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Original article

French version of the Mini BESTest: A translation and transcultural adaptation study incorporating a reliability analysis for individuals with sensorimotor impairments undergoing functional rehabilitation

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ABSTRACT

The Mini BESTest has been developed to comprehensively examine postural control in individuals with various pathologies treated by rehabilitation professionals. However, no formal French version of the Mini BESTest is available. This study aimed to translate and transculturally adapt the Mini BESTest to French and verify its intra- and inter-rater reliability. Translation and transcultural adaptation was performed in accordance with established guidelines, which included 2 initial translations and transcultural adaptations of the Mini BESTest to French that were then merged, a backward English translation, a subsequent adapted French version resolving discrepancies between the English versions, and pilot testing the final version by French-speaking physical therapists. In total, 20 participants with sensorimotor impairments with various etiologies and able to stand for at least 30 sec without human or technical assistance were video-recorded during evaluation with the Mini BESTest. From this video-recording, we calculated inter-rater and intrarater reliability (intraclass correlation coefficient = 0.974–0.988), internal consistency (Cronbach alpha = 0.895–0.929), standard error of measurement (1.05 and 1.63), and minimal detectable change at the 95% confidence interval (2.91 and 4.51). All values were comparable to those previously reported for the original version of the Mini BESTest. Furthermore, no significant ceiling or floor effect was detected. Therefore, the translated and transculturally adapted version of the Mini BESTest in French compares well to the original version and can be used by French-speaking rehabilitation professionals to examine postural control.

1. Introduction

For individuals undergoing functional rehabilitation, rehabilitation professionals frequently assess postural control, in part because postural control is a key determinant and predictor of walking capacity and risk of falls. First, the assessment of postural control aims to confirm a problem and identify potential underlying mechanisms related to postural control, a complex body function. In fact, based on the previous work by Horak et al. [1], Sibley et al. [2] identified 9 specific components of postural control that should be evaluated with a comprehensive assessment: static and dynamic stability, underlying motor systems, functional stability limits, verticality, reactive and anticipatory postural control, sensory integration, and cognitive influences. Then, the assessment of postural control guides the selection of interventions that will specifically address the identified problems. The assessment is also used to track changes over time that may result from rehabilitation interventions [1]. Therefore, clinicians need to have access to the best clinical measurement instrument that will meet these requirements.

Many measurement instruments are available for rehabilitation professionals to assess postural control. Sibley et al. [2] identified 66 standardized postural control assessments commonly used in clinical practice. Among those, the Balance Evaluation Systems Test (BESTest) is the only one to address all 9 components of

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postural control [1]. Because it comprises a total of 27 items, the assessment may take up to 45 min to complete, which is a key barrier to its implementation in clinical practice [1,3]. For this reason, a shortened version, the Mini BESTest (MBT), has been developed with Rasch and factorial analyses [3]. It encompasses a total of 14 different tasks from the BESTest, each rated on a 3-level ordinal scale ranging from 0 (severe postural control impairment) to 2 (no postural control impairment), with a maximal score of 28. This shortened version still addresses 8 of the 9 components and can be performed in 15 min [3–5]. After having been tested in various populations, the MBT demonstrated robust psychometric properties. Its content validity is supported by many of the 14 tasks being taken from well-established standardized postural control assessments [1]. The internal consistency of the test ranges from good to high (Cronbach alpha = 0.7–0.96) [6–10] and the reliability (inter-rater and test–retest) ranges from good to excellent (intraclass correlation coefficient [ICC] > 0.80) for many populations seen in rehabilitation such as people with Parkinson disease [5], chronic stroke [11], cervical spondylotic myelopathy [12], multiple sclerosis [13], and inpatients with various pathologies after a fall [6]. Many studies support the ability of the MBT to predict the risk of falling for a broad range of populations [5,11,14]. As compared with other measurement instruments of postural control, the MBT is among the most responsive [15–17]. Finally, no ceiling effect has been reported for the MBT, unlike, for example, the well-known Berg Balance Scale [18], so the MBT is suitable for evaluating higher-functioning individuals [19]. For these reasons, the MBT has gained acceptance and is being used by both clinical and research communities.

For any measurement instrument to be used in different countries, it must undergo translation and transcultural adaptation in various languages by using a rigorous process. This process should ensure that face and content validity are maintained, so that both the original version and the new version are comparable [20]. Many benefits may result from this process. First, the transculturally adapted evaluation becomes available to clinical and research staff who may not be familiar with the language of the original version. Second, groups and cultures can be compared with this evaluation. Finally, subsequent studies using the transculturally adapted version may contribute to a better understanding of the original version.

Although the MBT has been translated into various languages [21,22], to our knowledge, this instrument has not been formally translated into French, which limits its implementation in French-speaking clinical and research environments. Therefore, the aim of this study was a translation and transcultural adaptation of the MBT to Standard French. The internal consistency and reliability (intra- and inter-rater) of this new version were measured. The hypothesis was that the translated version of the MBT would present a level of reliability similar to the original version.

2. Methods

2.1. Research design

This is a methodological development study combined with a quantitative cross-sectional study.

2.2. Translation and transcultural adaptation

The translation and cross-cultural adaptation followed the method suggested by Beaton et al. [20] and Wild et al. [23] and was divided into 7 distinct stages. In stage 1, the MBT was translated from English to French by 2 native independent bilingual translators. In stage 2, a panel of experts, composed of 1 translator and the 3 authors (JFL, AR, and DHG), discussed the differences between each version, reached consensus on the most appropriate wording to use, and produced a synthesis of the translations based on this consensus. In stage 3, a professional medical translator who was naive to the original version performed a backward translation of this latter version to English. In stage 4, this new English version was compared to the original version by the same panel of experts who completed stage 2. From that comparison, adjustments were made to the French version to better reflect the semantics of the original version. In stage 5, this last version was pilot-tested by 5 physical therapists (range of clinical experience: 6–35 years) with various populations (Table 1). Four of these 5 physical therapists evaluated at least 1 of their patients with the most recent French version of the MBT and all answered a questionnaire on the clarity of the version and how well they felt the French version translated and adapted the original version. In stage 6, after reviewing all comments received, the panel of experts (JFL, AR, and DHG) reached consensus on the final French version of the MBT. Finally, in stage 7, the psychometric properties of the French version were tested following the procedures described below.

Table 1
Characteristics of the physical therapists who pilot-tested the Mini BESTest.

Characteristics	Physiotherapist				
	1	2	3	4	5
Sex	M	F	F	M	F
Expertise	Stroke	TBI	TBI	SCI	Stroke
Clinical experience (years)	6	11	11	35	15
Patients evaluated (n)	2	1	0	1	2

M: male; F: female; TBI: traumatic brain injury; SCI: spinal cord injury.

2.3. Psychometric properties of the MBT

To test the intra- and inter-rater reliability (stage 7), 20 participants with various types of sensorimotor impairments were recruited from the in- and out-patient population attending the Institut universitaire sur la réadaptation en déficience physique de Montréal (Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal). Inclusion criteria were:

- age 18 to 75 years presenting any type of sensorimotor impairments affecting postural control capacity;
- ability to stand for 30 sec without human assistance or assistive device;
- ability to follow simple instructions in French.

Potential participants presenting medical conditions that could interfere with the evaluation process or that could affect the results of the evaluation for reasons other than impaired balance were excluded from the study. Ethical approval was obtained from the research ethics committee of the Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR # 1123–0116). After reading and understanding the information about the research objectives and procedures, participants gave their informed consent before joining the study. Demographic data on age, sex, height, weight, time since injury, and diagnosis were gathered from participants' charts (Table 2).

Two physical therapists, with more than 15 years of clinical experience, participated in the reliability study. Before collecting data, both therapists carefully reviewed the French version of the MBT and agreed on how to rate performance using this version. Then, 1 of the physical therapists (E1) evaluated each participant by using the French version of the MBT. The evaluation was video-recorded by using 2 digital video-cameras (e.g., camcorder) placed

Table 2
Characteristics of participants who pilot-tested the Mini BESTest.

Age (years)	56.4 (17.14)
Height (cm)	168.0 (8.61)
Weight (kg)	74.6 (13.2)
Sex, male/female (*n*)	12/8
Time since injury (days)	760.6 (1832)
Diagnosis (*n*)	
Spinal cord injury	14
Paraplegia	8
Tetraplegia	6
Stroke	3
Orthopedic issue	1
Traumatic brain injury	1
Spinal cord injury + cerebral palsy	1

Data are mean (SD) unless indicated.

in the frontal and sagittal planes of the participants. Then to assess inter-rater reliability, the second physical therapist (E2) rated the video-recording of each participant's performance. To assess intrarater reliability, E1 re-evaluated the video-recording of each participant's performance about 3 weeks after the initial evaluation to reduce the impact of potential memory bias.

2.4. Data analysis

Descriptive statistics summarize the demographic information and clinical characteristics of participants. Intra- and inter-rater reliability was assessed by the ICC (2,1). According to Portney and Watkins [24], an ICC > 0.75 is considered appropriate and > 0.9 excellent. To further explore reliability (e.g., parallel reliability) and absolute agreement, Bland and Altman plots were produced for each pair of evaluations (i.e., first evaluation of E1 with second evaluation of E1, first evaluation of E1 with E2, second evaluation of E1 with E2) [25]. The standard error of measurement (SEM), used to measure absolute reliability, was derived as follows:

$$SEM\ \ agreement = \sqrt{\left(\delta^2 pt + \delta^2 residual\right)}$$

where $\delta^2 pt$ is the variance of the evaluator and $\delta^2 residual$ the residual variance resulting from the interaction between the evaluators and participants [26]. The minimal detectable change at the 95% confidence interval (MDC_{95}) was calculated by using the SEM as follows:

$$MDC_{95} = 1.96 \times SEM \times \sqrt{2}$$

The internal consistency of each evaluation was estimated by the Cronbach alpha, with 0.70 to 0.90 indicating acceptable reliability [27]. Floor and ceiling effects were calculated and were presented as the percentage of participants included below the lowest (floor) or above the highest (ceiling) MBT score. If 15% or more of the participants were included within the lowest or highest scores, floor and ceiling effects were considered [28]. Skewness was computed to assess data distribution and a potential ceiling effect. The skewness was interpreted as follows: highly skewed: > 1 or < -1; moderately skewed: -1 to -0.5 or 0.5 to 1; or approximately symmetric: -0.5 to 0.5 [29]. $P < 0.05$ was considered statistically significant. All statistical analysis involved use of R v3.3.3.

3. Results

3.1. Transcultural adaptation and translation phase

Table 3 presents, as an example, task #9 of the original version of the MBT along with the 2 French translations, the unified French translation, the backward translation in English, and the final French version of the MBT. All versions produced across the various phases involved using Standard French to facilitate international diffusion and improve understanding. Most discrepancies between the 2 French versions produced during stage 1 resulted from the use of synonyms or phrases with a similar meaning and therefore did not differ semantically. After verifying with the original author (F. Horak), the instruction "a second realignment step is allowed" included in item 4 was repeated in item 5 (compensatory stepping correction-backward). Translating the titles of items 4 to 6 (compensatory stepping correction) to French was conceptually challenging. The committee of investigators resolved this issue by reviewing publications on postural control in French as well as the translations produced during stage 1. All units used in the test were converted to the international metric system (feet to meters, inches to centimeters).

3.2. Psychometric testing phase

Among the participants evaluated, only 1 achieved a maximal score of 28/28 and none had a score of 0/28. Skewness across all 3 evaluations was between -0.595 and -0.493. The frequency distribution of the total score attributed by each evaluator is presented in Fig. 1. Intra-rater reliability (ICC = 0.988, 95% CI = 0.971–0.995) and inter-rater reliability (ICC = 0.974, 95% CI = 0.934–0.99) were excellent and were linked to low absolute differences between all assessments (mean difference: first evaluation of E1 with second evaluation of E1 = -0.4; first

Table 3
Example of one task (#9) from the original version of the Mini BESTest along with its French translations, unified version, inverted translation, and final version of the instructions.

Original version	French translation # 1	French translation # 2	Unified French version	Inverted translation	Final version
Stance (feet together) eyes opens firm surface: Instruction : "Place your hands on your hips. Place your feet together until almost touching. Look straight ahead. Be as stable and still as possible, until I say stop"	Debout (pieds ensembles) yeux ouverts surface ferme : Instructions : "Placez vos mains sur les hanches. Placez vos pieds ensembles jusqu'à ce qu'ils soient presque en contact. Regardez droit devant. Demeurez aussi stable que possible, jusqu'à ce que je dise d'arrêter"	Stabilité (pieds joints), yeux ouverts surface ferme : Directive : "Placez-vous les mains sur les hanches. Rapprochez les pieds autant que possible sans qu'ils se touchent. Regardez droit devant vous. Restez aussi stable que possible sans bouger, jusqu'à ce que je vous dise d'arrêter"	Debout (pieds joints) yeux ouverts surface ferme : Directives : "Placez les mains sur les hanches. Placez vos pieds ensembles jusqu'à ce qu'ils soient presque en contact. Regardez droit devant. Demeurez aussi stable et immobile que possible, jusqu'à ce que je dise d'arrêter"	Standing (feet together) eyes open steady surface : Instructions : "Place your hands on your hips. Put your feet together until they are nearly touching. Look straight in front of you. Remain as steady and still as possible until I say to stop"	Debout (pieds joints) yeux ouverts surface ferme : Directives : "Placez les mains sur les hanches. Placez vos pieds ensembles jusqu'à ce qu'ils soient presque en contact. Regardez droit devant. Demeurez aussi stable et immobile que possible, jusqu'à ce que je vous dise d'arrêter"

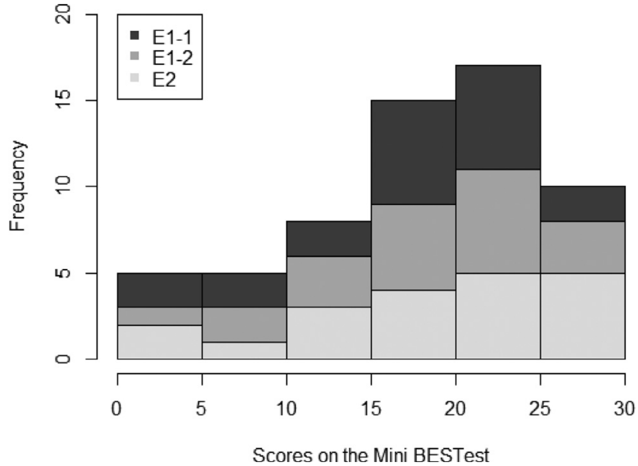

Fig. 1. Stacked bar charts of the frequency distribution of total scores on the French version of the Mini BESTest by each evaluator. E1-1: first evaluation of evaluator #1, E1-2: second evaluation of evaluator #1, E2: evaluator #2. Total scores tended to have a similar distribution across evaluators, with most performances scored between 15 and 25/28.

evaluation of E1 with E2 = −0.4; second evaluation of E1 with E2 = 0) (Fig. 2). The associated SEMs were 1.05 and 1.63 and resulted in an MDC_{95} of 2.91 and 4.51 linked to the intra- and inter-rater reliability, respectively. Furthermore, the internal consistency for all 3 evaluations (E1 twice and E2 once) was also excellent (Cronbach alpha = 0.895–0.929).

4. Discussion

This study used a standardized method to translate and transculturally adapt the MBT to French and one that is equivalent to the method used by Schuster et al. [30] for objectively assessed outcome measures. When used during intensive inpatient rehabilitation for individuals with physical disabilities, the French version displayed excellent intra- and inter-rater reliability and internal consistency, with no floor or ceiling effect. In addition, we report the SEM and MDC_{95} for the MBT, which can assist rehabilitation professionals and researchers in interpreting their results.

4.1. Transcultural adaptation and translation phase

The seven-stage process proposed by Beaton et al. [20] was originally developed for the transcultural adaptation and translation of self-reported measures. One key difference between self-reported and observational clinical assessments is that instructions for self-reported measures are directed toward the person being evaluated, whereas for clinical measurement instruments such as the MBT, instructions are directed mainly toward the rehabilitation professional who performs the evaluation. The fact that rehabilitation professionals typically use standardized language to describe performance facilitated that part of the translation process. This situation may explain in part the very few adjustments made on the basis of the feedback received from the participating physical therapists during stage 5. In fact, the therapists felt that the French version was clear and comparable to the original version.

4.2. Psychometric testing phase

The results confirm that the MBT has an excellent intra- and inter-rater reliability. In fact, the ICCs generated during our study fall well within the range of what was previously reported in various populations (ICC = 0.91 and 0.98, respectively) [5,11,15]. The evaluations performed by 2 experienced physical therapists may have strengthened these reliability coefficients. Also, performance on the MBT was video-recorded and a video-

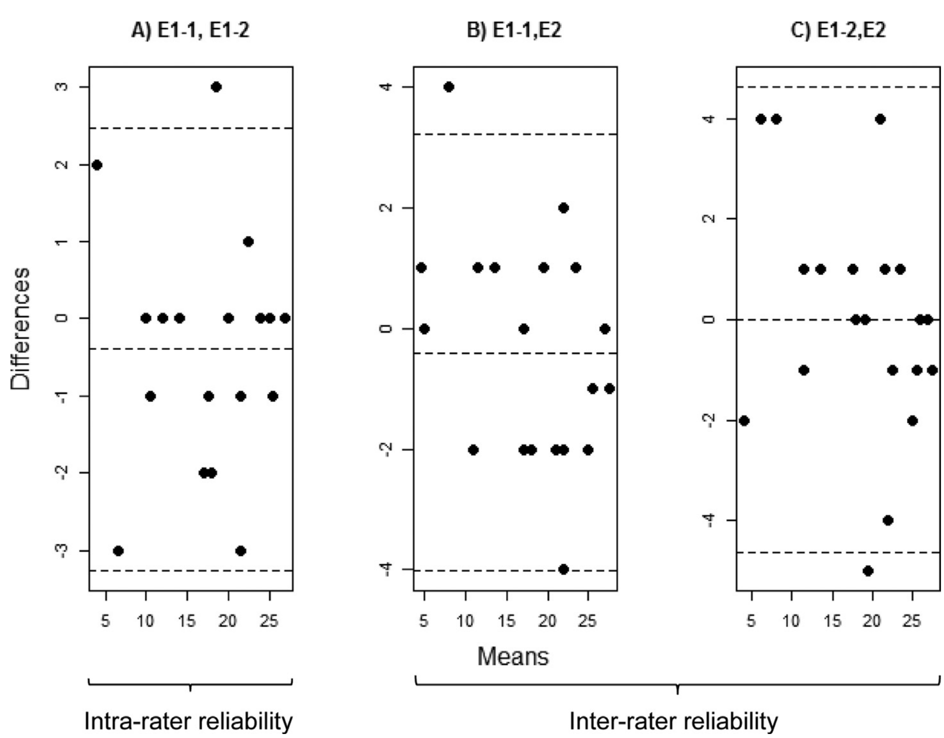

Fig. 2. Bland and Altman plots for intra- and interrater reliability. E1-1: first evaluation of evaluator #1, E1-2: second evaluation of evaluator #1, E2: evaluator #2. All but one difference between the evaluations were within the 95% confidence interval (dashed line), denoting adequate agreement between the evaluations. Also, the level of agreement remained stable as a function of mean scores (homoscedasticity of the differences): differences in scoring between the raters were similar for higher- and lower-functioning individuals.

based rating procedure was implemented. Therefore, many sources of variability, along with their potential interactions, were absent in the present study (e.g., variability induced by repeating a protocol, inherent biological variability), which may have helped increase our reliability coefficients to some extent.

Likewise, the internal consistency was considered acceptable, with values ranging from 0.895 to 0.929 across raters. Again, these values compare well to those previously reported in various populations, ranging from 0.89 to 0.94 [11,15]. Depending on whether only 1 or 2 different physical therapists completed the 2 assessments, our SEMs (e.g., 1.05 and 1.63) were similar to or slightly lower than those previously reported (e.g., 1.29 to 1.99 [5,15]), which may again be explained by differences in protocols as discussed above. Our MDC_{95} values (e.g., 2.91 and 4.51) fall on both sides of the value of 3 reported by Tsang et al. [11] and confirm that a change between 3 and 5 points on this scale is needed to be interpreted as a real change. The homoscedasticity of differences between scoring, seen on the Bland and Altman plots (Fig. 2), confirms the absence of systematic errors and supports the use of an absolute versus relative MDC_{95}. Despite the limitations of our protocol, these outcomes confirm the high reliability and precision of the French version of the MBT for evaluating individuals with sensorimotor impairments and functional disabilities undergoing rehabilitation and support its use among French-speaking rehabilitation professionals and researchers.

4.3. Ceiling effect

We found no ceiling effect because only one person scored the maximal score on the MBT (e.g., 28/28), which is equivalent to a proportion of 5% of the total sample and far below the threshold established, 15% [31]. In a recent review of the psychometric properties of the MBT, Di Carlo et al. reported that the maximal proportion of participants who reached the maximal score was 4.3% [32], a value similar to what we found. Hence, our results support previous research showing no ceiling effect with the MBT. This finding is further supported by the scores being considered close to a symmetric distribution, with skewness values reaching −0.595 and −0.493 when only 1 or 2 different physical therapists completed the 2 assessments, respectively. These results are better than those reported previously for community-dwelling individuals with neurological disorders (−0.93 to −0.810) [11,33]. A ceiling effect on a measurement instrument limits its ability to detect change in higher-functioning individuals. However, these results support the use of the MBT in individuals with a wide range of standing and walking capabilities. Hence, these outcomes confirm that no ceiling effect is anticipated when using the French version of the MBT and show that it can be used by French-speaking rehabilitation professionals and researchers.

4.4. Study limitations

Although the number of participants in this study was relatively low and most had a spinal cord injury, our results agree with previously reported findings and support the use of the French version of the MBT with other populations seen by rehabilitation professionals. One of the inclusion criteria (e.g., ability to stand for 30 sec), which aimed to assure that the MBT would be used to assess postural control in clinical practice, led to the recruitment of participants that were all able to at least initiate steps and walk very short distances, with or without assistive devices. This criterion may have prevented us from detecting a potential floor effect. Rehabilitation professionals are advised to remain cautious when intending to use the MBT in clinical practice because previous research has indicated a potential floor effect for the MBT [32]. However, rehabilitation professionals may also be tempted to use the MBT because no ceiling effect is anticipated. In the end, the MBT represents a good complement to other measurement instruments of postural control that may present a ceiling effect and have little or no floor effect such as the Berg Balance Scale [18] and the Postural Assessment Scale for Stroke [31,34]. Future research could compare these clinical measurement instruments (e.g., assessing a similar construct with different performance-based tasks) by using the item-response theory or a Rasch analysis paradigm that would model and classify all tested items e.g., tasks) in these instruments based on their difficulty levels. Such an approach would allow rehabilitation professionals to easily assess individuals with sensorimotor impairments who have a wide range of postural control abilities.

Translation involved using Standard French but reflects the idiom spoken more specifically in Quebec, which may differ somewhat from the French spoken elsewhere in the world. Although not formally part of the translation and transcultural adaptation process recommended by Beaton et al. and Wild et al. [20,23], validity testing of this French version could further support its use among rehabilitation professionals. The video-based reliability study used in this research protocol does not incorporate biological and protocol variability. Such a procedure may underestimate the measurement error proposed (i.e., MDC_{95}). Therefore, these values should be used with caution in clinical practice, in which evaluations are often performed on numerous occasions as compared with our protocol.

5. Conclusion

The instructions and scoring descriptors of the French version of the MBT are equivalent to those for the original English version of the MBT. The French version of the MBT presents similar psychometric properties to those documented for the English original version of the MBT. Hence, rehabilitation professionals and researchers in French-speaking regions are encouraged to use the French version of the MBT to evaluate postural control in individuals with sensorimotor impairments and functional disabilities who can stand for at least 30 sec without human or technical assistance and are undergoing rehabilitation or engaging in research protocols.

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Disclosure of interest

The authors declare that they have no competing interest.

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