pruissen, and the staff of the Fontys University of Applied Sciences Sports Education for their support during the preparation and execution of the screening.

Furthermore, I wish to show my gratitude to the Fontys University of Applied Sciences Sports Education and to the Fontys Paramedic University of Applied Sciences for placing the necessary material and facilities for this project at our disposal.

Last but not least, I would like to thank my co-researchers, Sybrich Vlas, Maud Opstals and Lotte Schaap, as well as my fellow colleagues for their insightful comments, support, and encouragement during the preparation and the execution of the screening, as well as during the writing of this research paper. Their feedback inspired me to widen my research from various perspectives.

Nina Goedert,

Eindhoven, January 2016
Abstract

**Background:** Functional tools, such as the Lower Quarter Y Balance Test (LQ-YBT) and the single-leg hop tests (HTs) are commonly used tests in the rehabilitation and the pre-participation screening of athletes.

**Purpose:** To investigate the relationship between the LQ-YBT and the HTs in a population of first year physical education teacher education (PETE) students. To determine whether there is a significant difference between participants who scored better or worse than the cut-off points for injury risk stated in the literature, with respect to different categories of sport.

**Methods:** A total of 58 students (36 males, 22 females; age = 19.50 ± 3.00) were included in this study. Correlations were generated between reach directions and composite reach scores (CS) of the LQ-YBT and HTs measures using the Spearman’s rank correlation coefficient. The Independent Samples Kruskal-Wallis test was used to check for a significant difference between participants with < 4 cm and those with ≥ 4 cm right-left asymmetry on the anterior reach direction of the LQ-YBT (LQ-YBT ANT), with respect to three distinct categories of sport. The statistical significance was set at p < 0.05.

**Results:** Negligible to weak correlations ($r= 0.260$-$0.457; p < 0.05) were found between bilateral LQ-YBT reach directions and single-leg hop (SLH) and single-leg triple hop (SLTH) scores. Slightly higher correlations ($r= 0.348$-$0.453; p < 0.05) were observed between CS and HTs scores. No significant difference was found between participants who scored better or worse in the LQ-YBT ANT, with respect to different categories of sport.

**Conclusions:** The LQ-YBT and the HTs seem to measure different constructs. It may, thus, be useful to perform both measures in pre-participation screenings in order to obtain a more thorough picture of the potential deficits influencing an individual’s readiness to engage in sports activities.

**Keywords:** Lower Quarter Y Balance Test, single-leg hop tests, screening, injury prevention, PETE students

---

1 Expressed in median ± interquartile range
Table of content:

1. Introduction .................................................................................................................. 1

2. Methods .......................................................................................................................... 3
   2.1. Study design and approach ....................................................................................... 3
   2.2. Participants ................................................................................................................ 3
   2.3. Assessors ................................................................................................................... 4
   2.4. Measurement tools .................................................................................................. 5
   2.5. Data collection ......................................................................................................... 6
   2.6. Data analysis ............................................................................................................ 7
   2.7. Ethical paragraph ..................................................................................................... 9

3. Results ............................................................................................................................... 10

4. Discussion .......................................................................................................................... 13

5. Conclusion .......................................................................................................................... 18

6. References ........................................................................................................................... 19

Appendices ..............................................................................................................................
   I. Information letter .......................................................................................................... I
   II. Informed consent ........................................................................................................ II
   III. Y Balance Test (LQ-YBT) protocol ........................................................................ V
   IV. Hop testing protocol ................................................................................................... VIII
   V. Scoring Sheet ............................................................................................................... XI
   VI. Questionnaire ............................................................................................................. XIV
   VII. Time management ..................................................................................................... XVII
   VIII. Confidentiality statement ...................................................................................... XVIII
   IX. Conveyance of Rights Agreement ........................................................................... XIX
1. Introduction

The numerous benefits of physical activity and sports on health and health-related quality of life are well documented in literature.(1–4) However, it has been found that the risk of encountering musculoskeletal injury rises with increasing physical activity.(5) In the Netherlands alone, 1.6 million sports injuries were medically treated in 2011.(6) The costs related to these injuries totalled 1.3 billion euros.(7)

Physical education teacher education (PETE) students are exposed to a considerable number of intracurricular and extracurricular sports activities, which makes them more prone to sports injuries. Two recent studies (8,9) investigating the risk and incidence rate of sports injuries in PETE students established an injury risk of 0.85 to 0.86 injuries per student per year and an incidence rate of 1.91 injuries per 1000 hours of total sporting time. These studies (8,9) also determined that the majority of the encountered injuries were acute injuries affecting the lower extremities. The most commonly affected body parts were the ankle, lower leg, and knee.(8,9) Furthermore, Goossens et al. (8) reported that 18.3% of the injured students ceased their sports activities for 1 to 2 weeks and 21.1% of them remained generally inactive for 3 to 4 weeks. Such periods of inactivity can have detrimental effects on a PETE student’s study progress. Absence from sports classes can often cause delayed examinations or lower grades, which may lead to a study delay and the increased costs of an extra semester.

In light of this, it is patently valuable to identify at-risk PETE students at the start of the study program. This can be accomplished through screening tests, where the findings may assist with the creation of training programs that minimize the students’ risk of sustaining a sports-related musculoskeletal injury. A frequently used, reliable screening test to determine injury risk (intrarater reliability: ICC=0.85–0.91; interrater reliability: ICC=0.85-1.00; test-retest reliability: ICC=0.80-0.93) is the Lower Quarter Y Balance Test (LQ-YBT), a derivation of the Star Excursion Balance Test.(10–13) During the test, single-limb stance must be maintained while completing an open-chain movement in the anterior, posteromedial and posterolateral direction using the contralateral limb.(14) The test challenges postural control, strength, flexibility, neuromuscular control, core stability, range of motion, and proprioceptive abilities.(14) Multiple studies (11,15,16) have described the ability of the LQ-YBT to predict injury (sensitivity=59 -100%; specificity=71.7-72%). In fact, Plisky et al. (11) and Smith et al. (16) reported that an anterior right/left reach distance asymmetry ≥ 4 cm was associated with an increased risk of non-contact lower-extremity injury. It has also been shown that components of the LQ-YBT are able to indicate deficiency in conditions such as anterior cruciate ligament (ACL) injury (17) and chronic ankle instability.(18)

Yet even if the LQ-YBT is executed in a controlled manner without major impact forces on (and power production of) the stance limb, the test may not mimic the basic requirements of sports that include tasks such as jumping and landing. Jumping tasks and directional changes are major components of sports such as basketball, volleyball and gymnastics.(19) Several studies (20,21) have found that a number of injuries are related to the task of landing from a jump. This is because during landing, an individual's
The single-leg hop tests (HTs) are commonly performed tests to quantify knee performance in the rehabilitation of ACL injuries. (23–27) They subject the individual's lower extremity to more sport-specific loads (23) and assess a combination of power, strength, neuromuscular control, balance, and confidence in the limb. (23,27) A number of hop tests, such as the single-leg hop (SLH) for distance, the triple hop (SLTH) for distance, the triple crossover hop (SLTCOH) for distance, and the 6m-timed hop (6MTH), are demonstrably valid \( r = 0.26-0.58 \) (23) and reliable \( (\text{ICC} = 0.66-0.96) \) performance-based outcome measures. (28) Munro et al. (29) suggest that a minimum limb symmetry index (LSI) score of 90% should be adapted as a 'return to sport' criterion in rehabilitation. Several studies have also found that hop tests can reliably determine lower limb power and strength, (30) self-reported knee function, (31) and dynamic knee stability. (32) At the time of this paper's completion, only the SLH and the SLTH have been reported to be able to predict risk of injury in female soldiers and female division III athletes, respectively. (33,34)

The LQ-YBT and the single-leg hop tests are thus both commonly used tools to screen for readiness to return or to participate in sports activities. (10,14,27) However, there is not much evidence currently available regarding the relationship of the LQ-YBT to other performance-based measures, such as the HTs. Therefore, the primary purpose of this study is to provide correlational data involving the LQ-YBT and single-leg hop performance measures. If there are low or no significant correlations between the two screening measures, it might be useful to perform both tests as part of a pre-participation screening at the start of the PETE study program. They may complement one another and, together, may offer a more thorough picture of the student's readiness to participate in sports. However, if there is a high significant correlation, it may be sufficient to administer only one of the tests to receive accurate insight into the athlete's functional abilities. Based on the different biomechanics involved in jumping and landing compared to squatting tasks, it is hypothesised that there will be weak correlations between the LQ-YBT reach distances and the distances scored on the HTs. (35)

Furthermore, this study will attempt to determine whether there is a significant difference between participants who score better and those who score worse than the cut-off points stated in the literature (< or ≥ 4 cm right/left asymmetry in the anterior reach direction on the LQ-YBT (LQ-YBT ANT) and < or ≥ 90% LSI on the hop tests), with respect to the type of extracurricular sport that subjects predominantly participate in during the current season. (11,16,29) It is hypothesised that the distribution of scores will be different across distinct categories of sport (H0).

---

2Torque: a rotatory force causing part of a structure to twist about an axis.
2. Methods

2.1. Study design and approach

This is a quantitative study directed at exploring the relationship between LQ-YBT and single-leg hop performance measures in healthy young PETE students. To the author's knowledge, relationships between these variables have not yet been established. These tests were selected based on a combination of their occurrence in literature, their ability to be easily administered in a sports-field setting, the minimal requirement of material, and the low costs of administration.

This research report is part of a larger, longitudinal screening study started by students of the Fontys Paramedic University of Applied Sciences in collaboration with the Fontys University of Applied Sciences Sports Education (FSH) in Eindhoven (NL) during the academic year 2014-2015. It will run over the course of several years, and its ultimate aim is to establish an injury prevention program for new students in order to diminish the number of students that incur a study delay -or even drop out of the program- due to sports injuries. There are currently three other research projects being conducted under the same setting. Therefore, the Functional Movement Screen (FMS) was performed in addition to the LQ-YBT and the HTs as part of the screening.(14)

2.2. Participants

A total of 191 first year students studying at the FSH in Eindhoven were recruited for this study. Students were informed about the nature, purpose, and risks of the experimental study, and their participation was solicited through an oral presentation and an informational letter (Appendix I) sent by e-mail. Participant eligibility for this study was determined by the inclusion and exclusion criteria listed in Table 1.
### Table 1: Inclusion and exclusion criteria.

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>• First year PETE student at the Fontys University of Applied Sciences Sports Education</td>
<td>• Occurrence of any kind of musculoskeletal (spinal and/or lower extremity) injury that occurred less than 6 months prior to testing, forced the participant to stop sports and/or school activities, and that the participant had not entirely recovered from at the day of testing</td>
</tr>
<tr>
<td>• ≥ 17 years old: if not aged 18 or more, participants were only included if at least one parent gave permission by signing the informed consent</td>
<td>• Surgery on the lower extremity and/or back less than 6 months prior to testing</td>
</tr>
<tr>
<td></td>
<td>• Occurrence of a neurological disorder less than 6 months prior to testing</td>
</tr>
<tr>
<td></td>
<td>• Presence of a balance disorder</td>
</tr>
<tr>
<td></td>
<td>• Occurrence of a concussion trauma less than 6 weeks prior to testing, which would possibly affect motor performance during 1 or more of the tests</td>
</tr>
<tr>
<td></td>
<td>• Intake of medication that is interfering with one’s balance</td>
</tr>
<tr>
<td></td>
<td>• Pain during any of the tests</td>
</tr>
<tr>
<td></td>
<td>• Use of crutches</td>
</tr>
<tr>
<td></td>
<td>• Use of a prophylactic (ankle, knee, hip) brace during the tests</td>
</tr>
<tr>
<td></td>
<td>• Inappropriately dressed for testing</td>
</tr>
</tbody>
</table>

**PETE:** Physical education teacher education

#### 2.3. Assessors

Four physiotherapy students enrolled in their seventh semester of the Bachelor physiotherapy program at the Fontys Paramedic University of Applied Sciences in Eindhoven were responsible for the data collection. Each one of them was assigned to one particular testing station (one hop test, one LQ-YBT, one FMS and one anthropometric data collection station), and had completed a total amount of 8 practice hours with that specific measurement tool before the start of the testing. Furthermore, a pilot study with 10 participants was conducted in order to improve the efficiency and consistency of the testing protocol (Appendix III & IV).
2.4. Measurement tools

All measurements were taken with the participant dressed in comfortable sports clothes. Participants removed their shoes and socks for the measurements of height, weight, limb length, and for the performance of the LQ-YBT. During the hop tests, participants wore athletic shoes.

Height and weight were recorded for descriptive purposes. Height was measured with a stadiometer (SECA 213, 2014, Hamburg, Germany). Weight was measured with a digital weight scale (OMRON BF511, 2013, Dalian, China). Height was recorded to the nearest 0.5 cm and weight was noted to the nearest 0.1 kg.

Lower limb length was measured in order to normalise reach distance on the LQ-YBT to leg length. The participant was in hooklying position on a treatment table. (12) The hips were actively lifted and returned to the starting position. The assessor then passively straightened the participant's legs to equalise the pelvis. (12) The limb length was measured from the inferior border of the anterior-superior iliac spine to the inferior border of the medial malleolus by means of a flexible cloth tape measure (BIG-SAM, length: 150 cm, width: 2 cm). (12) The length was recorded to the nearest 0.1 cm.

The LQ-YBT (Y-balance kit™) was used to test dynamic single-leg stability in three reach directions: anterior, posteromedial and posterolateral. The LQ-YBT was executed according to the provided protocol (Appendix III). While maintaining single-leg stance, the subject was asked to reach as far as possible away from himself/herself using the contralateral limb. (12) Before the test trials began, each participant was allowed four practice trials in order to minimize learning bias. (36) They had a maximum of six test trials per direction and limb to achieve three successful trials. (12) Reach distance was measured by observing the tape measure where the most distal part of the toes reached. (12) Figure 1 illustrates the starting position and the three reach directions on the LQ-YBT.

![Figure 1: (1) Starting position, (2) Anterior reach, (3) Posteromedial reach, (4) Posterolateral reach.](image-url)
The SLH, the SLTH, the SLCOH and the 6MTH were used to assess lower extremity performance. They were executed according to the protocol (Appendix IV). A 6 m long and 15 cm wide strip of conventional Painter's Grade masking tape was fixed on the floor. Two smaller strips, perpendicular to the 6 m long strip, indicated the start and finish lines. Each participant had one practice trial to get acquainted with the task and a maximum of four test trials per limb to complete two successful trials. The assessor noted the distance hopped to the nearest 0.5 cm, and calculated the mean. The time needed for the 6MTH hop was recorded to the nearest 1/100 s using a stopwatch (Hudora Stopwatch, Remscheid Germany). Figure 2 shows the starting position of all hop tests.

Instructions, practice trials, and scoring of the LQ-YBT and the HTs were standardised in the protocols in order to ensure consistency of the measurements throughout the testing procedure (Appendix III & IV).

### 2.5. Data collection

The data collection took place in the Exercise Laboratory of the FSH. Prior to data collection, all first-year students were divided into groups of six and were assigned a specific date and time for the screening. They were informed via e-mail about the date, time, and place of testing. Flyers, posts on the portal of the school’s website, and additional e-mails to the students and tutors of each class served as additional reminders.

The data collection was conducted using three different testing stations-one hop test station, one LQ-YBT station, one FMS station- and one station for anthropometric data collection. In order to maximize the participants’ concentration, the different testing stations were separated by room-dividing screens.

On the test day, the participants were given the chance to ask any remaining questions before signing the informed consent form (Appendix II), and filling in the questionnaire (Appendix VI). Their height, weight, and leg length were then measured as previously described. Thereafter, the participants performed the different tests (FMS, LQ-YBT and the HTs) in groups of two. Individual test scores were recorded on the Scoring sheet (Appendix V). The exact schedule of each testing session is depicted in Appendix VII.
2.6. Data analysis

The data was processed in Microsoft Excel 2013 (Microsoft Corporation) and transferred to the data processing program *Statistical Package for the Social Sciences* (SPSS v20; IBM Corp., Armonk, N.Y., USA).

In order to exclude asymmetries due to leg length on the LQ-YBT, the mean of the three valid trials was first determined and normalized by the following formula: \([(\text{sum of the 3 reach distances})/(3 \times \text{limb length})] \times 100\). (11) This calculation was performed for both the right and left legs. In order to establish reach asymmetry, the difference between right and left mean reach distances was calculated for all reach directions. The composite reach distance was found by summing the mean of the three reach directions, dividing the mean by three times the limb length, and multiplying that result by 100. (11)

For the hop tests, the LSI was used to determine asymmetries between the right and left limbs. For the SLH, the SLTH and the SLCOH, the LSI was obtained by dividing the mean distance hopped with the dominant limb, by the mean distance hopped with the non-dominant limb. For the 6MTH, LSI was calculated by dividing the mean time needed to cover the distance with the non-dominant limb, by the mean time needed when using the dominant limb. This was multiplied by 100 to obtain a percentage. The dominant limb was defined as the preferred stance-leg used by the participant when kicking a ball as the stance-limb is most often used to change the momentum of the body when in contact with the ground. (30)

The participants’ baseline demographic characteristics, and all of the parameters used for data analysis, were checked for normal distribution by means of the Shapiro-Wilk test. Descriptive statistics were calculated as means (± standard deviation) in the case of normal distribution and as median (± interquartile range) in the case of non-normal distribution.

Following the Shapiro-Wilk analysis, the data was processed using Spearman’s correlation coefficient (r). The three movement directions of the LQ-YBT, the composite reach scores, and the anterior right-left asymmetry were separately correlated with the scores of the SLH and the SLTH. Correlations were determined for right- and left-sided scores. Then, correlations were calculated between the anterior right-left asymmetry on the LQ-YBT and the LSI SLH, as well as the LSI SLTH. The size of the correlation coefficient was interpreted by means of Table 2. The statistical significance was set at p < 0.05.
Table 2: Interpretation of the size of the correlation coefficient. (37)

<table>
<thead>
<tr>
<th>Size of the correlation</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.90 to 1.00 (-0.90 to -1.00)</td>
<td>Very high positive (negative) correlation</td>
</tr>
<tr>
<td>0.70 to 0.90 (-0.70 to -0.90)</td>
<td>High positive (negative) correlation</td>
</tr>
<tr>
<td>0.50 to 0.70 (-0.50 to -0.70)</td>
<td>Moderate positive (negative) correlation</td>
</tr>
<tr>
<td>0.30 to 0.50 (-0.30 to -0.50)</td>
<td>Weak positive (negative) correlation</td>
</tr>
<tr>
<td>0.00 to 0.30 (0.00 to -0.30)</td>
<td>Negligible correlation</td>
</tr>
</tbody>
</table>

Subsequently, the participants were divided into 3 groups, according to the extracurricular sport they spent the most time on during the current season (Figure 3). Additionally, participants were divided into having ≥ 4 cm or < 4 cm right-left difference in the LQ-YBT ANT. This information was used to determine whether there is a statistically significant difference between participants who scored better and those who scored worse than the cut points stated in the literature, with respect to the type of extracurricular sport.

Figure 3: Grouping according to type of extracurricular sport.

An Independent Samples Kruskal-Wallis test was subsequently conducted. The hypothesis H0 was rejected if p < 0.05.

Furthermore, participants were divided into 2 groups, either having ≥ or < 90% LSI on the hop tests. The means (± standard deviations) of the two groups were described.
2.7. Ethical paragraph

The participants were sufficiently informed about the nature, purpose, and risks of the experimental study. As stated within the informed consent form, the subjects participated voluntarily and could withdraw their participation at any moment, without further consequences. The data was handled confidentially and presented anonymously.

Furthermore, the data collection itself did not take more than 1 hour and no major risks were involved with taking part in this research project. Thus, this is a non-WMO obligated study.
3. Results

A total of 191 first year PETE students from the FSH in Eindhoven were initially contacted to take part in this research project. Over the two testing weeks, 79 students volunteered their participation, and 58 were ultimately included in this study. Figure 4 illustrates the selection process for the research population.

![Selection process diagram]

**Figure 4:** Selection process of the research population.

The research population (N=58) consisted of 62% of males (N=36) and 38% of females (N=22). Detailed demographic characteristics of the research population are depicted in Table 3.

Table 4 represents the descriptive statistics of and the Spearman's correlation coefficient (r) between the selected LQ-YBT and HTs measures for the total research population.
Table 3: Demographic data of the research population.

<table>
<thead>
<tr>
<th></th>
<th>Female (n=22)</th>
<th></th>
<th>Male (n=36)</th>
<th></th>
<th>Total (n=58)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age (years)</td>
<td>Height (cm)</td>
<td>Weight (kg)</td>
<td>Age (years)</td>
<td>Height (cm)</td>
<td>Weight (kg)</td>
</tr>
<tr>
<td>Median ± IQR</td>
<td>18.50 ± 4.00</td>
<td>167.00 ± 9.38</td>
<td>63.65 ± 8.38</td>
<td>20.00 ± 3.00</td>
<td>180.18 ± 6.56</td>
<td>70.50 ± 9.85</td>
</tr>
<tr>
<td>Minimum</td>
<td>17.00</td>
<td>162.00</td>
<td>51.00</td>
<td>3.00</td>
<td>165.00</td>
<td>60.90</td>
</tr>
<tr>
<td>Maximum</td>
<td>24.00</td>
<td>184.50</td>
<td>79.50</td>
<td>32.00</td>
<td>194.50</td>
<td>95.30</td>
</tr>
</tbody>
</table>

n=number of subjects; IQR=interquartile range.

* The variables ‘height for the total population’, ‘height for males’ and ‘weight for females’ were normally distributed and, thus, are expressed as mean ± standard deviation.

Table 4: Descriptive statistics of- and correlations between- LQ-YBT and HTs measures (Total research population).

<table>
<thead>
<tr>
<th>SLH_R</th>
<th>SLH_L</th>
<th>SLTH_R</th>
<th>SLTH_L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>r</td>
<td>p</td>
<td>r</td>
</tr>
<tr>
<td>SLH_R</td>
<td>125.75 ± 22.78</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SLH_L</td>
<td>127.76 ± 24.39</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SLTH_R</td>
<td>421.79 ± 73.89</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SLTH_L</td>
<td>424.42 ± 77.26</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LSI_SLH</td>
<td>102.47 ± 10.98</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LSI_SLTH</td>
<td>100.45 ± 8.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>YBT_ANT_N_R</td>
<td>66.91 ± 7.26</td>
<td>0.285</td>
<td>0.030</td>
</tr>
<tr>
<td>YBT_ANT_N_L</td>
<td>67.48 ± 8.05</td>
<td>0.284</td>
<td>0.031</td>
</tr>
<tr>
<td>YBT_PL_N_R</td>
<td>101.67 ± 12.69</td>
<td>0.260</td>
<td>0.049</td>
</tr>
<tr>
<td>YBT_PL_N_L</td>
<td>96.77 ± 8.68</td>
<td>0.331</td>
<td>0.011</td>
</tr>
<tr>
<td>YBT_PM_N_R</td>
<td>101.51 ± 8.04</td>
<td>0.392</td>
<td>0.002</td>
</tr>
<tr>
<td>YBT_PM_N_L</td>
<td>101.80 ± 8.66</td>
<td>0.382</td>
<td>0.003</td>
</tr>
<tr>
<td>CS_R</td>
<td>89.24 ± 6.94</td>
<td>0.349</td>
<td>0.007</td>
</tr>
<tr>
<td>CS_L</td>
<td>88.95 ± 7.21</td>
<td>0.405</td>
<td>0.002</td>
</tr>
<tr>
<td>ASS_ANT_R/L</td>
<td>*3.00 ± 2.84</td>
<td>0.135</td>
<td>0.313</td>
</tr>
</tbody>
</table>

SD=standard deviation; r=correlation coefficient; p=statistical significance; R=right; L=left; N=normalized to limb length; YBT=Lower Quarter Y Balance Test; ANT=anterior; PM=postero medial; PL=postero lateral; CS=composite reach score; SLH=single-leg hop for distance; SLTH=single-leg triple hop for distance; ASS_ANT_R/L=right-left asymmetry in anterior reach direction on the LQ-YBT.

* The variables YBT_ANT_L, YBT_PL_R and ASS_ANT_R/L were not normally distributed and thus are expressed as median ± interquartile range.

* The mean (± SD) values of SLH_R, SLH_L, SLTH_R, SLTH_L and ASS_ANT_R/L are expressed in cm; all the other variables are expressed in %.

p§ < 0.05.
Table 2 in the method section of this report was used to interpret the size of the correlation coefficients. Mainly negligible to weak significant correlations were found when correlating the anterior and the posterolateral reach direction of the LQ-YBT with the SLH and the SLTH (r=0.260-0.388; p<0.05). Furthermore, weak significant correlations were generated between the posteromedial reach direction of the LQ-YBT and the two selected hop test scores (r=0.382-0.457; p<0.05), as well as between the composite reach scores of the LQ-YBT and the HTs scores (r=0.348-0.453; p<0.05). With the exception of the weak significant correlation between ASS_Ant_R/L and the SLTH_L (r=0.329; p=0.012), no significant correlations could be found between anterior right/left asymmetry and bilateral hop test scores. In addition, correlations between the anterior right-left asymmetry on the LQ-YBT and the LSI of the two hop tests were not significant.

At the time of testing, 28 participants (females n=7; males n=21) engaged in extracurricular sports involving frequent jumping and direction changes, whereas 21 subjects (females n=8; males n=13) mainly participated in extracurricular sports involving minimal jumping and direction changes. A total of nine students (females n=7; males n=2) indicated that they did not participate in any extracurricular sports activities during the present season.

A total of 40% (n=23) of the participants had ≥ 4 cm right-left difference in the LQ-YBT ANT. The median (± IQR) asymmetry between right and left leg performance of this group was 4.67 ± 1.67 cm. The remaining 60% (n=35) of the students had < 4 cm right-left asymmetry in the LQ-YBT ANT and a mean (± SD) difference of 1.95 ± 1.12 cm. No statistically significant difference (p= 0.699) was found between participants who had ≥ 4 cm and those who had < 4 cm asymmetry on the LQ-YBT ANT, with respect to the type of sport they played.

Due to the limited number of participants with an LSI lower than 90% on the HTs, only the differences in means between the higher and lower scoring groups were described in Table 5.

<p>| Table 5: Comparison of means (± SD) of participants with an LSI higher or lower than 90% on the HTs. |
|---------------------------------------------------------|---------------------------------------------------------|
| ≥ 90 % LSI | &lt; 90% LSI |</p>
<table>
<thead>
<tr>
<th>n</th>
<th>Mean (%) ± SD</th>
<th>n</th>
<th>Mean (%) ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLH</td>
<td>50</td>
<td>105 ± 9.6</td>
<td>8</td>
</tr>
<tr>
<td>SLTH</td>
<td>51</td>
<td>102 ± 6.5</td>
<td>7</td>
</tr>
<tr>
<td>SLTCOH</td>
<td>42</td>
<td>105 ± 8.2</td>
<td>16</td>
</tr>
<tr>
<td>6MTH</td>
<td>56</td>
<td>102 ± 8.0</td>
<td>2</td>
</tr>
</tbody>
</table>

n=number of subjects; SD= standard deviation; SLH= single-leg hop; SLTH= single-leg triple hop; SLTCOH= single-leg triple cross-over hop; 6MTH= 6 meter timed hop; LSI= limb symmetry index.
4. Discussion

This is a quantitative study, conducted as part of a larger, longitudinal screening study realized in collaboration with the FSH in Eindhoven (NL). Its primary aim was to determine the relationship between the LQ-YBT and single-leg hop performance measures. The tests were performed on a population of first-year PETE students. It was hypothesized that there would be weak correlations between the two screening measures, which was confirmed by the results of this study.

Mainly negligible to weak correlations ($r=0.260–0.457$; $p < 0.05$) have been established between bilateral LQ-YBT reach directions and single-leg hop test scores. Furthermore, there was no significant correlation between anterior right-left asymmetry on the LQ-YBT and the hop tests, nor between the anterior right-left asymmetry and the LSI of the hop tests. To the author’s knowledge this was the first study comparing the SLH and the SLTH to the LQ-YBT, when tested simultaneously. Unlike the insignificant to weak correlations found in this study, Garrison et al. (38) have recently suggested that $>4$ cm asymmetry in the LQ-YBT ANT at 12 weeks post ACL reconstruction seems to identify subjects who did not attain 90% LSI on the SLH and SLTH at time of return to sport.(38) The hop tests are functional tests that assess power, strength, neuromuscular control, balance, and confidence in the limb.(23,27) Although the LQ-YBT challenges balance, strength, flexibility, neuromuscular control, range of motion, core stability, and proprioceptive abilities,(14) the results of this study indicate that it measures different constructs than the hop tests. One explanation may be the different biomechanics used during jumping and landing tasks compared to squatting tasks.(35) While the LQ-YBT mainly consists of controlling the lower extremity in the sagittal plane, the HTs additionally require that the subject’s lower extremity muscles have a greater ability to produce power and movement during take-off and landing phases.(39) During landing tasks, impact forces need to be absorbed, and pre-stretched muscles need to be utilized by the lower extremity.(35) In fact, Donohue et al. (35) noted that squat tasks, such as those performed during the LQ-YBT, may not be sufficient for assessing sagittal plane motion during landing.

Higher correlations ($r=0.348–0.453$; $p < 0.05$) were found between the composite reach scores and the HTs. These findings may be explained by the fact that similar muscle activations are noted during landing and push-off phases of a jump as during the different reach directions of the LQ-YBT. For each reach direction of the LQ-YBT, muscles of the stance-leg are activated to a different extent.(40) The m. vastus medialis and lateralis are most active in the anterior direction, the m. biceps femoris and the m. tibialis anterior are most active in the posterolateral reach direction, and the m. tibialis anterior is most active in the posteromedial direction.(40) In comparison, during the landing phase of a jump, the m. tibialis anterior muscle is eccentrically activated to stabilise the ankle joint.(41) The m. vastus lateralis acts to stabilise the knee, and to decelerate the flexion movement at the knee joint. In contrast to the m. tibialis anterior, whose action is inhibited by the activation of the triceps surae during the push-off phase of a jump, the m. vastus lateralis remains active to extend the knee joint.(41) Even though biomechanics differ between jumping and landing tasks compared to squatting tasks, the composite reach score, representing a combination of all three reach directions of the LQ-YBT, may, thus, reflect similar muscle
activation patterns as required during different phases of a jump.

As an aside, correlations between left LQ-YBT and left HTs scores were slightly higher than those between right LQ-YBT and right HTs scores. In this study, the dominant limb was defined as the preferred stance-leg used by the participant when kicking a ball. This difference may be explained by the majority of the participants’ left limb dominance.

The second purpose of this study was to investigate if there was a significant difference between participants who had < 4 cm and those who had ≥ 4 cm difference in the LQ-YBT ANT, with respect to sports participation. It was hypothesised that the distribution would be different across categories of sport. The results showed no statistically significant variance. The hypothesis was, therefore, rejected. In the present study, the right-sided normalized mean (±SD) anterior reach distance of the total research population (66.91±7.26 cm) was lower than the scores of high school basketball players and female soccer players tested by Plisky et al. (11,12) Unfortunately, it was difficult to compare the left-sided normalized anterior scores to existing literature because they were not normally distributed. However, considering the discrepancies in anterior reach distances in literature, it seems clear that differences exist between types of sport. Bressel et al. (42) found that there were no discrepancies between gymnasts and soccer players in terms of dynamic balance, whereas basketball players presented inferior dynamic balance compared to soccer players. The same study (42) also stated that the statistical differences in dynamic balance among different sports may be more related to specific sensorimotor challenges imposed by each sport, than to simply general sports activities. The reason behind the negligible difference between sports in this study may be explained by the fact that the neuromuscular system of PETE students may have adapted to a multitude of functional tasks through their experience in engaging in a variety of intracurricular sports activities. Additionally, given their participation in 7-8 hours per week of intracurricular sport lessons, a considerable number of students also indicated that they play more than one extracurricular sport. Thus, division of participants into three categories of sports may not have been appropriate for, nor representative of, this research population.

This has been the first research paper investigating differences in sport participation in relation to cut-off points for injury risk. Descriptive data related to scores below or above the cut-off points are not available in the literature. In fact, to this day, there exists no particular consensus about sport-specific cut-off points for risk of injury in the literature. Smith et al. (16) determined a single cut-off point of ≥ 4 cm asymmetry in the LQ-YBT ANT across multiple sports to be associated with an increased risk of non-contact injury. In contrast, Butler et al. (15) found that collegiate American football players had 3.5 times more risk of encountering a noncontact lower extremity injury when scoring below 89.6% CS. A third study by Plisky et al. (11) observed that a CS of less than or equal to 94 % was associated with increased risk of injury in all players and females only and that ≥ 4 cm asymmetry was associated with increased lower extremity injury risk in all players, males only and females only. This lack of consensus suggests that it may be valuable to investigate sport-specific cut-off points, as the sensorimotor system is not triggered the same way in all sports. However, this may not be sufficient differentiation considering the fact that there are even discrepancies between individual positions within certain sports.
Another goal of the present study was to determine if there was a significant difference between participants with ≥ or < 90% LSI on the hop tests, with respect to sports activity. The data did not allow for this type of analysis due to the lack of participants scoring < 90% LSI. Therefore, HTs scores could merely be described. In this study, SLH scores (right: 125.75±22.78; left: 127.76±24.39) were lower than scores found by Myers et al. (44) and Munro et al. (29), but higher than scores established by Brumitt et al. (33). Additionally, SLTH distances were considerably lower (right: 421.79±73.89; left: 424.42±77.26) than scores found in previous studies.(30,44) The differences among studies in the distances hopped may be due to the differences in their study populations. In the study conducted by Myers et al. (44), soccer and basketball players were tested, whereas only soccer players were tested in the study by Hamilton et al. (30). These sports require a considerable amount of jumping, direction changes, and speed. In comparison, the sample of the current study comprised an equal number of individuals who engaged in jumping sports, and those who engaged in sports with a minimal amount of jumping tasks or in no sports at all. This might have led to better hop distances in the studies by Myers et al. (44) and Hamilton et al. (30) compared to the current study. Different levels of competition, gender, and the lack of consensus on restrictions to arm movements in hop test protocols may also be partly responsible for the discrepancies in hop distances found in the literature.(30,33,44) In fact, previous research has shown that male athletes performed better than female athletes on all hop tests (33,44) and that free arm motions account for 21.2% more jump distance in contrast with restricted arm movements.(45)

The lack of consensus in the literature about the notion of dominant and non-dominant limbs in calculating the hop test LSIs makes it difficult to compare results of LSI scores.(29,30,44) This is further impeded by the poor agreement between LSI cut-off scores used to decide if a subject is ready to return to and/or participate in sports. (29,46,47) Noyes et al. (46) proposed a LSI of 85%, whereas Grindem et al. (47) determined a cut-off LSI of 88% as the appropriate measure of adequate limb symmetry. Munro et al. (29) even suggested the adoption of a 90% LSI during rehabilitation and conditioning.

Several strengths in this study are noted. Firstly, standardised protocols and instructions were followed throughout the testing procedure in order to ensure consistency of the measurements. This enables easy reproducibility in future studies, as well as in clinical practice. Furthermore, in contrast to a number of other studies that used the average balance score of both limbs, this study took both limbs separately into account. This is an important factor because a difference in reach distance between the two limbs is considered a potential risk factor for injury to either limb.(11) In fact, proprioceptive deficits, a lack of static and dynamic stability and a lack of muscle strength, might contribute to altered biomechanics and increased injury risk not only in the less adept leg, but also in the more adept contralateral lower extremity.(48) Due to poor balance on the less adapt limb, the athlete might put increased load on the more adept limb, which in turn will absorb excessive forces.(49) The less adept limb may not supply a stable base of support for tasks such as landing and pivoting, and consequently, it may put both limbs at increased risk for injury.(49,50) Studies that averaged the right- and left-sided reach distances did not take poor balance into consideration as a risk factor for injury.
Nevertheless, it is also important to note the limitations of the current study. One of its major limitations is the limited number of participants. Out of 190 potential participants, only 79 presented themselves for the testing, and only 58 could be used in the data analysis. Consequently, several specific analyses could not be appropriately conducted due to the small sample sizes that resulted when dividing the total population into groups. Furthermore, the sample was screened for injuries by means of a questionnaire, and participants were excluded if they had encountered a lower extremity or spinal injury 6 months prior to testing that they had not recovered from on the day of testing. Including those participants in the current study might have ultimately resulted in an increased number of participants with ≥ 4 cm asymmetry in the LQ-YBT ANT and with less than 90% LSI on the HTs. In any case, despite Shaffer et al.’s (13) findings of good inter-rater reliability (ICC= 0.85-0.93) of the LQ-YBT when performed in a large group testing setting by assessors with minimal experience, the limited experience of the assessors in this study may also have influenced the efficacy and consistency of the rating. In contrast to the study by Shaffer et al. (13), the practice hours in this study were not supervised by a more experienced assessor. Furthermore, participants performed each test in pairs and the screens that were used to divide the different testing stations were not sufficient to completely shield each station. Verbal and visual input from other students may thus have influenced the participants’ concentration and motivation and, ultimately, may have led to inferior or superior scores. Another limiting factor was the inability to control the students’ schedules and, consequently, the sports activities they participated in prior to testing. Students might have had fatigued muscles, which could have led to decreased performance on both the hop tests and the YBT. Previous studies (51,52) have shown that fatigue alters landing biomechanics during single-leg hop tasks and that it can induce a decrease in motor-control performance. Furthermore, due to time constraints, participants had only one practice trial for each of the four hop tests. This may have been insufficient to account for the motor learning that takes place when first performing the tests. (23,29) However, when consulting the existing literature, there is no evidence of consensus regarding the number of practice trials that should be performed. (28,29,53) Krishnan (53) even stated that practice trials could be minimised without compromising validity, especially when only testing LSI. Additionally, the battery of hop tests used in this study covers many aspects of athletic performance, but it does not trigger the endurance element necessary to a sport-specific setting. In fact, when a volleyball player is repeatedly jumping and landing, power endurance is an important variable to take into consideration. (19) With increasing fatigue, the athlete’s flexion angles at the hip, knee, and ankle may decrease, and less energy will be absorbed by the MTCs. This, in turn, might lead to an increased risk of injury. (19) Therefore, it might be useful to include an endurance measure -such as the side hop test- in the pre-participation screening. Finally, a multitude of correlations were calculated, which might have led to type I errors due to alpha inflation. This could have been corrected by using the Bonferroni adjustment. However, such an adjustment is a very conservative method that may have led, in turn, to type II errors (false negatives). Thus, this method was not applied in this study.

Due to their affordability and easy administration, both tools could easily be integrated into a pre-participation screen for students at the FSH in Eindhoven. The predominantly low correlations between
the HTs and the LQ-YBT support the idea that both tests appear to measure different constructs. Thus, both tasks may be important to consider during injury risk screening and/or rehabilitation in order to cast a wider net for potential deficits that may influence an individual’s readiness to participate or return to sports activities. Furthermore, based on the results of the injury risk screening, exercise-based intervention programs could subsequently be offered in order to diminish the risk of encountering a lower extremity injury. These exercise-based training programs should consist of a variety of neuromuscular, core stability, strength, balance, and plyometric exercises, which have all been proven to effectively decrease the risk of lower extremity injuries. (54–58)

Due to their affordability and minimal requirements of material, both tests could, thus, also be used as preventive screening measures in sports clubs in order to act on a broader scale to prevent sports injuries. The two measurement instruments could also easily be performed in the physiotherapy practice, not only to screen for injury risk and readiness to return to sport, but also to objectively follow a patient’s progress throughout rehabilitation. (10, 23)

To the author’s knowledge, this is one of the first studies investigating the relationship between single-leg hop performance and LQ-YBT measures. It is hoped that it will stimulate further research in this field. Firstly, studies should be conducted to determine gender, sport, and position-specific cut-off points for injury risk on the LQ-YBT and more research should be done determining the accuracy of the HTs in predicting injury risk. Secondly, studies should seek gender specific and sport-specific normative data for the LQ-YBT and for the HTs within larger populations. These findings could be helpful for clinicians and coaches in rehabilitation and pre-participation screening when evaluating patients’ or athletes’ readiness to engage in sports activities, with minimal risk of re-injury. (10) Thirdly, future studies should also investigate the effect of the number of sporting hours and of participation in multiple sports on the two tests. Finally, it may be interesting to investigate the predictive ability of more newly developed screening tools, such as the Performance Matrix, regarding injury risk. (59) This screening tool includes sport-specific screens aimed at identifying performance-related inefficient control of movement in the kinetic chain, to allow for the development of specific training programs. (59)
5. Conclusion

Negligible to weak correlations were found between different variables of the LQ-YBT and HTs measures. These results suggest that it may be important to perform both measures in pre-participation screenings in order to get a more thorough picture of potential deficits influencing an individual's readiness to participate or return to sport activities. Furthermore, no significant difference could be established between participants scoring above or below cut-off scores for increased injury risk on the LQ-YBT, with respect to categories of sport. However, based on present literature, this result is called into question. The assumption that sport-specific differences exist in risk rates should remain, and further research in this field would be necessary to refute the established theory.
6. References


Appendices

I. Information letter

Beste studenten,

Wij zijn Nina, Maud, Lotte en Sybrich en wij zijn 4e jaars studenten van de opleiding Fysiotherapie. In samenwerking met de Sporthogeschool doen wij ons afstudeerproject op de Sporthogeschool. Dit is een project wat loopt over meerdere jaren.

Het doel van het project is dat wij de risico’s op blessures bij studenten van het eerste jaar Lichamelijke Opvoeding in kaart brengen en aan de hand hiervan proberen te voorspellen of er eventueel verhoogde kans is op studievertraging of uitval. Dat jullie meedoen aan ons onderzoek is dus niet alleen voor ons en voor de Sporthogeschool van essentieel belang, maar ook zeker voor jezelf. Als blessures vroegtijdig kunnen worden opgespoord, is de kans op studievertraging of zelfs het moeten stoppen met de opleiding kleiner. Als je vroegtijdig alert bent dat je een grote kans op blessures hebt, kun je specifiek gaan trainen om deze risico te verminderen. Verder is het een kans om een onderzoek mee te maken wat jullie zelf in het vierde jaar moeten uitvoeren.

De testen zullen worden afgenomen tussen 12 en 23 Oktober op de Sporthogeschool, het tijdstip waarop jullie verwacht worden zal in het rooster worden ingepland, net als het lokaal. Iedere testsessie duurt maximaal 1 uur en 15 minuten. Op de testdag verzoeken we jullie een korte broek, T-shirt en sportschoenen te dragen. De testen die we gaan afnemen zijn de Functional Movement Screen, de Y- balance test en de Hoptesten.

Deelname vanaf 17 jaar. Voor studenten <18 is het voor ons van belang dat je ouders toestemming geven. In de bijlage vind je het Informed Consent, voor deelnemers onder de 18 jaar graag dit door je ouders laten ondertekenen en meenemen op de testdag. Deelname aan de testen is niet verplicht maar nogmaals, wel zeer gewenst. Er kan op elk moment beslist worden te stoppen met de testen. De uitslagen van de testen worden geanonimiseerd en enkel gebruikt voor het afstudeerproject. De uitslagen blijven binnen de Fontys Sporthogeschool en Fontys Paramedische Hogeschool.

Als er voorafgaand aan de testen al vragen zijn, mogen jullie deze mailen naar sybrich.vlas@student.fontys.nl. Overige vragen kunnen op de dag van de testen gesteld worden, uiteraard zal er dan ook een uitgebreide uitleg zijn.

Hopelijk zien we jullie allemaal op de testdag!

Met vriendelijke groet,
Sybrich Vlas, Maud Opstals, Lotte Schaap en Nina Goedert
II. Informed consent (Toestemmingsverklaring formulier)

Afstudeerproject 4e jaars- fysiotherapie studenten in samenwerking met de Sporthogeschool

Titel: Screening van de eerste jaars studenten aan de Sporthogeschool te Eindhoven

Onderzoekers: Sybrich Vlas, Nina Goedert, Lotte Schaap en Maud Opstals

Doel:
Met behulp van een vragenlijst, de FMS, de Y-Balance Test en de hop testen wordt er een screening uitgevoerd bij studenten van de Sporthogeschool te Eindhoven. Tijdens dit onderzoek worden vier subdoelen onderzocht:

- De correlatie tussen de Y-Balance test en de Hop testen.
- Of de Y-balance test enkel instabiliteit kan aantonen met validatie van de FADI vragenlijst.
- Of de Functional Movement Screen en de Y-balance test indicators zijn voor een hoger risico op blessures.
- Is er een relatie tussen het hebben van een eerdere blessure aan de onderste extremiteit in het afgelopen seizoen en de scores van de Functional Movement Screening en Y-Balance test.

Aan de hand van een vooraf opgesteld protocol zal worden getest. De resultaten die uit de metingen zullen komen worden per subdoel gebruikt om een artikel te schrijven. Aan het eind van het artikel wordt bekeken of er conclusies kunnen worden getrokken. Als onderzoekers hopen we aan het eind van het onderzoek meer inzicht te hebben gekregen in de bovengenoemde meetinstrumenten en zo een bijdrage te kunnen leveren aan het Praktijk Gericht Onderzoek en blessure preventie bij studenten van de Sporthogeschool.

In te vullen door de deelnemer:

Ik verklaar dat:
- Ik 18 jaar of ouder ben.
- Duidelijk ben ingelicht over de aard, methode, doel en (indien aanwezig) de risico's en belasting van de testen.
- Ik op de hoogte ben van mijn recht op gegevensbescherming welke van toepassing zijn op dit onderzoek.

Ik weet dat:
- Er vertrouwelijk wordt omgegaan met de onderzoeksresultaten. De verzamelde data blijft binnen de Fontys Sporthogeschool en Fontys Paramedische Hogeschool en wordt volledig anoniem verwerkt.
- Deelneming op eigen risico is.
- Indien ik besluit tussentijds te stoppen met het onderzoek dit geen verdere consequenties
heeft.

- Ik bij eventuele vragen over het onderzoek de contactpersoon kan contacteren, ook na afronding van dit onderzoek.

Mijn vragen zijn naar tevredenheid beantwoord.
Ik stem in geheel vrijwillig deel te nemen aan de testen.

Ik, Ondergetekende…………………………………………………………………………………. verklaar hiermee kennis te hebben genomen van het onderzoek en de daarbij gestelde voorwaarden en ga akkoord dat mijn data gebruikt mag worden.

Datum: ………………………
Plaats: ………………………
Handtekening deelnemer: ………………………

☐ ja, ik zou graag na het onderzoek mijn gegevens en de conclusie van het onderzoek ontvangen. Vul dan hieronder je e-mail adres in.

E-mail:……………………………………………………………………………………………………

Indien geen 18+. Graag ondertekening van één van de ouders:
Naam ouder: ………………………
Datum: ………………………
Plaats: ………………………
Handtekening ouder: ………………………

**In te vullen door de uitvoerende onderzoeker:**

Ik heb een mondelinge en schriftelijke toelichting gegeven over de testen. Ik zal resterende vragen over het onderzoek naar vermogen beantwoorden ook na afronding van het onderzoek.

De deelnemer zal van eventuele voortijdige beëindiging van deelname aan dit onderzoek geen nadelige gevolgen ondervinden.

Ik verklaar bovenstaande punten zo duidelijk mogelijk en naar waarheid de deelnemers hebben toegelicht.

Naam onderzoeker 1:
…………………………………………………………………………………………………….
Datum:………………………….. Handtekening onderzoeker:………………………….
Naam onderzoeker 2:

Datum:........................... Handtekening onderzoeker:.................................

Naam onderzoeker 3:

Datum:........................... Handtekening onderzoeker:.................................

Naam onderzoeker 4:

Datum:........................... Handtekening onderzoeker:.................................
III. Y Balance Test (LQ-YBT) protocol

Equipment needed

- 1 Y Balance Kit™
- Y Balance Test scoring sheet
- Room dividing screens
- Testing room

Participants

Participants wear comfortable sport clothes. They remove their shoes and socks for the performance of the test.

Procedure

Two participants approach the assessor and hand over their scoring sheets. They are dressed appropriately. The assessor gives a short demonstration and explanation before the start of each reach direction (see Instructions). Questions can be asked after each demonstration and are answered by the assessor.

Participant 1 (P1) performs four practice trials, with the right leg as stance-limb, in the anterior movement direction. Participant 2 (P2) waits off to the side. Subsequently, P2 will perform the four practice trials with his right leg as stance-limb in the anterior movement direction, while P1 rests. This should provide each participant with sufficient rest (approximately 1 minute) between right and left limbs, and between movement directions, to counteract fatigue. After the practice trials, P1 will begin the test trials using the same limb, and moving in the same reach direction as during the practice trials. P2 should be resting on the side. When P1 has achieved three successful trials, P2 will proceed with his/her test trials. Each participant has a maximum of six test trials per direction and limb to achieve three successful trials. This procedure remains consistent throughout the testing (for all movement directions and right and left limbs). In order to minimize fatigue by alternating stance limbs, the standard testing order is: right anterior, left anterior, right posteromedial, left posteromedial, right posterolateral, left posterolateral (Figure 1).

After each trial, the assessor moves the reach indicator back to its starting position. A trial is discarded and repeated if the participant uses the reach indicator as stance support, loses balance and touches the floor with the reach foot, fails to return the reach foot to the starting position under control, or fails to keep the reach foot in contact with the reach indicator on the target area while it is moving. A trial is also rejected if the hands are removed from the hips while performing the test. Stance foot movement is allowed, which means that the participant is allowed to lift his heel/forefoot from the surface. Controlled body movement is also allowed. Reach distance is measured by reading the tape measure where the most distal part of the toes reached. It is noted on the participant’s scoring sheet.
Instructions

The following preliminary instructions are given:

You have four practice trials with both limbs in each of the three movement directions. While one of you is performing the practice trials in the anterior direction with the right limb as stance-limb, the other person rests on the side. Then, the second person will perform the same practice trials while the first person rests. After the practice trials, the first person will start the test trials in the anterior direction with the right limb as stance-limb. When he/she has achieved three successful trials, it will be the second person’s turn again. Once the two of you have finished the test trials in the anterior direction on your right leg, you are going to switch to your left leg, and do the same over again. I will always indicate which leg you should stand on, and in which direction you should push.

You have a maximum of six test trials per direction and limb to complete three successful trials. All movements are performed with your hands on your hips. You are not allowed to touch the floor with your reach foot, or push away the reach indicator. Thus, your toes must always stay in contact with the red target area on the reach indicator while it is in motion. Furthermore, you should try to not lose balance and you should return your reach foot in a controlled manner to the starting position. Also, do not rest your reach foot on the reach indicator. In case you fail to do so, the trial is discarded and repeated. You are allowed to move your body in a controlled manner and to lift your toes or heel from the centre plate. Do you understand these instructions?

The following instructions are given before the practice trials and the actual measurement in the anterior direction: (the participant is informed when the actual measurement starts)

Stand on your right foot on the centre footplate, with the distal aspect of your toes at the starting line. Your toes are not allowed to cross this line during the test. Place your hands on the hips and keep them there throughout the test. While maintaining this position, push the reach indicator in front away from you as far as possible, using your left leg. Do you understand these instructions? (Repeat until three successful trials have been achieved).

Now switch legs.

Stand on your left foot on the centre footplate, with the distal aspect of your toes at the starting line. Your toes are not allowed to cross this line during the test. Place your hands on the hips and keep them there throughout the test. While maintaining this position, push the reach indicator in front away from you as far as possible, using your right leg. Do you understand these instructions? (Repeat until three successful trials have been achieved).
The following instructions are given before the practice trials and the actual measurement in the posteromedial direction: (the participant is informed when the actual measurement starts)

Stand on your right foot on the centre footplate, with the distal aspect of your toes at the starting line. Your toes are not allowed to cross this line during the test. (12) Place your hands on the hips and keep them there throughout the test. (13) While maintaining this position, push the reach indicator left behind away from you as far as possible, using your left leg. Do you understand these instructions? (Repeat until three successful trials have been achieved).

Now switch legs.

Stand on your left foot on the centre footplate, with the distal aspect of your toes at the starting line. Your toes are not allowed to cross this line during the test. (12) Place your hands on the hips and keep them there throughout the test. (13) While maintaining this position, push the reach indicator right behind away from you as far as possible, using your right leg. Do you understand these instructions? (Repeat until three successful trials have been achieved).

The following instructions are given before the practice trials and the actual measurement in the posterolateral direction: (the participant is informed when the actual measurement starts)

Stand on your right foot on the centre footplate, with the distal aspect of your toes at the starting line. Your toes are not allowed to cross this line during the test. (12) Place your hands on the hips and keep them there throughout the test. (13) While maintaining this position, push the reach indicator right behind away from you as far as possible, using your left leg. Do you understand these instructions? (Repeat until three successful trials have been achieved).

Now switch legs.

Stand on your left foot on the centre footplate, with the distal aspect of your toes at the starting line. Your toes are not allowed to cross this line during the test. (12) Place your hands on the hips and keep them there throughout the test. (13) While maintaining this position, push the reach indicator left behind away from you as far as possible, using your right leg. Do you understand these instructions? (Repeat until three successful trials have been achieved).
IV. Hop testing protocol

**Equipment needed**

- Standard measuring tape fixed on the ground to measure the horizontal distance hopped
- Standard white sport tape
- Hop test scoring sheet
- Room dividing screens
- Testing room
- Stopwatch (Hudora Stopwatch, Remscheid Germany)

**Participants**

All participants must wear comfortable sport clothes and athletic shoes.

**Procedure**

Two participants approach the assessor and hand over their scoring sheets. The participants are dressed appropriately. The assessor gives brief instructions and a demonstration before the performance of each hop test (see Instructions). Questions can be asked after each demonstration and are answered by the assessor. A six metre long, and fifteen centimetre wide line of white tape is put onto the floor. The start and finish line are indicated by two smaller pieces of white tape, placed perpendicularly to the long piece of tape, six metres apart from each other (Figure 2). A standard measuring tape is fixed in the centre of the white tape.

No additional warm-up activity is carried out before performing the four hop tests. This is consistent with the original description. Each participant has one practice trial per leg in order to get acquainted with the task. The two test trials are performed immediately after the practice trial. If needed, the participant will have up to 30 seconds of rest in between each trial, as well as a one minute break in between each of the four hop tests, to minimize fatigue. If the participant loses balance, falls, does an extra hop on landing, lifts his heel or toes from the floor, or touches the floor with either the contralateral limb or an upper limb, the test trial is repeated until he/she has accomplished two successful test trials. Furthermore, for the hops for distance to be recognized as successful, the landing has to be maintained for 2 seconds. Each participant has a maximum of four trials to complete two successful trials. The hands are placed on the hips and have to remain there throughout each test. If the hands are removed from this position, the trial is repeated.

The hop distance is measured in centimetres from the marked starting line to the posterior part of the participant's heel in the single-leg hop for distance, the triple hop for distance, and the crossover hop for distance. The distance is measured to the nearest 0.5 cm. The time for the 6m timed hop is
measured with a stopwatch beginning when the participant crosses the starting line, and ending when the participant’s heel is entirely over the finish line. (27) The time is measured to the nearest 1/100 seconds. (27)

**Instructions**

**The following preliminary instructions are given:**

You have one practice trial per leg, and you must accomplish two successful trials in a maximum of four test trials. The two test trials are performed immediately after the practice trial. A test trial is repeated if you lose balance, fall, do an extra hop on landing, or touch the floor with either the opposite leg or an upper limb. (23)

You can have a 1 minute break in between each of the four hop tests, and a break lasting up to 30 seconds in between trials, if needed. (23) Do you understand these instructions?

**The following instructions are given before each practice trial. (The participant is informed when the actual measurement starts):**

**Single-leg hop for distance (27):**

Stand with the toes of your right/left foot behind the marked starting line and lift the left/right foot up from the floor. Keep your left/right leg in the air throughout the trial. Put your hands on your hips. Your hands have to remain in this position throughout the test.

When I say ‘GO’, try to hop horizontally along the white tape as far as possible and land on the same leg. Keep your knee bent when landing in order to decrease the risk of injury. The landing position must be held for at least two seconds. Do you understand these instructions?

GO.

Now switch legs.

**Triple hop for distance (27):**

Stand with the toes of your right/left foot behind the marked starting line and lift the left/right foot up from the floor. Keep your left/right leg in the air throughout the trial. Put your hands on your hips. Your hands have to remain in this position throughout the test.

When I say ‘GO’, try to do three consecutive maximal hops along the white tape. Keep your knee bent when landing in order to decrease the risk of injury. The landing position must be held for at least two seconds.
seconds. Do not compose yourself and/or pause between the three hops. Do you understand these instructions?

GO.

Now switch legs.

*Triple Cross-over hop for distance (27):*

Stand with the toes of your right/left foot behind the marked starting line and lift the left/right foot up from the floor. Keep your left/right leg in the air throughout the trial. Put your hands on your hips. Your hands have to remain in this position throughout the test.

When I say ‘GO’, try to do three consecutive maximal hops, crossing the centre strip with each hop. The three hops are performed using the same leg. Do not alternate legs in between hops. Keep your knee bent when landing in order to decrease the risk of injury. The landing position must be held for at least two seconds. Do not compose yourself and/or pause between the three hops. Do you understand these instructions?

GO.

Now switch legs.

*6m- timed hop (27):*

Stand with the toes of your right/left foot behind the marked starting line and lift the left/right foot up from the floor. Keep your left/right leg in the air throughout the trial. Put your hands on your hips. Your hands have to remain in this position throughout the test.

When I say ‘GO’, try to hop as quickly as possible along the six-metre-long white tape from the marked starting line to the end line. The time is stopped when your heel is entirely over the finish line. Do not alternate legs during the hops. Keep your knee bent when landing in order to decrease the risk of injury. Try to make large, forceful, propulsive hops over the distance. Do you understand these instructions?

GO.

Now switch legs.
V. Scoring sheet

Last name: ________________________  First name: ________________________

Date of birth: ___/___/______  Gender : Male/ female

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Data</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg length (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height tibia plateau (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand length (cm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lower Quarter Y Balance Test (LQ-YBT) scoring sheet

<table>
<thead>
<tr>
<th>Supporting leg &amp; Direction</th>
<th>Trial 1 (cm)</th>
<th>Trial 2 (cm)</th>
<th>Trial 3 (cm)</th>
<th>Average (cm)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Anterior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Anterior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Posteromedial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Posteromedial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Posterolateral</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Posterolateral</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Functional Movement Screen (FMS) scoring sheet

<table>
<thead>
<tr>
<th>Test</th>
<th>Raw Score</th>
<th>Final Score</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Squat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hurdle Step</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-line Lunge</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder Mobility</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impingement Clearing Test</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active Straight-Leg Raise</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trunk Stability Push-Up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Press-Up Clearing Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotary Stability</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior Rocking Clearing Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*This score is used to denote right and left side scoring. The right and left sides are scored in five of the seven tests and both are documented in this space.

**This score is used to denote the overall score for the test. The lowest score for the raw score (each side) is carried over to give a final score for the test. A person who scores a three on the right and a two on the left would receive a final score of two. The final score is then summarized and used as a total score.
## Hop testing scoring sheet

<table>
<thead>
<tr>
<th></th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Average</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-leg hop for distance (cm)</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-leg triple hop for distance (cm)</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-leg triple cross-over hop for distance (cm)</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6m timed hop (s)</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VI. Questionnaire

Achternaam: ...........................................  Voornaam: ...........................................

Geboortedatum: ............ - ............ - ............  Geslacht: Man □ Vrouw □

- Voorkeursbeen: Met welk been schop je bij voorkeur een bal weg?  Rechts □ Links □
- Geef in onderstaande tabel per sport die je beoefend (buiten de schooluren) het volgende aan:
  - Hoe lang doe je deze sport(en) al?
  - Aantal uur per week (afgerond op 0.5u) dat je op dit moment gemiddeld aan deze sport besteed.
  - Aantal uur per week (afgerond op 0.5u) dat je afgelopen seizoen gemiddeld aan deze sport besteedde.
  - Kruis per sport aan op welk niveau je afgelopen seizoen de sport beoefende (nationale selectie is ook internationale competitie).

<table>
<thead>
<tr>
<th>Sport</th>
<th>Hoe lang doe je deze sport al?</th>
<th>Op dit moment: Uren per week incl. wedstrijd (0.5 u.)</th>
<th>Afgelopen Seizoen: Uren per week incl. wedstrijd (0.5 u.)</th>
<th>Internat. competitie</th>
<th>Nationale competitie</th>
<th>Regionale competitie</th>
<th>Recreatief, geen competitie</th>
</tr>
</thead>
</table>

Sport je momenteel niet. Vul dan graag hierbeneden je reden in:

...........................................................................................................................................................................

- Heb je in de afgelopen 6 weken een hersenschudding gehad?  Ja □ Nee □

- Heb je in de afgelopen 6 maanden neurologische stoornissen ervaren?
Denk aan gevoelsstoornissen (tintelingen, verdoofdheid), extreme spierzwakte, wazig zicht, epileptische krampaanval, terugkerende duizeligheid, terugkerende rilling.

Zo ja, geef de neurologische stoornissen aan:

- Heb je last van evenwichtsstoornissen?  
  Ja □ Nee □

- Gebruik je op dit moment medicijnen die invloed hebben op het evenwicht?  
  Ja □ Nee □

- Gebruik je op dit moment krukken?  
  Ja □ Nee □

- Gebruik je tijdens het sporten een heup-, knie- of/en enkelbrace?  
  Ja □ Nee □

Zo ja, geef aan:

- Welke soort brace: ........................................................................................................
- Tijdens welke sport(en): ............................................................................................
- Gebruik je deze brace tijdens wedstrijden en/of trainingen? ..............................

- Eerwaar je op dit moment lichamelijke pijn (in je spieren, botten, banden, pezen)? Spierpijn niet meegerekend. Geef op deze schaal van 0 tot 10 aan hoeveel pijn je ervaart. Omkirkel het toepasselijke nummer.

  [Beeld van een schaal van 0 tot 10]

  Geen pijn 1 2 3 4 5 6 7 8 9 10 Ergst denkbare pijn

  Is de pijn hoger dan 0, omschrijf dan hieronder waar je pijn ervaart en wat voor soort pijn het is. (bijv. stekend, zeurend e.d.)

  ……………………………………………………………………………………………………………....

- Heb je in het afgelopen seizoen (last van) een blessure gehad?  
  Ja □ Nee □

Zo ja, vul de tabel in:

- lijn 1:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 2:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 3:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 4:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 5:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 6:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 7:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 8:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 9:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 10:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 11:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 12:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 13:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 14:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 15:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 16:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 17:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 18:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 19:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken: 

- lijn 20:
  - lichaamsdeel/gewricht: 
  - links/rechts: 
  - contact of non-contact ongeval: 
  - diagnose/aard: 
  - hoelang geleden: 
  - hoelang herstelling: 
  - moest stoppen met sporten en/of school: 
  - behandeld door: 
  - hoeveel uur per week: 
  - hoeveel weken:
VII. Time management

The testing stations will be carried out in pairs of two. The time management will take place as indicated in Table 6.

*Table 6: Time management*

<table>
<thead>
<tr>
<th>Time management</th>
<th>FMS</th>
<th>Y-balance test</th>
<th>Hop tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>10 minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 1</td>
<td>15 minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 2</td>
<td>15 minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 3</td>
<td>15 minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conclusion</td>
<td>5 minutes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In total: 45 minutes data collection, 15 minutes introduction and conclusion. 6 students participate per testing session.

Pair 1
Pair 2
Pair 3
VIII. Confidentiality statement

1. By signing this Statement, the Fontys Paramedic University of Applied Sciences in Eindhoven commits itself to keep any information concerning provided data and results obtained on the basis of research of which is taken cognizance as part of the above practical research project and of which it is known or can be reasonably understood that said information is to be considered secret or confidential, in the strictest confidence.

2. This confidentiality requirement also applies to the employees of the Fontys Paramedic University of Applied Sciences, as well as to others who by virtue of their function have access to or have taken cognizance of the aforesaid information in any way.

3. The above notwithstanding, the student will be able to perform the practical research project in accordance with the statutory rules and regulations.

Student:

Name: Goedert Nina

(signature) Date: 11/12/2015

Supervisor:

Name: Steven Onkelinx

(signature) Date: 11/12/2015

Coordinator: for receipt

Name: Steven Onkelinx

(signature) Date: 11/14/2015
IX. Conveyance of Rights Agreement

AGREEMENT

Pertaining to the conveyance of rights and the obligation to convey/return data, software and other means

The undersigned:

1. Mr./Ms. Goedert Nina [full name as stated in passport], residing at L-9066 Ettelbrück, [postal code, place of residence] at the 4, rue des Verugas, [street and house number], hereinafter to be called "Student"

and

2. Fontys Institute trading under the name Fontys University of Applied Sciences, Rachetamoelen 1, 5612 MA Eindhoven, hereinafter to be called "Fontys"

CONSIDERATION

A. Student is studying at the Fontys Paramedic University of Applied Sciences in Eindhoven and is performing or will perform (various) activities as part of his/her studies, whether or not together with third parties and/or commissioned by third parties, as part of research supervised by the lectureship of Fontys Paramedic University of Applied Sciences. The aforesaid activities will hereinafter be called "Lectureship Study Activities". At the time of the signing of this Statement, the Lectureship of Fontys Paramedic University of Applied Sciences supervises in any case the studies listed in Appendix 1., but this list is not an exhaustive one and may change in the future.

B. It is of essential importance to Fontys Paramedic University of Applied Sciences that (the results of) the Lectureship Study Activities can be further developed and applied without any restriction by Fontys Paramedic University of Applied Sciences and/or used for the education of other students. Fontys wishes in any event – but not exclusively – (i) to be able to share with and/or convey to third parties (the results of) the Lectureship Study Activities, (ii) to publish these under its own name, where the Student may be named as co-author providing that this is reasonable under the circumstances, (iii) to be able to use these as a basis for new research projects.

C. In case intellectual ownership rights and/or related claims on the part of Student will be/are attached to (the results of) the Lectureship Study Activities, parties wish – taking into account that which was mentioned under (B) – Fontys Paramedic University of Applied Sciences to be the only claimant with regard to said rights and claims. The Student therefore wishes to convey all his/her current and future intellectual property rights as well as related claims concerning (results of) the Lectureship Study Activities to Fontys, subject to conditions to be specified hereafter;
D. Student furthermore wishes to enter into the obligation – again taking into account that which was mentioned under (B) – to convey all data collected by him/her as part of the (results of) the Lectureship Study Activities to Fontys and not to retain any copies thereof, and also to return all data, software and/or other means previously provided by Fontys as part of (the results of) the Lectureship Study Activities, such as measuring and testing equipment, to Fontys without retaining copies thereof, all the above being subject to conditions to be specified hereafter.

**AGREE THE FOLLOWING**

1. **Conveyance of intellectual property rights**

1.1 Student herewith conveys to the Fontys Paramed University of Applied Sciences all his/her current and future intellectual property rights and related claims concerning (the results of) the Lectureship Study Activities, for the full term of these rights.

1.2 Intellectual property rights and/or related claims are understood to refer to, in any case – but not limited to – copyright, data bank law, patent law, trademark law, trade name law, designs and model rights, plant breeder’s rights, the protection of know-how and protection against unfair competition.

1.3 The conveyance described under 1.1 shall be without restriction. As such, the aforesaid conveyance shall include all competences related to the conveyed rights and claims, and said conveyance shall apply to all countries worldwide.

1.4 Insofar as any national law requires any further cooperation on the part of Student for the conveyance mentioned under 1.1, Student will immediately and without reservation lend such cooperation at first request by Fontys Paramed University of Applied Sciences.

1.5 Fontys accepts the conveyance described under 1.1.

2. **Waiver of personal rights**

2.1 Insofar as permitted under article 25 ‘Copyright’ and any other national laws that may apply, Student waives his/her personal rights, including – but not limited to – the right to mention Student’s name and the right to oppose any changes to (the results of) the Lectureship Study Activities. If and insofar as Student can claim personality rights pursuant to any national laws notwithstanding the above, Student will not appeal to said personality rights on unreasonable grounds.
2.2 In deviation from that which was stipulated under 2.1, the Fontys Paramedic University of Applied Sciences may decide to mention the name of Student if this is reasonable in view of the extent of his/her contribution and activities.

3. Compensation

Student agrees that he/she will receive no compensation for the conveyance and waiver of rights as described in this Statement.

4. Guarantee concerning intellectual property rights

Student declares that he/she is entitled to the aforesaid conveyance and waiver, and declares that he/she has not granted or will grant in future, license(s) for the use of (the results of) the Lectureship Study Activities in any way to any third party/parties. Student indemnifies Fontys from any claims by third parties within this context.

5. Obligation to convey/return data, software and other means

5.1 At such a time as Student is no longer performing any Lectureship Study Activities and/or is no longer a student at Fontys, Student is obliged to convey to Fontys all data, in the widest sense of the word, collected by him/her as part of (the results of) the Lectureship Study Activities, including – but not limited to – studies and research results, interim notes, documents, images, drawings, models, prototypes, specifications, production methods, process descriptions and technique descriptions.

5.2 Student guarantees not to have kept any copies in any way or form of the data meant under 5.1.

5.3 Student is obliged to return to Fontys all data, software and other means provided to him/her by Fontys as part of the Lectureship Study Activities, and guarantees not to have kept copies in any way or in any form, of the provided software and/or other means.

5.4 Student agrees that if he acts and/or proves to have acted contrary to the obligations mentioned under 5.1 up to and including 5.3, (a) he/she shall be liable for all and any damages incurred or to be incurred by Fontys, and (b) that this will qualify as fraud and that Fontys can apply the appropriate sanctions hereto. The sanctions to be applied by Fontys may consist of, among other things, the denying of study credits, the temporary exclusion of the Undersigned from participation in examinations, but also the definitive removal of the registration of the Undersigned as a student at Fontys.
6. **Waiver**
Student waives the right to terminate this Agreement.

7. **Further stipulations**
7.1 Insofar as this Agreement deviates from the Student Statute, this Agreement shall prevail.

7.2 This Agreement is subject to Dutch law. All disputes resulting from this statement will be brought before the competent judge in Amsterdam.

---

**Student:**
Name: **Goedert** Nina  
(signature)

**Fontys Institute**
trading under the name Fontys Hogescholen
Supervisor:
Name: **Steven Overbeek**  
(signature)

**Date:** 1640 2015  
**Place:** Eindhoven

---

**I, Ms. M.H. de Waard, sworn translator for the English language registered at the Court in Groningen, the Netherlands, and registered in the Dutch Register of Sworn Translators and Interpreters (Rbtv) under nr. 2202, herewith certify the above to be a true and faithful translation of the attached Dutch document into the English language.**

Groningen, 23 May 2012,

[M.H. de Waard]


---

XXII