

**CORRECTION**

# Short Physical Performance Battery: Response to Pulmonary Rehabilitation and Minimal Important Difference Estimates in Patients With Chronic Obstructive Pulmonary Disease



The article by Stoffels et al, Short Physical Performance Battery: Response to Pulmonary Rehabilitation and Minimal Important Difference Estimates in Patients With Chronic Obstructive Pulmonary Disease, published in Archives of Physical Medicine and Rehabilitation 2021; 102(12), p2283-2496, [https://www.archives-pmr.org/article/S0003-9993\(21\)00452-4/fulltext](https://www.archives-pmr.org/article/S0003-9993(21)00452-4/fulltext), contained errors. There was a mistake in the transformation of the post-pulmonary rehabilitation (PR) 4-meter gait speed (4MGS) test time (s) to speed (m/s). The correct post-PR 4MGS is 1.1 (0.9-1.3) m/s for all patients, and 0.8 (0.6-0.9) m/s, 1.1 (0.9-1.2) m/s and 1.2 (1.1-1.3) m/s for the low performance group, moderate performance group, and high performance group, respectively. This results in significant mean improvements in 4MGS following PR for the whole sample, and after stratification for the baseline performance groups. In addition, anchor-based and distribution-based minimal important differences (MIDs) can be calculated for 4MGS due to the significant improvement following PR.

The original and corrected paragraphs, and corrected figures and tables that changed due to these corrections, have been listed below:

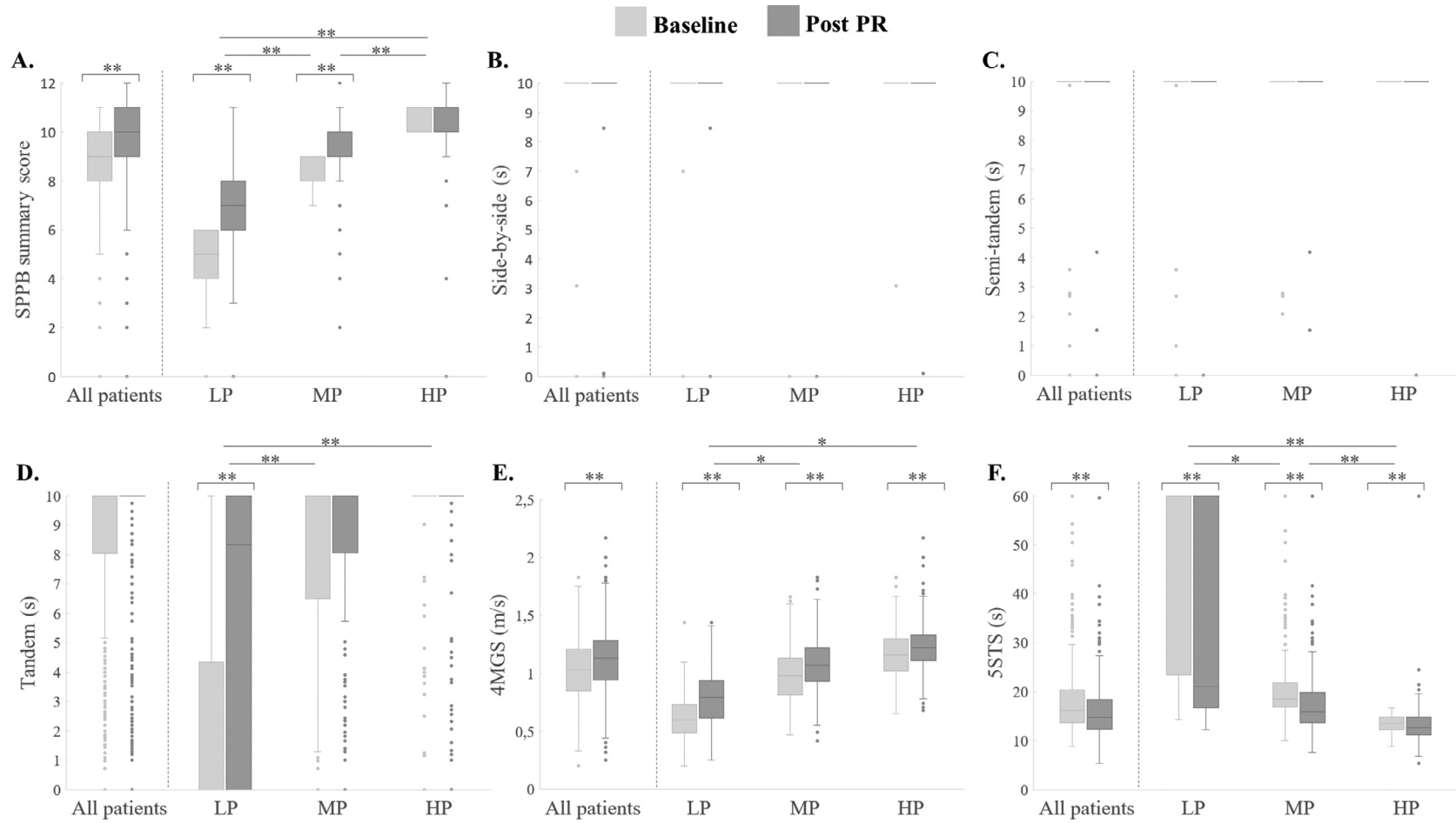
## Response to PR in SPPB (results)

### Original

The 5STS was the only SPPB subtest responsive to PR, with a median  $\Delta$ 5STS of -1.14 (-4.20 to -0.93) seconds in patients with COPD ( $P < .001$ ). Furthermore, SPPB summary score improved significantly from 9 (8-10) to 10 (9-11) points after PR ( $P < .001$ ) (fig 1).

The baseline LP group showed improvements in balance tandem (median  $\Delta = 0.00$  [0.00-10.00]s and mean  $\Delta = 3.36 \pm 4.96$ s), 4MGS ( $\Delta = 0.81$  [0.37-1.40] m/s), and 5STS ( $\Delta = -6.16$  [-35.00 to 0.00]s) subtests of the SPPB after PR (all  $P < .001$ ). The MP group showed a significant effect of PR on 4MGS ( $\Delta = 0.06$  [-0.18 to 0.33] m/s) and 5STS ( $\Delta = -2.40$  [-6.40 to 0.17]s) subtests. The HP group only improved on 5STS ( $\Delta = -0.74$  [-2.40 to 1.00]s,  $P < .001$ ) and even showed a decline in 4MGS ( $\Delta = -0.27$  [-0.44 to -0.05] m/s,  $P < .001$ ). Improvements in the LP group were significant larger in contrast to MP and HP groups, which resulted in a larger increase in SPPB summary score for the LP group than the MP and HP groups (see fig 1). A maximum post-PR SPPB summary score of 12 was obtained in 23 patients in the MP group and 63 patients in the HP group.

Furthermore, baseline and post-PR proportion of patients per performance group were significantly different ( $P < .001$ ). The flow and direction of this change in performance group classification is presented in figure 2. Because differences in the type of PR program could potentially influence the SPPB response to PR, comparisons between changes in SPPB subtests and summary scores were made for patients participating in inpatient and outpatient PR programs. Changes in SPPB subtests were not significantly different between the 2 types of PR programs, except for the change in 4MGS (outpatient = -0.2 [-0.4 to 0] m/s vs. inpatient = 0.1 [-0.2 to 0.4] m/s;  $P < .001$ ). However, this difference did not affect the change in SPPB summary score, which was comparable between both groups (table E7, available online only at <http://www.archives-pmr.org/>).



**Fig 1** Box plots of the baseline and post-PR (A) SPPB summary score, (B) balance side-by-side, (C) semi-tandem, (D) tandem, (E) 4MGS, and (F) 5STS of all patients and the LP, MP, and HP group. \*Indicates a significant difference at  $P < .01$ ; \*\*Indicates a significant difference at  $P < .001$ . The boxes in (B) and (C) are displayed as lines at the top because almost all patients maintained the balance side-by-side and semi-tandem positions for the maximum of 10 seconds.

## Corrected

In contrast to balance tests, the 4MGS ( $\Delta=0.08$  [-0.05 to 0.21] m/s) and 5STS ( $\Delta=-1.14$  [-4.20 to -0.93] s) were responsive to PR in patients with COPD (all  $P<.001$ ). Furthermore, SPPB summary score improved significantly from 9 (8-10) to 10 (9-11) points after PR ( $P<.001$ ) (fig 1).

The baseline LP group showed improvements in balance tandem (median  $\Delta=0.00$  [0.00-10.00]s and mean  $\Delta=3.36\pm 4.96$ s), 4MGS ( $\Delta=0.17$  [0.06-0.29] m/s), and 5STS ( $\Delta=-6.16$  [-35.00 to 0.00]s) subtests of the SPPB after PR (all  $P<.001$ ). The MP group showed a significant effect of PR on 4MGS ( $\Delta=0.08$  [-0.05 to 0.23] m/s) and 5STS ( $\Delta=-2.40$  [-6.40 to 0.17]s) subtests (all  $P<.001$ ). The HP group improved on 4MGS ( $\Delta=0.06$  [-0.05 to 0.19] m/s) and 5STS ( $\Delta=-0.74$  [-2.40 to 1.00]s) (all  $P<.001$ ). Improvements in the LP group were significant larger in contrast to MP and HP groups, which resulted in a larger increase in SPPB summary score for the LP group than the MP and HP groups (see fig 1). A maximum post-PR SPPB summary score of 12 was obtained in 23 patients in the MP group and 63 patients in the HP group.

Furthermore, baseline and post-PR proportion of patients per performance group were significantly different ( $P<.001$ ). The flow and direction of this change in performance group classification is presented in figure 2. Because differences in the type of PR program could potentially influence the SPPB response to PR, comparisons between changes in SPPB subtests and summary scores were made for patients participating in inpatient and outpatient PR programs. Changes in SPPB subtests and SPPB summary score were not significantly different between the 2 types of PR programs (table E7, available online only at <http://www.archives-pmr.org/>).

**Table E7** Baseline, post-PR and delta (post-PR minus baseline) data of the SPPB subtests and summary score in patient following an in- or outpatient program.

	Inpatient (n = 387)			Outpatient (n = 238)			Differences in delta's P-value
	Baseline	Post-PR	Delta	Baseline	Post-PR	Delta	
Side-by-side (s)	10 (10-10)	10 (10-10)	0 (0-0)	10 (10-10)	10 (10-10)	0 (0-0)	0.823
Semi-tandem (s)	10 (10-10)	10 (10-10)	0 (0-0)	10 (10-10)	10 (10-10)	0 (0-0)	0.723
Tandem (s)	10 (7-10)	10 (8-10)	0 (0-0)	10 (10-10)	10 (10-10)*	0 (0-0)	0.144
4MGS (m/s)	1.0 (0.8-1.1)	1.1 (0.9-1.2)**	0.1 (-0.1-0.2)	1.1 (1.0-1.3)	1.2 (1.1-1.4)**	0.1 (-0.1-0.2)	0.988
5STS (s)	17 (14-23)	16 (13-20)**	-1 (-4-1)	15 (13-18)	13 (11-16)**	-1 (-4-0)	0.256
SPPB summary score	9 (8-10)	9 (8-10)**	0 (0-2)	10 (9-11)	10 (9-11)**	1 (0-2)	0.092

Data is presented as median (Q1 – Q3).

Abbreviations: SPPB, Short Physical Performance Battery; 4MGS, 4-meter gait speed; 5STS, 5-repetition sit-to-stand.

\* Indicates a significant difference between baseline and post-PR of  $P<.01$ ,

\*\* Indicates a significant difference between baseline and post-PR of  $P<.001$ .

## MID (results)

### Original

Because only 5STS and SPPB summary score were responsive to PR, MID estimates were not determined for the balance tests and 4MGS. Using distribution-based techniques, the MID of the 5STS ranged between 2.19-6.33 seconds and between 0.83-0.96 points for the SPPB summary score (table 2). Furthermore, the change in 6MWT and CAT was not correlated or only weakly correlated with the change in 5STS and SPPB summary score and could therefore not be used as reliable anchors to determine the MIDs (table E8, available online only at <http://www.archives-pmr.org/>).

### Corrected

The MID estimates were determined for the 4MGS, 5STS and SPPB summary score as these tests were responsive to PR, in contrast to the balance tests. Using distribution-based techniques, the MID ranged between 0.05-0.13 m/s for the 4MGS, between 2.19-6.33 seconds for the 5STS, and between 0.83-0.96 points for the SPPB summary score (table 2). Furthermore, the change in 6MWT and CAT was not correlated or only weakly correlated with the change 5STS and SPPB summary score and could therefore not be used as reliable anchors to determine the MIDs. However, the change in 4MGS did correlate significantly with the change in 6MWT ( $r=0.372$ ,  $P<.001$ ) and the change in CAT ( $r=-0.235$ ,  $P<.001$ ) (table E8, available online only at <http://www.archives-pmr.org/>). As we aimed to have a significant correlation of  $\geq 0.3$ , only the change in 6MWT was used to calculate the anchor-based MID. Using linear regression analysis, we obtained a MID for 4MGS of 0.10 (95%CI 0.06-0.11) m/s. It was not possible to compute the MID using the ROC statistics as the obtained AUC was below 0.7 (AUC=0.687,  $P<.001$ ).

**Table 2** Distribution-based methods to estimate the minimal important difference in 4MGS, 5STS and SPPB summary score in patients with COPD.

Method	Formula	4MGS (m/s)	5STS (s)	SPPB Summary score (Points)
SEM	$SD_{\text{baseline}} * \sqrt{1 - ICC}$	0.05	2.19	0.83
Empirical rule effect size	$0.08 * 6 * SD_{\text{delta}}$	0.10	4.05	0.86
Cohen's effect size	$0.5 * SD_{\text{delta}}$	0.10	4.22	0.89
$0.5 * SD_{\text{baseline}}$	$0.5 * SD_{\text{baseline}}$	0.13	6.33	0.96
MID range		0.05-0.13	2.19-6.33	0.83-0.96

Abbreviations: ICC, intraclass correlation coefficient; MID, minimal important difference; SD, standard deviation; SEM, standard error of the mean; SPPB, short physical performance battery; 4MGS, 4-meter gait speed; 5STS, 5-repetition sit-to-stand.

**Table E8** Correlations between change in CAT score and 6MWT with the change in 4MGS, 5STS and SPPB summary score for patients with COPD.

	$\Delta$ CAT score		$\Delta$ 6MWT (m)	
	Correlation coefficient	P-value	Correlation coefficient	P-value
4MGS (m/s)	-0.235	<0.001	0.372	<0.001
$\Delta$ 5STS (s)	0.109	0.010	-0.178	<0.001
$\Delta$ SPPB summary score	-0.166	<0.001	0.274	<0.001

Abbreviations: CAT: COPD Assessment Test, SPPB: short physical performance battery, 4MGS: 4-meter gait speed, 5STS: 5-repetition sit-to-stand, 6MWT: 6-minute walk test

## Discussion

### Original

Generally, the SPPB subtest 5STS and the SPPB summary score are responsive to PR in patients with COPD. In patients with a low performance at baseline, balance tandem and 4MGS are responsive to PR as well. Based on distribution-based calculations, the MID estimates range between 2.19-6.33 seconds for 5STS and 0.83-0.96 points for SPPB summary score.

In accordance with previous studies, 5STS and SPPB summary score were responsive to PR in patients with COPD.<sup>9-11,13</sup> However, the current study did not show an improvement in 4MGS in all patients with COPD as was expected based on previous studies.<sup>10,12</sup> Only LP and MP patients improved their 4MGS. A possible explanation for the decline in 4MGS in the HP group could be a ceiling effect; Kon et al<sup>12</sup> have reported that patients with a better baseline 4MGS were less responsive to PR than patients with a worse baseline 4MGS. Furthermore, only the LP group improved balance tandem time after PR but had a change of 0 (0-10) seconds (or mean change of  $3.36 \pm 4.96$ s), which makes the clinical significance of the improvement questionable. No performance group showed an effect of PR in balance side-by-side or semi-tandem. Although balance impairments are common in patients with COPD,<sup>39</sup> most participants were able to complete the balance tests without difficulty. These results imply that standing balance tests are less useful and effective and perhaps not adequacy sensitive in evaluating the effectiveness of PR in patients with COPD, suggesting the use of more complex balance tests like Berg Balance Scale or Balance Evaluation Systems Test.<sup>39</sup> Another possible explanation could be the minor focus on balance issues during PR; Marques et al highlighted the value of balance training during PR.<sup>40</sup>

The mean 5STS MID estimates (2.19-6.33s) are larger than the MID estimate by Jones et al (1.7s) in patients with COPD after an 8-week outpatient PR program in the United Kingdom.<sup>13</sup> The current SPPB summary score MID estimates (0.83-0.96 points) are comparable with the study of Perera et al, who reported a small meaningful change of 0.5 points and a substantial change of 1.0 point for SPPB summary scores in older patients.<sup>41</sup> Because the SPPB summary score is reported in whole numbers, it seems reasonable to conclude that an improvement of 1 point on the SPPB summary score can be taken as the MID in patients with COPD after PR. This MID can be interpreted and applied at individual and group levels to determine whether patients improve after PR.

### Corrected

Generally, the SPPB subtests 4MGS and 5STS, and the SPPB summary score are responsive to PR in patients with COPD. In patients with a low performance at baseline, balance tandem is responsive to PR as well. The MID estimates range between 0.05-0.13 m/s for 4MGS, 2.19-6.33 seconds for 5STS and 0.83-0.96 points for SPPB summary score.

In accordance with previous studies, 4MGS, 5STS and SPPB summary score were responsive to PR in patients with COPD.<sup>9-13</sup> Furthermore, only the LP group improved balance tandem time after PR but had a change of 0 (0-10) seconds (or mean change of  $3.36 \pm 4.96$ s), which makes the clinical significance of the improvement questionable. No performance group showed an effect of PR in balance side-by-side or semi-tandem. Although balance impairments are common in patients with COPD,<sup>39</sup> most participants were able to complete the balance tests without difficulty. These results imply that standing balance tests are less useful and effective and perhaps not adequacy sensitive in evaluating the effectiveness of PR in patients with COPD, suggesting the use of more complex balance tests like

Berg Balance Scale or Balance Evaluation Systems Test.<sup>39</sup> Another possible explanation could be the minor focus on balance issues during PR; Marques et al highlighted the value of balance training during PR.<sup>40</sup>

The distribution-based and anchor-based MID estimates for 4MGS (0.05-0.13 m/s) are comparable with the MID estimate of Kon et al (0.11 m/s).<sup>12</sup> The mean 5STS MID estimates (2.19-6.33s) are larger than the MID estimate by Jones et al (1.7s) in patients with COPD after an 8-week outpatient PR program in the United Kingdom.<sup>13</sup> The current SPPB summary score MID estimates (0.83-0.96 points) are comparable with the study of Perera et al, who reported a small meaningful change of 0.5 points and a substantial change of 1.0 point for SPPB summary scores in older adults.<sup>41</sup> Because the SPPB summary score is reported in whole numbers, it seems reasonable to conclude that an improvement of 1 point on the SPPB summary score can be taken as the MID in patients with COPD after PR. This MID can be interpreted and applied at individual and group levels to determine whether patients improve after PR.

## 2<sup>nd</sup> paragraph of study limitations

### Original

Inpatient and outpatient PR programs were combined in the analyses performed in this study. Although the  $\Delta$  SPPB summary score was comparable between groups, differences were found in other attributes, which partly may be explained by differences at baseline. Indeed, patients with the most severe limitations participated in the inpatient program. Furthermore, due to the retrospective design, it was not possible to regain details of the actual content of the program.

### Removed

*\*This paragraph will be removed from the manuscript as there is no difference anymore between the change in 4MGS between patients following the inpatient and outpatient PR program.*

## Conclusions

### Original

The SPPB subtest 5STS and summary score are both responsive to PR in patients with COPD after PR. The balance tandem test and 4MGS are only responsive to PR in patients with COPD with a low performance at baseline. Based on distribution-based calculations, an MID estimate of 1 point for the SPPB summary score is recommended in patients with COPD. Future research is needed to confirm MID estimates for the SPPB in different centers using anchor-based methods as well.

### Corrected

The SPPB subtests 4MGS and 5STS, and summary score are responsive to PR in patients with COPD. The balance tandem test is only responsive to PR in patients with COPD with a low performance at baseline. Based on distribution-based calculations, a MID estimate of 1 point for the SPPB summary score is recommended in patients with COPD. Future research is needed to confirm MID estimates for the SPPB in different centers using anchor-based methods as well.

### Figures and tables

Figure 1 and Tables 2, E7 and E8 were incorrect, and have been corrected appropriately.