Chapter 5

VALIDATING

the Mobility Performance simulation


The Wheelchair Mobility Performance (WMP) test assesses mobility performance in wheelchair basketball in a reliable and valid way. The aim of this study was to examine the sensitivity to change of the WMP test by manipulating wheelchair configurations. Sixteen wheelchair basketball players performed the WMP test three times in their own wheelchair: 1) without adjustments (control), 2) with 10 kg additional mass (weight) and 3) with 50% reduced tire pressure (tire). The outcome measure was time (s). If paired t-tests were significant (p<.05) and differences between conditions were larger than the Standard Error of Measurement, the effect sizes (ES) were used to evaluate the sensitivity to change. ES values ≥0.2 were judged as sensitivity to change. The overall performance times for the manipulations were significantly higher than the control condition, with mean differences of 4.40s (weight – control, ES=0.44) and 2.81s (tire – control, ES=0.27). The overall performance time on the WMP test was judged as sensitive to change. For 8 of the 15 separate tasks on the WMP test, the tasks were judged as sensitive to change for at least one of the manipulations. The WMP test has the ability to detect change in mobility performance when wheelchair configurations were manipulated.
5.1 Introduction

In wheelchair basketball, the interaction between the player, the wheelchair and the environment determine the overall performance. More specifically, and in line with several other studies (31,54), all actions a wheelchair basketball player can perform using the wheelchair, such as turning, blocking, stopping and accelerating, are considered to be part of mobility performance. In order to repeatedly monitor athletes’ mobility performance, standardized field-based tests are informative and helpful (38,98). Recently, de Witte et al. (30) developed a standardized field-based Wheelchair Mobility Performance test (WMP test) to assess mobility performance in wheelchair basketball. Extensive analyses of matches with elite wheelchair basketball athletes were performed in order to determine the most common wheelchair handling activities and their characteristics (30,31,87). These characteristics were combined in a test-circuit consisting of 15 specific wheelchair basketball mobility performance tasks (Appendix I). The WMP test covers the full range of relevant mobility performance tasks in wheelchair basketball, meaning that all aspects of an athlete’s mobility performance can be assessed in one single standardized test.

The reliability and construct validity of the WMP test has already been determined (30). The reliability of the WMP test for the overall performance outcome appeared to be excellent (ICC=0.95) (30). Furthermore, the construct validity of the WMP test was confirmed by showing that the WMP test was able to detect differences in mobility performance between athletes for who it was expected that they differed in their level of physical capacity (17,44). In line with expectations, men performed better than women and international male athletes performed better than national male athletes on the WMP test. A borderline significant difference in mobility performance was found between low classification (1.0 to 2.5) and high classification (3.0 to 4.5) athletes. It was concluded that the WMP test was reliable and valid and could be used to assess the capacity of mobility performance of elite wheelchair athletes in wheelchair basketball players.

Besides reliable and valid, the WMP test should also be sensitive to change to apply the test in sports practice but also in scientific research (28). A test that is sensitive to change is one that is able to detect changes. Sensitivity to change can be defined as the ability of a test to detect change in its outcome when it has occurred (16,47,48). In elite sports, differences in performance are very small and, therefore, it is important to be able to detect changes in the determinants of performance (21). If the WMP test is sensitive to change, the change or difference in performance time assessed using the WMP test can be truly attributed to a systematic change in mobility performance in-person and not to noise or random error. The psychometric characteristic sensitivity to change of the WMP test can be studied by such manipulation of the mobility performance for which it can be expected that the WMP test is able to detect its change in mobility performance. Potential manipulations that can be studied to explore the sensitivity to change of the WMP test are the configuration of the wheelchair (e.g. wheel diameter, mass), characteristics of the athlete (e.g. body weight) or manipulations in the interface between wheelchair and athlete (e.g. seat height). If the WMP test is able to detect a change in performance time when wheelchair, athlete or interface configurations
were manipulated, it is justified to use the test in practice and scientific research. The test can be used, for instance, to optimize the design of the wheelchair in wheelchair basketball. Therefore, the objective of the present study was to examine the sensitivity to change of the standardized field-based WMP test in wheelchair basketball by systematically manipulating wheelchair configurations.

5.2 Methods
5.2.1 Participants
Sixteen wheelchair basketball players (15 men, 1 woman) with a mean age of $23.5 \pm 8.4$ years, a mean body weight of $71.1 \pm 21.4$ kg and $7.8 \pm 6.6$ years of experience in wheelchair basketball voluntarily participated in this study. All participants trained at least two times a week and played in the B- or C-division of the Dutch wheelchair basketball competition. An overview of their classification is shown in Figure 1. Prior to participation, all participants were informed about the study objectives and procedures, and signed an informed consent form. The study was approved by the Ethical Committee of the Faculty of Behavioural and Movement Sciences, Vrije Universiteit Amsterdam (VCWE 2016-091).

![Distribution of classification](image)

**Figure 1.** Overview of the classification categories for 16 wheelchair basketball players.

5.2.2 Procedure
The Wheelchair Mobility Performance (WMP) test consists of 15 sport specific tasks based on extensive observation of wheelchair basketball matches (30) (see Appendix 1 for the description of the test). The test-retest reliability of the WMP test was excellent (ICC=0.95) for the overall performance time and the WMP test is a valid tool to assess mobility performance in wheelchair basketball players (30).
The participants performed the WMP test three times in their own wheelchair: 1) in the Control Condition (CC) the participants had to perform the test with normal tire pressure (standardized at 7 bar) and with no extra mass attached to the wheelchair; 2) in the Weighted Condition (WC) the participants had to perform the test with normal tire pressure but with an additional mass of 10 kg attached to the wheelchair. The extra mass was distributed over the wheelchair frame by using five masses of 2 kg (Figure 2); 3) in the Tire Condition (TC) the participants performed the test in their own wheelchair with a tire pressure which was reduced by 50% (3.5 bar) and with no additional mass attached to the wheelchair. Tire pressure was determined using a high-pressure pump (Lezyne Alloy Drive SE Floor Pump).

Prior to the WMP tests, verbal instructions were given to the participants about the procedure of performing the test and the participants had to practice the tasks of the WMP test in the presence of a researcher who gave verbal instructions on each task. After the instructions, the participants filled out a form concerning general information: age, body weight, type of impairment, years of experience in wheelchair basketball and classification. After a self-selected warm up, the participants performed the three experimental conditions of the WMP tests in a randomized and counterbalanced order to avoid learning effects. All standardized tasks of the WMP test were carried out in succession in a fixed order, separated by standardized rest periods as described in the test protocol (30). The WMP tests were performed indoors on a synthetic soft-top basketball court on one day. Each WMP test took about 6.5 minutes and was followed by a rest period of 10 to 15 minutes.

5.2.3 Performance times
All WMP tests were video recorded from the side of the field with a Casio Exilium EX-ZR1000 (Casio, Tokyo, Japan) or a Samsung Galaxy S5 (Samsung, Seoul, South Korea), both at 30 frames per second. The outcome of the WMP test was time (s), which was manually assessed.
from video analyses using Kinovea (Kinovea 0.8.15, France). These analyses resulted in 16 performance time values, one for each of the 15 tasks of the WMP test (time tasks no. 1 - 15) and the overall performance time, which was the sum of the performance times of the 15 separate tasks. Measurement time was accurate to 0.03s (30Hz).

5.2.4 Statistical analysis

Normality of the data was checked with the Shapiro-Wilk test, the Z-values for kurtosis and skewness, Q-Q plots and Boxplots. For all performance time data, the assumption of normality was not violated. Descriptive statistics for performance measurements (time WMP test tasks no. 1 - 15 and the overall performance time) were presented as mean ± standard deviation (SD). In line with previous research (42,47,48,67), sensitivity to change of the measurements was examined using paired t-tests, the Standard Error of Measurement for agreement (SEM_{agreement}) and Cohen’s d effect sizes (ES).

Paired t-tests were used to examine the differences in performance time between WC and CC and between TC and CC. All data were analysed with IBM SPSS Statistics 23 (IBM Corporation, Armonk, NY, USA) using a significance level of \( p<0.05 \).

The SEM for agreement was calculated with Equation (1). This analysis has previously been performed and published in the reliability and validity study of the WMP test (30). From variance component analyses, two components were estimated, variance attributable to observers (Var_{observer}) and residual error (Var_{residual}), with the square root of their summation resulting in the SEM_{agreement}.

\[
\text{Equation 1: } SEM_{agreement} = \sqrt{Var_{observer} + Var_{residual}}
\]

The Cohen’s \( d \) Effect Size (ES) was calculated to assess the meaningfulness of the different test conditions (see equations 2 and 3). For the calculation of ES, the SD of the two testing conditions to be compared were converted into one pooled SD (SD\text{_{pooled}}).

\[
\text{Equation 2: } SD_{pooled} = \sqrt{(SD_1^2 + SD_2^2)/2}
\]

In which \( SD_1= SD \text{ of the control condition, } SD_2= SD \text{ of the weight or tire pressure condition.}

\[
\text{Equation 3: Effect size (ES) } = \frac{\text{Mean}_1-\text{Mean}_2}{SD_{pooled}}
\]

In which \( \text{Mean}_1= \text{Mean of the control condition, } \text{Mean}_2 = \text{Mean of the weight or tire pressure condition.} \)
5.2.5 Sensitivity to change
For the assessment of the sensitivity to change of the WMP test, a significant difference in performance time must be detected between the manipulation conditions (WC and TC) and CC. Furthermore, the observed differences between both conditions must be larger than the SEM_{agreement}. If the results meet both requirements, the ES was used to evaluate the magnitude of the differences between the manipulated and control conditions. Cohen’s d cut-off points for ES values were: trivial (d<0.2), small (0.2≤d<0.5), moderate (0.5≤d<0.8) and large (d≥0.8) (15). In our case, the WMP test was judged as not sensitive to change for ES values lower than 0.2, values equal or higher than 0.2 were judged as sensitive to change.

5.3 Results
The mean overall performance time on the WMP test for the Control Condition (CC) was 101.59 (±9.63) seconds, for the Weighted Condition (WC) 105.99 (±10.52) seconds and for the Tire Condition (TC) 104.39 (±11.03) seconds as can be seen in Table 1. Overall performance time for the WC and TC was significantly higher than the CC (p<0.05). The observed overall differences between the manipulated and control conditions (ΔWC-CC=4.40±2.05s, ΔTC-CC=2.81±2.25s) were larger than the reported Standard Error of Measurement (SEM) (>0.98). The ES for the WC-CC was 0.44 and for the TC-CC 0.38. Therefore, the overall performance time was judged as sensitivity to change (ES≥.20). The individual differences in the overall performance times between the different conditions per wheelchair basketball player were shown in Figure 3.

![Figure 3](image)

**Figure 3.** Differences in total performance time in seconds on the Wheelchair Mobility Performance test per wheelchair basketball player between the (a) Control Condition and Weighted Condition (10kg extra mass) and between the (b) Control Condition and 50% reduced tire pressure condition.

For the performance times of the separate tasks, only the 3-3-6m sprint showed, for both WC and TC condition, was sensitive to change (ES: WC-CC= 0.31, TC-CC=0.37). In the WC, performance times for 7 out of the 15 WMP tests tasks were significantly different from those in the CC, while at the same time the differences were larger than the SEM. The tasks 180\(^\circ\) turn on the spot left (ES=0.43), 12m sprint (ES=0.51), 3-3-6m sprint (ES=0.31), 3-3-6m rotation to the right (ES=0.50), 12m-dribble (ES=0.35), 12m-rotation dribble to the left (ES=0.34), and
the combination task (ES=0.61) were judged as sensitive to change. For the TC, as indicated above, only the performance time on the 3-3-6m sprint (ES=0.37) and the overall performance time (ES=0.27) were significantly different from the CC.
<table>
<thead>
<tr>
<th>Control condition</th>
<th>Weighted condition</th>
<th>Tire condition</th>
<th>SEM (sec)</th>
<th>Differences Weighted condition – Control condition</th>
<th>Differences Tire condition – Control condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean in sec (±SD)</strong></td>
<td><strong>Mean in sec (±SD)</strong></td>
<td><strong>Mean in sec (±SD)</strong></td>
<td><strong>Differences in sec (±SD)</strong></td>
<td><strong>P-values</strong></td>
<td><strong>Effect Size</strong></td>
</tr>
<tr>
<td>1. Tik-Tak box</td>
<td>8.26 (2.06)</td>
<td>8.79 (2.46)</td>
<td>8.66 (2.54)</td>
<td>0.53 (0.80)</td>
<td>0.017*</td>
</tr>
<tr>
<td>2. 180° Turn on the spot (left)</td>
<td>1.22 (0.29)</td>
<td>1.35 (0.31)</td>
<td>1.24 (0.23)</td>
<td>0.10</td>
<td>0.13 (0.24)^</td>
</tr>
<tr>
<td>3. 12 m sprint</td>
<td>5.37 (0.48)</td>
<td>5.63 (0.51)</td>
<td>5.57 (0.48)</td>
<td>0.24</td>
<td>0.26 (0.17)^</td>
</tr>
<tr>
<td>4. 12 m rotation (right)</td>
<td>6.92 (0.61)</td>
<td>7.08 (0.50)</td>
<td>7.01 (0.57)</td>
<td>0.16</td>
<td>0.17 (0.41)^</td>
</tr>
<tr>
<td>5. 12 m rotation (left)</td>
<td>6.85 (0.65)</td>
<td>7.01 (0.59)</td>
<td>7.08 (0.92)</td>
<td>0.22</td>
<td>0.16 (0.43)</td>
</tr>
<tr>
<td>6. 180° Turn on the spot (right)</td>
<td>1.29 (0.40)</td>
<td>1.30 (0.23)</td>
<td>1.32 (0.40)</td>
<td>0.10</td>
<td>0.01 (0.29)</td>
</tr>
<tr>
<td>7. 3-3.6m sprint</td>
<td>8.19 (0.90)</td>
<td>8.50 (1.08)</td>
<td>8.54 (1.00)</td>
<td>0.28</td>
<td>0.31 (0.57)^</td>
</tr>
<tr>
<td>8. 3-3.6m rotation (left)</td>
<td>9.08 (1.00)</td>
<td>9.39 (1.03)</td>
<td>9.29 (1.04)</td>
<td>0.26</td>
<td>0.32 (0.68)^</td>
</tr>
<tr>
<td>9. 3-3.6m rotation (right)</td>
<td>8.93 (0.80)</td>
<td>9.36 (0.91)</td>
<td>9.28 (0.93)</td>
<td>0.37</td>
<td>0.43 (0.47)^</td>
</tr>
<tr>
<td>10. 90°-90° turn on the spot with stop (left)</td>
<td>1.99 (0.35)</td>
<td>2.07 (0.30)</td>
<td>2.04 (0.38)</td>
<td>0.14</td>
<td>0.08 (0.18)</td>
</tr>
<tr>
<td>11. 12 m dribble</td>
<td>6.84 (0.83)</td>
<td>7.18 (1.09)</td>
<td>7.01 (1.06)</td>
<td>0.31</td>
<td>0.34 (0.57)^</td>
</tr>
<tr>
<td>12. 12 m rotation dribble (right)</td>
<td>9.32 (1.34)</td>
<td>9.35 (1.38)</td>
<td>9.43 (1.60)</td>
<td>0.56</td>
<td>0.03 (1.00)</td>
</tr>
<tr>
<td>13. 12 m rotation dribble (left)</td>
<td>9.40 (1.98)</td>
<td>10.01 (1.58)</td>
<td>9.67 (1.38)</td>
<td>0.51</td>
<td>0.60 (0.87)^</td>
</tr>
<tr>
<td>14. 90°-90° turn on the spot with stop (right)</td>
<td>2.03 (0.30)</td>
<td>2.03 (0.28)</td>
<td>2.09 (0.49)</td>
<td>0.11</td>
<td>0.00 (0.24)</td>
</tr>
<tr>
<td>15. Combination</td>
<td>15.90 (1.42)</td>
<td>16.94 (1.95)</td>
<td>16.18 (1.58)</td>
<td>0.34</td>
<td>1.04 (0.78)^</td>
</tr>
<tr>
<td><strong>Overall performance time (sum tasks 1-15)</strong></td>
<td>101.59 (9.63)</td>
<td>105.99 (10.52)</td>
<td>104.39 (11.03)</td>
<td>0.98</td>
<td>4.40 (2.05)^</td>
</tr>
</tbody>
</table>

* Significant effect of manipulation condition (P<0.05) in performance time compared to control condition
^ Difference between manipulation condition and control condition larger than Standard Error of Measurement
# Standard Error of Measurement not available

Table 1. Mean (±SD) performance times (s) for each task and overall performance time (s) for the wheelchair mobility performance test for the control condition and the manipulation conditions, weighted and tire condition. The table is complemented with the mean differences between the manipulation conditions and control condition, p-values, Cohen’s d effect sizes, 95% Confidence Intervals of the effect size and the Standard Error of Measurement retrieved from the study of de Witte et al. (2017) (30).
5.4 Discussion

In this study, the sensitivity to change of the standardized field-based WMP test was determined in order to assess whether the WMP test is able to detect changes in mobility performance in wheelchair basketball players. The mean total performance times for the 10kg extra mass condition and the reduced tire pressure condition, were significantly more than for the control condition. The overall performance time of the WMP test was judged as sensitive to change. It can, therefore, be concluded that the WMP test has the ability to detect changes in mobility performance when wheelchair configurations were manipulated. The separate tasks of the WMP test showed different levels of sensitivity to change dependent on the manipulation condition. For 8 of the 15 separate tasks on the WMP test, the tasks were judged as sensitive to change for at least one of the manipulations.

5.4.1 Sensitivity to change

In the present study sensitivity to change was investigated in order to determine whether the WMP test is able to detect changes in mobility performance. The term “sensitivity to change” is generally used as a common measure to detect change when it has occurred (47,48,64). The cause of the change may vary, for instance, as to the topic of the present study, because of changes in wheelchair configuration but also because of changes in time. However, in the literature also the term responsiveness is used. Literature indicates that the term responsiveness is specifically used when it concerns changes over time in the construct to be measured (28,59).

As we aimed to investigate whether the WMP test is able to detect changes in mobility performance because of changes in wheelchair configuration we decided to use the term sensitivity to change. This does not mean that the WMP test is not sensitive to changes in mobility performance in time. The test showed to be able to detect manipulated changes in mobility performance and we can expect the test to be able to detect change in mobility performance because of training or injury in time. Change should however be beyond the limits of agreement as described in the validity and reliability study of the WMP test (30). Furthermore, De Vet et al. (28) state that responsiveness is relevant for measurement instruments used in evaluative applications and that if an instrument is only used for discrimination between patients at one point in time, then responsiveness is not an issue. According to Deyo & Centor (32), responsiveness relates to a true change in clinical (health) status over time. This means that the outcome measure must remain stable when no (clinical) change has occurred (specificity) and it must detect meaningful (clinical) change when it has occurred (sensitivity). However, in the present study, differences in performance times on the WMP test between conditions are assumed to be caused by the manipulations in wheelchair configuration. The aim of this study was to measure whether change occurred and what the magnitude of that change was, therefore, we decided to use sensitivity to change.
5.4.2 Conditions
Sensitivity to change was examined by manipulating wheelchair configuration, which can have a significant impact on mobility performance (53). Other manipulations could have been chosen to study sensitivity to change. For instance, manipulation of the athlete or the wheelchair-athlete interaction could change the mobility performance, for instance by limiting trunk function, the movement of the trunk will be limited and performance may decrease. In this study, a 10kg extra mass and a 50% reduced tire pressure were used to examine sensitivity to change. These manipulations were chosen because they were relatively easy to apply to the athlete’s own wheelchair (control condition) and they clearly increase the required external work and thus reduce mobility performance. The magnitude of the manipulations was chosen in agreement with previous studies (5,9,19,24). Beekman et al. (5) found that in a 7.8kg lighter wheelchair speed and distance travelled were greater compared to a heavier wheelchair and Cowan et al. (19) found that velocity decreased as the weight of the wheelchair increased with 9.05 kg. Therefore, we used 10kg additional mass in the weight condition. Booka et al. (9) & de Groot et al. (24) stated that less tire pressure needs more work even on a hard level surface. To increase the work, the tire pressure was reduced with 50% in this study. In both manipulated conditions, the power output was increased while this may not impact the skill of mobility performance because the wheelchair-athlete settings have remained unchanged.

5.4.3 Performance times
In the weighted condition, all tasks that were not judged as sensitive were related to rotational tasks. In this study, the masses (5 x 2 kg) were attached on the outside of the frame (Figure 2). It could be that the weight distribution had less effect on the performance time for the rotational tasks compared to translation tasks or that the amount of weight had less effect on rotational tasks. Moreover, the extra mass was for all the participants 10kg, which may mean that the relative weight gain was different between the participants. This may have led to an overestimation of the results. If the amount additional mass is determined relative to the total mass of the athlete and wheelchair, the disadvantage of extra mass is the same for all the athletes. Based on this study, it can be concluded that mass influences performance times but it does not provide insight into what extent mass influences the performance times. To research that relation, in further research the effect of additional mass should be studied relative and not absolute.

In the tire condition, only the performance on the 3-3-6m sprint and the performance time on the entire WMP test were judged as sensitive to change. A recent study of Leboeuf et al. (46) showed that a lower tire pressure (5 compared to 9 bar) only decreases sprint performance in a straight line and not when other movements were included such as stops and half-turns. This is in line with the results of the present study. It could be that the differences between the conditions on the separate tasks were too small to appear as sensitive to change but the sum of
the separate tasks was large enough to appear as sensitive to change. Another explanation could be that the tires deformed during changes in directions and stops. By inflating the tires as much as possible, the friction between the ground and the tires reduces which, possibly, results in skidding. Skidding leads to loss of grip and thus waste of time. This can be an explanatory hypothesis of the comparable time between the tire pressure conditions.

In the present study, the outcome measure time (in seconds) was used which can be assessed using a timer or, as was done in the present study, using video. Therefore, the test is easy to use in practice to determine changes in performance. However, information about kinematic outcomes such as (rotational) acceleration could provide additional information and can be measured with inertial sensors on the wheelchair (6,87). The use of additional kinematic outcome measures could provide more in-depth information about the sensitivity of change. However, specific knowledge and material like the inertial sensors is required and, therefore, more difficult to use in practice. For research purposes, it is recommended to use additional kinematic outcomes to analyze the sensitivity of change.

5.4.4 The WMP test

The WMP test was developed to assess the capacity of mobility performance of wheelchair athletes in wheelchair basketball. For research purposes, Mason et al. (53) recommended that a standardized field-based test can be used to examine the impact of different wheelchair configurations on mobility performance. However, the test should be reliable, valid and sensitive to change. In a previous study the reliability and construct validity of the WMP test were determined (30) and in the present study the sensitivity to change. The combination of the results of both studies include two analyses concerning sensitivity to change (tire pressure and weight), a reliability analysis and three analyses for construct validity (gender, playing standard and classification). We decided that the reliability must meet an ICC≥0.70 (indicated as satisfactory) and that minimal 4 of the 5 remaining analyses must meet the requirements to be judged as valid and sensitive to change. Based on this requirement, it can be concluded that the WMP test is reliable, valid and sensitive to change for the 3-3-6m sprint task, the combination task (sprint, turn, slalom, turn) and the overall performance time. If the cut-off was set at all analysis must meet the requirements, than only the 3-3-6m sprint task and the overall performance time appear as an useful outcome measure. The sensitivity to change of the combination task in the tire pressure manipulation was borderline significant (P=.07). The selected measurement outcomes gives an overview of the mobility performance capacity of a wheelchair basketball athlete. The WMP test is not able to detect change in separate tasks in a reliable, valid and sensitive way. For further research, researchers must focus on the three described performance outcomes (3-3-6m sprint, combination task and overall performance outcome) to draw a conclusion on mobility performance capacity.
5.4.5 Implications of the WMP test

The WMP test can be used in a reliable and valid way to assess the capacity of mobility performance of elite wheelchair athletes in wheelchair basketball (30). The test can be used to periodically monitor the capacity of the mobility performance of the athlete, to detect strengths and limitations of an athlete, to detect talented athletes and to examine whether an athlete is sufficiently recovered from an injury in a reliable and valid way. Furthermore, the selected outcomes are sensitive to change and can be used to assess differences in performance time when wheelchair-athlete configurations were changed. The difference should, however, be larger than the limits of agreement as reported in the reliability and validity study (5). The test is easy to perform for athletes, little material is required and measuring time in seconds doesn’t need specific knowledge. At this point, besides the applications mentioned above, the test can be used in practice to optimize the wheelchair-athlete configuration or the design of the wheelchair. The selected test parts showed that performance time was sensitive to change when configuration settings were changed and can be used in further research. However, as mentioned earlier, performance time is one outcome measure. Kinematic outcomes such as (rotational) acceleration could provide more in-depth information about the effects of configurations on mobility performance.

5.4.6 Limitations

A limitation of this study was that the test was not blinded. The sequence of test conditions was randomized, but the participants could see or hear the manipulations being applied to their wheelchair. This may have biased the results, but it is unknown to which extent this has affected the test results. In future research, the researchers must be aware of this potential effect. Furthermore, in the weighted condition, for all participants, 10kg extra mass was attached to the wheelchair. The magnitude of the effect was different for all participants which may have affected the measurements. It is possible that the results were overestimated because the relative weight gain was not the same for all the participants. In further research a relative value should be determined so the effect is for all the participants the same. Another limitation of the WMP test is that not all separate tasks can be used to analyze mobility performance. For example, the single rotational tasks could not be used in assessing the mobility performance.

It can be concluded that the WMP test has the ability to detect changes in mobility performance, for instance, the wheelchair configuration was manipulated. When the results of this study are combined with the results of the reliability and construct validity study, it is recommended to monitor the performance on the 3-3-6m sprint (task 7), the combination (task 15) and the entire WMP test when used in further research and practice.