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SHORT COMMUNICATION

BOX AND BLOCK TEST IN BENINESE ADULTS

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Objective: **To determine the Box and Block Test norm in a sub-Saharan population and to compare these data with published norms for North American adults.**
Methods: **A total of 692 healthy Beninese people, age range 20–85 years, were recruited. These subjects were asked to perform the Box and Block Test with both hands.**
Results: **Box and Block Test scores (mean and standard deviation (SD)) for women and men were, respectively, 81.3 (15.4) and 79 (16.6) for the dominant hand and 73.2 (13.7) and 72 (14.8) for the non-dominant hand. Mean Box and Block Test scores ranged from 89.1 (12.7) for people under the age of 25 years to 55.23 (10.5) for people over the age of 74 years.**
Discussion: **Manual dexterity was better for women than men, for dominant hand than non-dominant hand, and for younger subjects. In comparison with published results for US subjects, Beninese subjects had better dexterity below the age of 50 years in both sexes for the right hand and worse dexterity over 64 years of age in both sexes for the right hand.**
Conclusion: **Developing and validating outcome scales in Africa will help to improve functional assessment of African populations in clinical practice and research.**

Key words: manual dexterity; impairment; evaluation; hand.

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INTRODUCTION

Dexterity is defined as ‘’voluntary movements used to manipulate objects during a specific task’’ (1). Manual dexterity can be described in terms of: gross manual dexterity (“the ability to handle objects with the hand”) and finger dexterity (“the ability to manipulate objects, in which the fingers are primarily involved”) (1). Manual dexterity is influenced mainly by age, sex, motor coordination (2), sensibility (2, 3) and anthropometric variations (i.e. measurement of the human individual) (2). It can improve with repetitive training (2, 4). Impairments in dexterity impact the ability to live independently, as shown by the close link between impaired manual dexterity and the reduced ability to perform activities of daily living (5).

Many dexterity tests have been described in the literature (6). Selection of an appropriate assessment tool must be based on several factors, such as its psychometric properties, the time taken to administer it and interpret the measurements, cost, the need for specific equipment and training, and portability (7).

The Box and Block Test (BBT) is a simple, low-cost, efficient test of gross manual dexterity (8). The BBT has very high validity. Its results correlate well with the Minnesota Rate of Manipulation ($r = 0.91$) and the General Aptitude Test Battery ($r = 0.86$) (9). It also shows high inter-rater reliability ($r > 0.9$) for the left and right hands and high test-retest reliability ($r > 0.9$) for the left and right hands (8). The main adult norms for the BBT were obtained in a Western population (USA) of 628 subjects, aged 20–94 years, in a study by Mathiowetz et al. (8). Men and women were divided into 12 age groups at 5-year intervals, with the exception of subjects 75 years old and older, who were placed in the same group (8).

The BBT can easily be replicated in Africa, since it is simple to manufacture and use, and is inexpensive.

Manual dexterity is affected by anthropometric variations, which are also affected by geographical location; we therefore assumed that the available BBT norms might be inappropriate for Beninese adults.

The objectives of this study were to replicate the study of Mathiowetz et al. (8) in Beninese adults, using the BBT to evaluate gross manual dexterity, in order to establish specific norms for Beninese adults and to compare these with published norms for US adults.

METHODS

A total of 692 healthy Beninese people were recruited in churches, universities and shopping centres in Cotonou.

Inclusion criteria were: age 20 years or over, living at home, and maintaining their usual lifestyle. Exclusion criteria were: subjects

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presenting with pain, mobility limitations, sensory impairment, or muscle paresis in the upper limbs at the clinical examination (Manual Muscle Testing and sensibility examination of both hands), or a history of upper limb surgery.

A question was asked about hand dominance, but if subjects were ambidextrous, dominance was determined using the Manual Preference Questionnaire adapted by Stanley Coren (10).

Subjects were asked to perform the BBT following the procedure described by Mathiowetz et al. (8). The subject sat in a chair facing a table with the BBT on the table in front of them. The blocks were in the compartment facing the dominant hand. The examiner explained the test and instructed the subject as follows: "I want you to move the blocks one by one from one compartment to the other for a minute". The examiner showed the subject how to perform the test, moving 3 blocks one at a time, and allowed the subject to practice for 15 s before starting the test with the dominant hand. If the subject took 2 blocks at the same time, it was counted as only one block. If a block fell after the hand had crossed the wall, the block was counted. The score was the number of blocks moved from one compartment to the other in 1 min.

Subjects were divided into 12 age groups with 5-year intervals, except for the group 75 years and over, which included subjects aged 75–85 years. The mean and standard deviation (SD) sample size was 28.8 (4.2) for each group. Descriptive data for the subjects are shown in Table I. Mean BBT scores were calculated for each age group for the dominant or non-dominant hands. Three-way analysis of variance (ANOVA) ($12 \times 2 \times 2$) was used to compare the scores of subjects according to age group, sex and handedness. Holm-Sidak method was used for multiple comparison procedure (MCP).

The results were compared with published US adult norms (8), because they are the most referenced in the literature. US adult norms for BBT were presented for the right and left hand. To perform this comparison, the present data were adapted to obtain the right and left mean scores for Beninese data, as with the US data. Student's *t*-test (for parametric data) or Wilcoxon's test (for non-parametric data) was applied to compare the mean BBT score within each age group for each side and sex. When the difference was significant, effect size (d) was calculated.

The level of statistical significance was $p \leq 0.05$. Microsoft Excel, version 2010 and SigmaStat software, version 3.5, were used to analyse the data.

The study was approved by the local ethics committee of Cotonou city. All subjects provided written informed consent before participation.

RESULTS

Mean BBT scores for both hands for men and women in each age group are shown in Table II. There were significant effects for sex (df = 1, F = 10.96, $p < 0.001$), age (df = 11, F = 105.54, $p < 0.001$) and handedness, (df = 1, F = 148.42, $p < 0.001$).

Table II. *Box and Block Test scores for men and women in each age group*

	BBT score: men		BBT score: women	
Age range	Dominant Mean (SD)	Non-dominant Mean (SD)	Dominant Mean (SD)	Non-dominant Mean (SD)
20–24 years	95 (11.5)	84.2 (9.9)	94.5 (11.6)	82.6 (12.5)
25–29 years	89.1 (13.3)	80.6 (11.4)	93 (12.2)	82.5 (11)
30–34 years	90.1 (11.4)	82.2 (10.2)	87.3 (10.7)	79.6 (11)
35–39 years	90.4 (9.6)	82.7 (9)	86 (9.2)	78.7 (7.2)
40–44 years	83.6 (9.6)	74.8 (10.1)	84.8 (16)	75.8 (9.8)
45–49 years	78 (13.1)	72.5 (13.3)	85.4 (11.4)	79.4 (9.1)
50–54 years	73.7 (10.5)	68.4 (12)	83.2 (11.8)	72.4 (11)
55–59 years	77.9 (13.7)	71 (12.3)	80.2 (11.6)	73.5 (10.9)
60–64 years	71 (11.6)	65 (11.5)	77.2 (10.1)	69.8 (10.2)
65–69 years	67.1 (11.5)	60.7 (12.3)	65.5 (8.6)	60.9 (8.6)
70–74 years	59.9 (12.3)	57.3 (11.3)	67.8 (11.6)	61.7 (11.7)
≥75 years	57.8 (11.6)	52 (8.7)	58.6 (10)	52.5 (10.3)
All subjects	79 (16.6)	72 (14.8)	81.3 (15.4)	73.2 (13.7)

SD: standard deviation; BBT: Box and Block Test.

Male manual dexterity scores were significantly lower than female scores (Fig. 1) for both hands (dominant hand: $t = 9.21$, $p < 0.001$, $d = 0.14$; non-dominant hand: $t = 8.01$, $p < 0.001$, $d = 0.08$).

Within the female population, the overall mean (SD) score was significantly higher for the dominant hand (81.3 (15.4)) than for the non-dominant hand (73.2 (13.7)) ($t = 2.91$, $p = 0.004$, $d = 0.45$). Similarly, within the male population, the overall mean (SD) score tended to be higher for the dominant hand (79 (16.6)) than for the non-dominant hand (72 (14.8)), but the difference was not statistically significant ($t = 1.76$, $p = 0.07$).

Except for a few age groups in both sexes, manual dexterity decreased progressively as a function of age (Table III). In all age groups these differences were not significant.

US data were then compared with the data from the current study. Below the age of 50 years, the right hand mean scores were lower in US subjects than in Beninese subjects in both

Table I. *Subjects' characteristics: number of subjects, age, sex, and hand dominance by age group*

	Male subjects				Female subjects			
			Handedness, *n*				Handedness, *n*	
Age group	*n*	Mean age, years	Right	Left	*n*	Mean age, years	Right	Left
20–24 years	35	22.0	35	0	37	22.2	35	2
25–29 years	36	27.0	36	0	35	27.1	34	1
30–34 years	37	32.2	37	0	25	31.6	25	0
35–39 years	26	37.2	26	0	27	37.2	26	1
40–44 years	28	42.0	28	0	27	41.2	27	0
45–49 years	26	46.2	26	0	33	46.5	33	0
50–54 years	26	51.8	26	0	32	51.0	32	0
55–59 years	26	57.3	26	0	25	56.7	25	0
60–64 years	26	61.7	26	0	30	60.9	30	0
65–69 years	26	66.8	26	0	26	66.5	26	0
70–74 years	26	71.2	25	1	26	71.6	25	1
≥75 years	26	76.8	25	0	25	77.5	25	0
All subjects	344	47.4	343	1	348	47.8	343	5

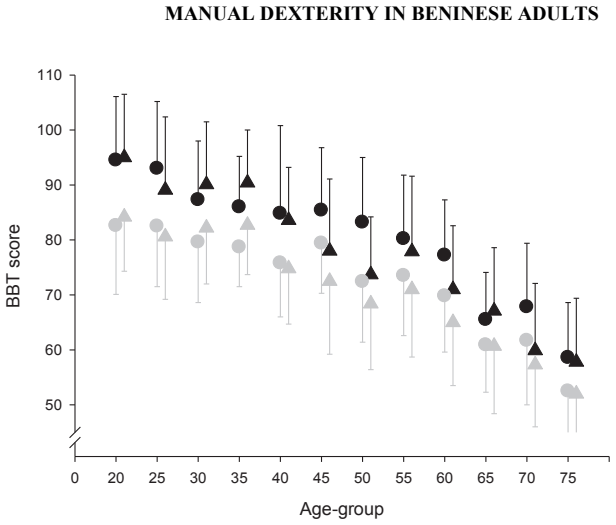

Fig. 1. Comparison of Box and Block Test (BBT) mean score for Beninese men (triangles) and women (circles) for dominant (black symbols) and nondominant (gray symbols) hands and standard deviation (vertical line).

sexes. These differences were significant for the following age groups with moderate (i.e. $0.5 \leq d \leq 0.8$) to large (i.e. $d > 0.8$) effect sizes: 20–24 years ($t = -2.61$, $p = 0.01$, $d = 0.7$), 30–34 years ($t = -3.09$, $p = 0.003$, $d = 0.8$) and 35–39 years ($t = -3,17$, $p = 0.002$, $d = 0.9$) for men; 20–24 years ($t = -2.39$, $p = 0.02$, $d = 0.6$) and 25–29 years ($t = -2.53$, $p = 0.01$, $d = 0.7$) for women. In contrast, over the age of 64 years, in both sexes, the right hand mean scores were lower in Beninese subjects than in US subjects. These differences were significant for the following age groups: 70–74 years ($t = 2$, $p = 0.05$, $d = 0.6$) for men; 65–69 years ($t = 3.2$, $p = 0.002$, $d = 0.9$) and 75 years and older ($t = 2$, 64, $p = 0.01$, $d = 0.7$) for women (Table IV).

DISCUSSION

To our knowledge, there are no African dexterity norms available in the literature. The main aims of this study were to evaluate Beninese adult gross manual dexterity with the BBT and to establish norms.

Table III. *Box and Block Test score comparison for women and men by age group*

	Female		Male	
Age group comparison	*t*	*p*	*t*	*p*
20–24 vs 25–29 years	0.83	0.4	1.85	0.06
25–29 vs 30–34 years	5.1	0.000	3.50	0.000
30–34 vs 35–39 years	0.35	0.72	3.81	0.000
35–39 vs 40–44 years	4.83	0.000	1.41	0.15
40–44 vs 45–49 years	4.12	0.000	4.29	0.000
45–49 vs 50–54 years	16.13	0.000	14.89	0.000
50–54 vs 55–59 years	2.70	0.007	2.50	0.01
55–59 vs 60–64 years	0.02	0.98	1.46	0.14
60–64 vs 65–69 years	2.63	0.009	1.20	0.22
65–69 vs 70–74 years	6.19	0.000	2.14	0.03
70–74 vs ≥75 years	3.4	0.001	4.15	0.000

Table IV. *Comparison of Beninese and US data for Box and Block Test (BBT) score for right hand*

	BBT score for Beninese males, right hand		BBT score for US males, right hand			Effect
Age group	Mean (SD)	*n*	Mean (SD)	*n*	*p*-value[a]	size
20–24 years	95 (11.5)	35	88.2 (8.8)	29	0.01	0.7
25–29 years	89.1 (13.2)	36	85 (7.5)	27	0.2	
30–34 years	90.1 (11.4)	37	81.9 (9)	27	0.003	0.8
35–39 years	90.4 (9.5)	26	81.9 (9.5)	25	0.002	0.9
40–44 years	83.6 (9.5)	28	83 (8.1)	26	0.8	
45–49 years	78 (13.1)	26	76.9 (9.2)	28	0.7	
50–54 years	73.7 (10.5)	26	79 (9.7)	25	0.06	
55–59 years	77.9 (13.7)	26	75.2 (11.9)	21	0.5	
60–64 years	70.9 (11.6)	26	71.3 (8.8)	24	0.9	
65–69 years	67.1 (11.5)	26	68.4 (7.1)	27	0.6	
70–74 years	59.6 (12.1)	26	66.3 (12)	26	0.03	0.6
≥75 years	57.8 (11.6)	26	63 (7.1)	25	0.06	

[a]Student *t*-test.
SD: standard deviation.

Manual dexterity in the Beninese subjects was found to be better for the dominant hand, for women and for younger subjects. These results confirm the published data regarding dexterity. In their study of US adults, Mathiowetz et al. (8) found that BBT scores decreased with age, female scores were better than male scores (8), and dominant hand scores were better than non-dominant hand scores (8).

The Beninese data were compared with the US adult norms developed by Mathiowetz et al. (8). Right hand manual dexterity for people under 50 years of age was better for Beninese subjects than for US subjects in both sexes (Fig. 2). This observation may be related to Beninese subjects undertaking more manual and more precision vocational activities compared with US subjects, resulting in improved manual dexterity. In contrast, right hand manual dexterity for older (over 64 years of age) was lower for Beninese subjects than for US subjects (Fig. 2). This maintained manual dexterity in US subjects may be related to the preservation of a high level of manual activity after retirement, such as gardening and domestic activities.

Left hand manual dexterity in both sexes was lower for Beninese subjects than for US subjects (Fig. 2). This observation might be related to the low rate of left hand dominance observed in the Beninese population. Indeed, the proportion of left-handed subjects in our sample was 1%, which was lower than that found in Mathiowetz et al.'s study (7%) (8). Hand preference is influenced by socio-cultural factors (11) and the proportions of right- and left-handers vary greatly across different geographical areas (12). Higher rates of left hand dominance (15–20%) are reported in the US population, and the lowest (0.06–2.8%) in the African population (13).

Other normative data were found in the literature. Mendes et al. (14) developed the BBT norm using 446 subjects aged 15–86 years in Brazil. Although they were not the same age intervals, the mean (SD) BBT scores for Brazilian subjects in both hands for men (right hand: 65.9 (11); left hand: 64.1 (10.6)) and for women (right hand: 66.2 (10.5); left hand: 64.7

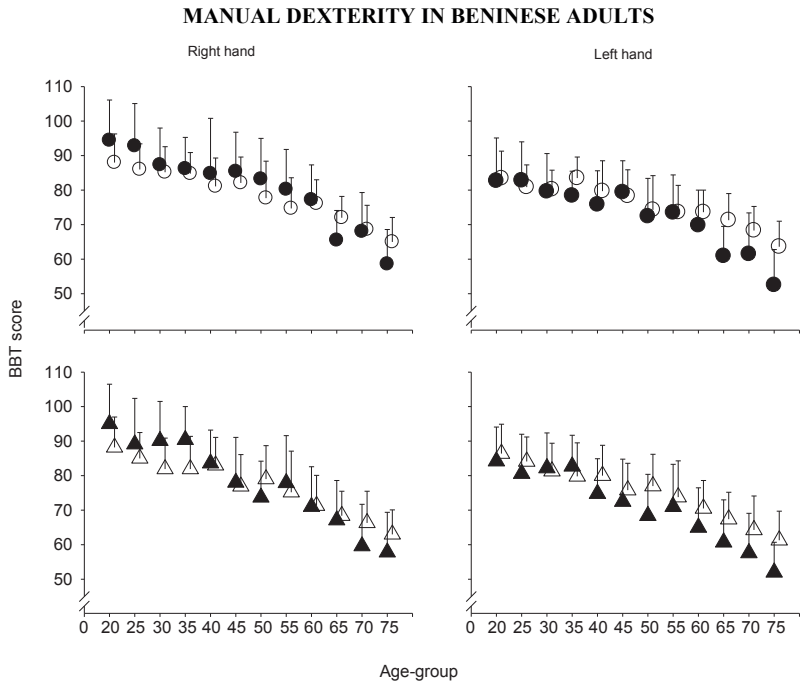

Fig. 2. Comparison of Box and Block Test (BBT) mean score (triangle or circle) and standard deviation (vertical line) between Beninese (black point) and American (white point) for men (triangle point) and women (circle point) subjects.

(9.7)) were lower than the mean (SD) BBT scores for Beninese subjects, respectively for men (right hand: 79 (16.6); left hand: 72 (14.8)) and women (right hand: 81.3 (15.4); left hand: 73.2 (13.7)). Similarly, Desrosiers et al. (15) found other norms in 360 elderly subjects aged 60 years old and over irrespective of sex (mean (SD) BBT score for the right hand: 66.9 (9.2); and for the left hand: 66.3 (9.4)). These norms were better than the Beninese norms. However, Desrosiers et al. (15) and for Mendes et al. (14) found no influence of sex on gross manual dexterity.

In conclusion, the BBT is a simple, inexpensive instrument designed to assess gross manual dexterity. In addition to variations depending on sex, age and hand dominance, this study confirmed that the manual dexterity of Beninese subjects differed somewhat from that of US subjects. These norms could help Beninese rehabilitation professionals to assess patients' manual dexterity levels and to determine the appropriate therapy.

The authors declare no conflicts of interest.

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