ORIGINAL ARTICLE

https://doi.org/10.1590/1806-9282.20210896

Wheelchair basketball improves the treatment of urinary tract infection in people with motor disabilities: a clinical trial

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SUMMARY

OBJECTIVE: Few studies on physical medicine and rehabilitation analyze the benefit of wheelchair basketball in people with motor disabilities. Given these, this study aimed to investigate the effect of the intervention of wheelchair basketball on urinary tract infection in people with motor disabilities.
METHODS: A 12-month experimental *follow-up* was conducted in a single-center study. A total of 48 male individuals aged 18–55 years were allocated to the control group and experimental group. The experimental group practiced wheelchair basketball for 2 h, twice a week. Intra- and intergroup comparisons were made pre- and post-interventions over urinary tract infection.
RESULTS: There was a significant improvement in urinary tract infection and urine culture in pre- and post-intervention antibiograms, respectively. Moreover, the intergroup comparison presented a decrease in infection caused by *Klebsiella pneumoniae*, as well as an increase in the time variability of partially activated thromboplastin, average corpuscular hemoglobin, and hemoglobin and platelets. In the experimental group, there was an increase in hemoglobin and hematocrit and a decrease in glycated hemoglobin (%$HbA1_C$). On the intragroup comparison, there was a reduction of triiodothyronine (T3), %$HbA1_C$, interleukin-6 pre-intervention, and C-reactive protein post-intervention.
CONCLUSIONS: There was a decrease in urinary tract infection and improvement in biochemical, immunological, and microbiological biomarkers evaluated with physical exercise practice by wheelchair basketball, as well as by multiprofessional *follow-up* and health guidance.
KEYWORDS: C-reactive protein. *Klebsiella pneumoniae*. Interleukin-6. *Escherichia coli*. Sports medicine. Quality of life.

INTRODUCTION

There are several types of people in a wheelchair with motor disabilities (PWD-M)[1], featuring the spinal cord injury (SCI) and presenting typical neurological symptoms, such as neurogenic intestine and bladder[2]. PWD-M are constantly affected by urinary tract infection (UTI) due to the incomplete bladder emptying and incorrect usage of relief probes, which are potential triggers for cystitis, urethritis, and pyelonephritis, leading to increased inflammation of biomarkers (i.e., IL-6, C-reactive protein, and leukocytes) and increased complications of kidney dysfunction (urea and creatinine) such as chronic kidney disease[3].

Few studies on physical medicine and rehabilitation have analyzed the benefits of wheelchair basketball (WB) in PWD-M on the prevalence of UTI[4-6]. because it is asymptomatic and has limited complaints in the early stages of the infection[7,8].

Therefore, there is a knowledge gap in the understanding of functional limitations in PWD-M engaged in high-performance

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Conflicts of interest: the authors declare there is no conflicts of interest. Funding: This study was financially supported by the Programa Pesquisa para o SUS: gestão compartilhada em saúde (PPSUS) – Edital nº 003/2017 da Fundação de Amparo à Pesquisa e Inovação do Estado de Mato Grosso (FAPEMAT), em parceria com o Ministério da Saúde (MS), por meio do Departamento de Ciência e Tecnologia da Secretaria de Ciência, Tecnologia e Insumos Estratégicos (Decit/SCTIE/MS), com o Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) e com a Secretaria de Estado da Saúde de Mato Grosso (SES). RGO was recipient of National Post-Doctoral Fellowship (CAPES/PNPD).
Received on February 09, 2022. Accepted on February 09, 2022.

exercise associated with kidney function[7]. In this sense, data regarding the accessibility of complete examinations, as well as health services, and clinical trial research with a long-term *follow-up* of intervention with WB in PWD-M are scarce in the literature[8].

In view of these, this clinical trial aimed to investigate the effect of the 12-month intervention of WB on the inflammatory, immunological, microbiological, and biochemical parameters, as well as the effect on UTI in PWD-M.

METHODS

Study design

This is a 12-month experimental *follow-up* study with intervention of WB training. It is outlined by randomized clinical essay strategy, allocated in two arms, following standardization from Consolidated Standards of Reporting Trials (CONSORT, 2010) (Figure 1).

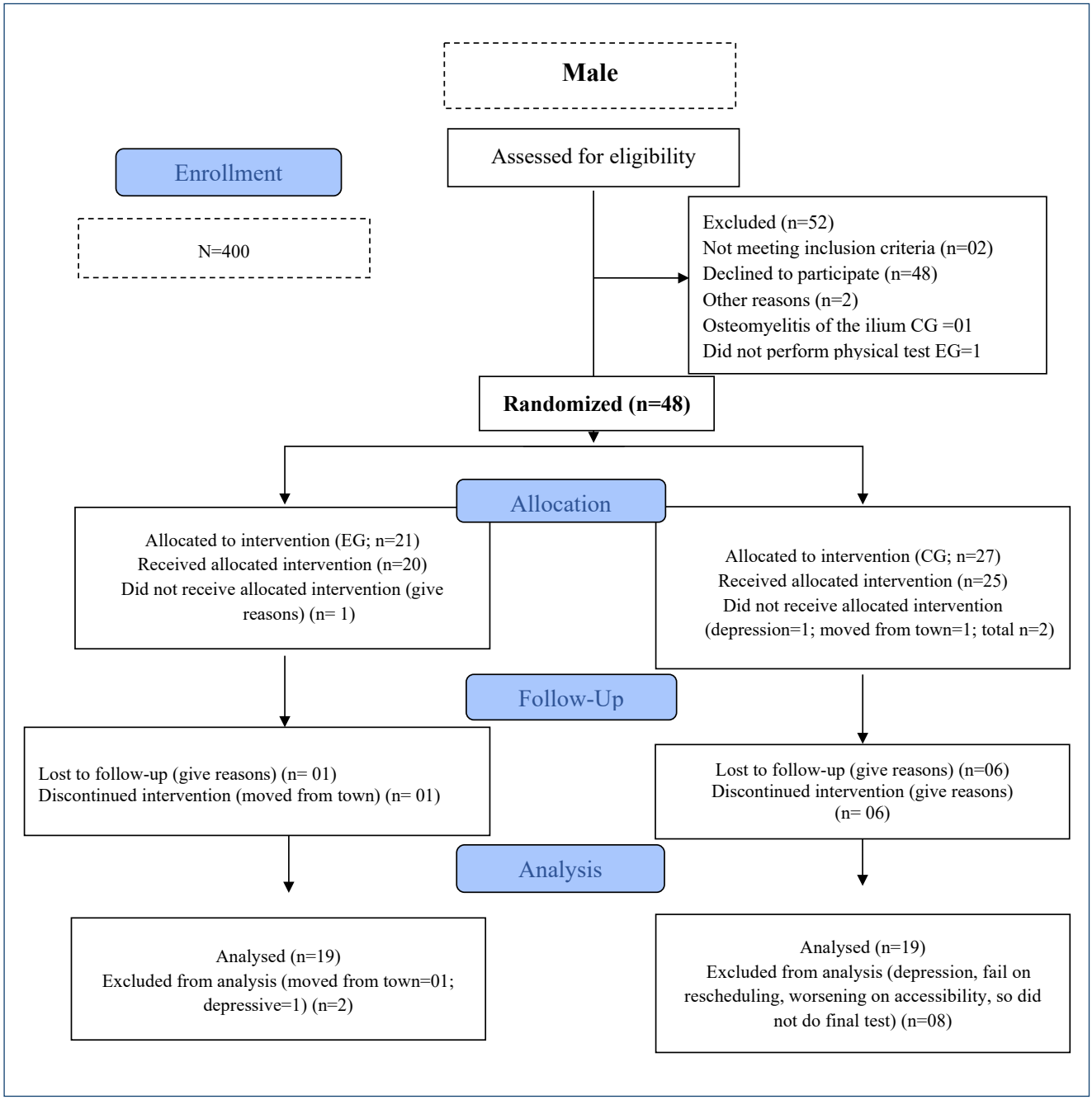

Figure 1. Standardization from Consolidated Standards of Reporting Trials (CONSORT, 2010).

Participants, criteria of selection, exclusion criteria, and randomization

A total of 48 male individuals, aged 18–55 years, were divided into the control group (CG; n=21) and experimental group (EG; n=27).

People with motor disabilities who signed the free informed consent form were presorted and then recruited through subscription supplied by Physically PWD Association and State Health Secretary.

People with motor disabilities who refused to give blood and urine samples examination, those not participated in the WB intervention, absence or affinity with the sport, severe scoliosis, advanced cancer, usage of amphetamines, and those who gave up the research were excluded from the study.

Later, a simple-random raffle of 100 male PWD-M was made, for possible losses and withdrawals. Out of this raffle, 50 participants were selected for EG and CG in accordance with the International Wheelchair Basketball Federation (IWBF).

Clinic trial registration: All participants signed the consent form (TCLE in Portuguese) according to resolutions 466/12 from National Health Council (CNS) approved by the Research Ethics Committee CEP-HUJM: CAAE: 56973516.3.000.5541 and Brazilian Clinical Trials Registry (ReBEC) number: RBR-9w7vxd (https://ensaiosclinicos.gov.br/rg/RBR-9w7vxd) and WHO UTN U1111-1204-1907 (https://apps.who.int/utn/utnvalid.aspx).

Intervention

By following general rules for the sports practice, the EG performed WB training twice a week, with approximately 2 h of training involving physical and tactical conditioning techniques. The study was performed between 2018 and 2019. The WB training was performed in the Gymnasium of Sports and Leisure Adjunct Secretary with support from the Hospital and the University staff.

Assessment

The biochemical tests were performed using an automated biochemical device, VITROS Fusion 5.1 model, *System of Ortho-Clinical Diagnostics* from Johnson & Johnson® (Barcelona, CA, USA). For hematological analysis, a complete hemogram test was performed, using the device from MINDRAY© of Bio-Medical Electronics (Shenzhen, China).

The urinalysis was performed by simple reading of biochemical values in the Uriscan pro BioSys+ Kovalent© (Niterói, RJ, Brazil) device, and then through centrifugation and analysis. In the second sample, the urine was cultured in a CPS culture medium plate, and in the case of positive urine culture samples, the antibiograms were processed in a VITEK Compact 2 device, BIOMERIEU© (Niterói, RJ, Brazil). T3, T4, and TSH levels, serum concentrations of vitamins D and B12, and MDA and IL-6 levels were evaluated.

Efficacy measures

The primary outcome was to estimate the UTI prevalence by sedimentoscopy analyses of abnormal elements (SAE) on moment's pre- and post-intragroup intervention with drugs prescription according to the medical records of urine and blood markers. As a secondary outcome, the objectives were the quantification of biomarkers on moment's pre- (baseline) and post-intragroup and intergroup interventions.

Safety measures

Adverse events to health were monitored during the research by a multiprofessional team. Monitoring of the participant was adopted, with field journal, standardized form for anamnesis, which included sociodemographic data, lifestyle and health background, usage of medication or illicit drugs, anthropometry, functional physical tests, and complementary examinations. During WB training, blood pressure, pulse oximeter, and frequency counters were assessed.

Sample size

The sample calculation used the following formula:

$$n = \frac{z^2 p(1-p)N}{E^2(N-1)+z^2 p(1-p)} = \frac{1{,}96^2 \times 0.5 \times 0.5 \times 320}{0{,}1^2 \times 319 + 1.96^2 \times 0.5 \times 0.5} = 74 \quad \text{n}\approx 74 \text{ PWD} \quad (1)$$

Statistical analysis

Sample distribution analysis was made with the Shapiro-Wilk test, and comparison on moments pre- and post-interventions was carried out with t-test, paired or not paired, with significance level at $p<0.05$ and 95% confidence interval. Analysis was done with the intent of treating (ITT) for UTI with physical exercise (PE) compared to WB effect versus CG without WB effect.

RESULTS

Of the participants included (n=100), allocated, and randomized by stratification and initial sample pairing, EG began and concluded the study, due to one participant not having accomplished the first part of laboratory exams requested. Next, the CG initiated the study but concluded with withdrawal and participants who did not perform laboratory examinations PWD-M were analyzed (Table 1).

Table 1. Descriptive characteristic of sample of males with physical disability allocated to the trial arms in the clinical study performed between 2018 and 2019, Cuiabá, Mato Grosso, Brazil.

Variables	n	%
Age (completed years) M±DP (35±8.8) Minimum and maximum=(20–54)	48	100
Etiology		
TRM-spinal injury	28	58.3
Child Poliomyelitis	11	22.9
Plegia fracture of lower member (MI)	02	4.2
TRM-TCE (cranium encephalic trauma)	02	4.2
Amputee, bifid spine, HTLV, transverse myelitis, Suzuki syndrome	05	10.4
Disability time		
2–5 years	16	33.3
6–10 years	15	31.3
11–15 years	01	2.1
Above 20 years	16	33.3
Neurogenic bladder (self-report)		
Yes	32	66.7
No	16	33.3
Pressure ulcer		
Yes	10	20.8
No	38	79.2
UTI (self-report)		
Yes	04	8.3
No	44	91.7
Usage of vesicle probe		
Yes	25	52.1
No	23	47.9
Usage of diapers		
Yes	13	27.1
No	35	72.9
UTI (EAS) biochemical		
Did not do tests	06	12.5
Yes (reference over 5 leukocytes/field)	19	39.6
No	23	47.9
Social security		
Receives nothing (Zero income per capita)	05	10.4
Active worker	06	12.5
Disease aid BPC	14	29.5
Disease aid by work accident	03	6.3
Accident aid (private insurance, DPVAT)	04	8.4
Retirement by accident	16	33.3

HTLV=human T-lymphotropic virus; UTI=urinary tract infection; BPC=continued delivery benefit; DPVAT=Danos Pessoais por Veículos Automotores Terrestres (Brazilian public insurance).

The SAE urinalysis test was found positive in 30% pre-intervention in EG and 75% in CG. On the post-intervention moment, SAE was observed only with a reduction of 19% in the EG, while in the CG, it was 57.90%. In the urine culture test, only *Escherichia coli* was observed in the pre- and post-interventions in EG. In contrast, in the CG pre- and post-intervention moments, these bacteria as well as *Klebsiella pneumonia* (20%) and other strains were observed. There was a reduction of UTI (p=0.004) in the EG compared to the CG. On intergroup comparison, there was an improvement (p=0.011) in the UTI. In addition, on the intergroup comparison, UTI caused by *K. pneumoniae* was found in the CG (p=0.027) (Table 2).

In the pre-intervention intragroup analysis of the EG, there was an increase in mean corpuscular hemoglobin (MCH) (p=0.032), hemoglobin (Hb) (p=0.01), hematocrit (Ht) (p=0.005), and activated partial thromboplastin time (APTT) (p=0.008). In the pre-intervention intergroup comparison, there were higher values in MCH (p=0.032) and mean corpuscular hemoglobin concentration (MCHC) (p=0.021), as well as APTT (p=0.046). However, there was a decrease in platelets (p=0.022). In addition, there was decrease in the prothrombin of EG (p=0.02) (Table 2).

In the EG, the $\%HbA1_C$ (p<0.001) as well as IL-6 (p=0.044) were reduced, and there was an increase in creatinine (p=0.008), when compared at baseline and after intervention. In the CG, a decrease in the values of $\%HBA1_C$ (p=0.026), T3 (p=0.010), and IL-6 (p=0.006) was observed in the intra-group comparison. In the inter-group comparison, there was a reduction in C-reactive protein (CRP) (p=0.035) (Table 2).

DISCUSSION

This clinical study analyzed the effects of a 12-month structured WB. There was a prevalence of *E. coli* in the UTI of participants. Furthermore, the intergroup comparison showed *K. pneumoniae* survived in the CG, but not in the EG, implying that the PWD-M was protected due to the effect of a 12-month exercise of intervention of WB[9].

Poor hygiene during self-catheterization and relief probing, which must be done at least four to five times daily in PWD-M, is linked to the recurrence of UTI. Given the importance, research participants did not know they had UTIs, the incidence of the infection was said to be lower in the initial interview, or in the self-report. The habit of reusing the relief catheter to perform bladder catheterization was also observed by the same token[10].

Physical activity (PA) increased gas exchange through the synthesis and replenishment of red blood cells (RBC) by

Table 2. Characteristics of etiological factors of urinary tract infection and hematological, coagulation, and biochemical parameters in males with motor disability subjected to wheelchair basketball in the clinical trial performed between 2018 and 2019, Cuiabá, Mato Grosso, Brazil.

Variables	Experimental Group (EG)				Control Group (CG)				Intergroup (EG) × (CG)			
	Pre-intervention 2018	Post-intervention 2019	χ^2	p-value	Pre-intervention 2018	Post-intervention 2019	χ^2	p-value	χ^2	p-value	χ^2	p-value
Etiology												
Medullary trauma	9 (40.00)	8 (38.10)			15 (68.20)	12 (63.20)						
Poliomyelitis sequels	9 (45.00)	9 (42.90)	0.119	0.942	03 (13.60)	3 (15.80)	0.114	0.994	5.233	0.073	5.233	0.073
Other factors	3 (15.00)	4 (19.00)			04 (18.20)	4 (21.10)						
UTI												
Positive	06 (30.00)	04 (19.00)			15 (75.00)	11 (57.90)						
Negative	14 (70.00)	17 (81.00)	0.666	0.414	05 (25.00)	8 (42.10)	1.283	0.257	8.120	0.004**	6.423	0.011*
Type of bacterial flora (urine culture)												
Escherichia coli	6 (30.00)	4 (19.00)	0.666	0.414	8 (40.00)	4 (21.00)	1.642	0.2	0.440	0.507	0.025	0.874
Klebsiella pneumoniae	0 (0.00)	0 (0.00)			4 (20.00)	4 (21.00)	0.007	0.935	4.444	0.035*	4.912	0.027*
Proteus mirabilis	0 (0.00)	0 (0.00)			1 (5.00)	0 (0.00)	0.975	0.323	1.026	0.311		
Morganella morganii	0 (0.00)	0 (0.00)			1 (5.00)	1 (5.30)	0.001	0.97	1.026	0.311	1.134	0.287
Citrobacter freundii	0 (0.00)	0 (0.00)			0 (0.00)	1 (5.30)	1.080	0.299			1.134	0.287
Flora mista	0 (0.00)	0 (0.00)			1 (5.00)	0 (0.00)	0.975	0.323	1.026	0.311		
Pseudomonas aeruginosa	0 (0.00)	0 (0.00)			0 (0.00)	1 (5.30)	1.080	0.299			1.134	0.287
Red blood cells (millions/mm^3)	19	5.02±0.40	5.11±0.45		0.254	18	4.99±0.49	5.14±0.55		0.126	0.468	0.78

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Table 2. Continuation.

Variables	Experimental Group (EG)				Control Group (CG)				Intergroup (EG) × (CG)			
	Pre-intervention 2018	Post-intervention 2019	χ^2	p-value	Pre-intervention 2018	Post-intervention 2019	χ^2	p-value	χ^2	p-value	χ^2	p-value
Hemoglobin (g/dl)	19	14.44±0.99	14.95 ±1.29		0.01*	18	13.95±1.44	14.52±1.26		0.102	0.068	0.21
Hematocrit (%)	19	43.74±2.89	45,35±3.73		0.005**	18	43.34±3.84	44.16±3.22		0.222	0.239	0.26
MCV (fl)	19	88.43±4,47	88,86±3.96		0.214	18	86.88±5.17	86.76±5.87		0.931	0.156	0.69
MCH (pg)	19	29.22±1.74	28,78 ±3.18		0.446	18	28.05±2.11	28.41±2.22		0.497	0.032*	0.97
MCHC (%)	19	33.03±0,85	32,96±0.77		0.713	18	32.26±1.04	32.66±0.75		0.093	0.021*	0.32
RDW (%)	19	13.67±0.73	13,74±0.639		0.403	18	14.05±1.33	14.47±1.77		0.21	0.369	0.06
Leukocytes (%)	19	6615.2±2064.9	6319,4 ±1779		0.451	18	7363,8±2034.1	6931.1±2122.2		0.402	0.32	0,22
Platelets (mm^3)	19	215,840±44.34	212,379±73752.4		0.792	18	274,500 ±105243.2	250,000±57557.1		0.333	0.022*	0.14
Prothrombin (s)	19	11.28±1.04	11.30±1.17		0.89	17	11.75±0.99	11.42±0.90		0.113	0.223	0,02*
APTT (s)	19	28.07±3.02	32.42±6.59		0.008**	18	30.83±5.40	34.16±5.19		0.082	0.046*	0.30
INR	19	1.01±0.09	1.0±0.11		0.738	17	1.05±0.08	1.55±2.17		0.363	0.206	0.27
Vitamin D3 (ng/ml)	18	32.9±15.84	29.8±11.9		0.263	18	26.84±8.16	24.61±6.98		0.217	0.068	0,08
Vitamin B12 (µmol/L)	18	359.1±111.2	372.0±144.6		0.509	17	447.6±171.8	397.0±141.1		0.219	0.161	0.57
Folic acid (ng/ml)	18	6.41±4.12	6.78±3.39		0.599	18	4.77±±5.76	5.76±2.71		0.11	0.179	0.32
Urea (mg/dl)	18	36.27±16.27	32.77±7.55		0,380	17	33.29±13,43	28.29±8.93		0.19	0.501	0.174
Creatinine (%)	18	0.64±0.17	0.71±0.15		0,008*	17	0.68±0,16	0.65 ±0.16		0.42	0.929	0.158
Sodium (mEq/L)	19	141.7±3.04	141.8±1.60		0,933	18	143.5±3.80	141.4±1.97		0.046	0.109	0.416
Potassium (mEq/L)	19	4.72±1,11	4.50±0.38		0,409	18	4.48±0,37	4.66±0.42		0.169	0.445	0.272

Continue...

Table 2. Continuation.

Variables	Experimental Group (EG)				Control Group (CG)				Intergroup (EG) × (CG)			
	Pre-intervention 2018	Post-intervention 2019	χ^2	p-value	Pre-intervention 2018	Post-intervention 2019	χ^2	p-value	χ^2	p-value	χ^2	p-value
Glucose (mg/dl)	19	95.26±29.41	92.84±4,53		0,351	18	92.22±31.96	92.55±29.72		0.905	0.767	0.911
Glycated hemoglobin (%HBA1$_C$)	19	5.47±1.01	5.09±0.67		0,000*	17	5.66 ±1.50	5.28±0.94		0.026*	0.733	0.492
Total cholesterol (mg/dl)	19	165.1±36.03	168.1±38.0		0,481	18	167.5±39.01	178.0±50.08		0.190	0,719	0.405
Triglycerides (mg/dl)	19	148.2±123.2	190.3±215.4		0,181	18	152.2±103.3	150.2±74.92		0.902	0.962	0.474
LDL (mg/dl)	19	87.73±43.89	86.21±37.59		0,753	18	92.05±39.77	107.0±37.95		0.221	0.494	0.102
HDL (mg/dl)	19	41.31 ±15.49	41.84±14.14		0,784	18	39.66±9.03	41.11±9.18		0.430	0.486	0.775
VLDL (mg/dl)	19	20.25±13.95	27.49 ±18.54		0,062	18	24.96±13.28	29.65±14.50		0.256	0.310	0.708
TSH (standardized data)	18	-0.05±0.96	0.045±1.05		0,679	19	0.10±1.06	-0.156±0.90		0.196	0.694	0.948
T3 (standardized data)	17	-0.46±1.10	0.356±1.23		0,059	19	0.34±0.64	-0.23±0.77		0.010*	0.002*	0.142
T4 (standardized data)	18	-0.00±0.85	0.22±1.47		0,611	19	0.07±1.22	-0.22±0.27		0.250	0.875	0.211
C-reactive protein (CRP) (mEq/L)	19	10.91±13.36	7.58±4.96		0,208	16	18.65±15.72	16.79±19.02		0.720	0.143	0.035*
IL-6 (pg/ml)	18	14.97±20.27	4.15±5.71		0,044*	17	26.98±25.38	7.36±10.89		0.006*	0.159	0.136
MDA (µmol/L)	18	2.99±0.57	3.02±0.54		0.823	18	3.21±0.59	2.872±90.79		0.189	0.704	0,715

SAE=sedimentoscopy of abnormal elements; X^2=Pearson's chi-square test, *p<0.05 and **p<0.01; 95% and 99%. Variation set: Student's paired t-test, (average and standard deviation); independent sample t-test=average (minimum and maximum) or Wilcoxon test. Bold indicates *p<0.05; **p<0.01 and confidence interval of 95%. MCV=mean corpuscular volume; MCH=mean corpuscular hemoglobin; MCHC=mean corpuscular hemoglobin concentration; RDW= red cell distribution width; APTT=activated partial thromboplastin time); INR=international normalized ratio; SD=standard deviation.

the bone marrow, as evidenced by improved Ht and Hb values in the EG compared to the CG in hematological tests. In this way, after 12 months of EG intervention, the practice of WB resulted in a positive Ht and Hb outcome[11].

There was an increase in time in the EG in the APTT, a laboratory test that analyses the effectiveness of the intrinsic route to measure the time of fibrin clot formation[12], due to stimulation by prolonged PE, which leads to the improvement of muscle responsiveness to trauma. In the CG, there was an increase in the APTT and platelets at baseline, most likely due to the existing UTI with hematuria issues due to recurrent infections[11,12].

Participants with anemia diagnosed by the Hb, MCH, and MCHC values, dehydration, infection, and coagulation markers, as well as platelet and APTT alterations, had chronic inflammatory and/or infectious processes reported in the baseline clinic[11]. The variable creatinine improved with an increase in the EG, which can be attributed to the care provided and WB that improved kidney function[13]. There is no worldwide consensus estimating kidney function in PWD-M, although they stated that there are limitations as simple approaches based on serum creatinine concentration and glomerular filtration rate generally overestimate creatinine clearance[14]. A 24-h urine collection has been recommended for the monitoring of kidney function in patients with SCI. They also claimed that the serum creatinine level is not sensible on precocious detection of kidney function in SCI patients[15].

$HbA1_C$ was reduced in both EG and CG, but with a greater reduction in the EG, which can be attributed to the practice of PE and multidisciplinary monitoring in both arms of the study[16,17]. In the practice of PE, there is a decrease in % $HbA1_C$ through the mechanism of glucose uptake by skeletal muscle cells through GLUT-4 receptors, as well as by providing cardiometabolic fitness by WB practitioners[18].

IL-6 is an important inflammatory mediator in kidney and inflammatory diseases and was found to be elevated in plasma after the practice of acute PA of high intensity[19]. There was a reduction of intragroup values on pre- and post-interventions on EG and CG. However, no improvement was achieved on intergroup after 12 months of intervention of WB, with both values being above normative parameters of IL-6 according to the normative parameters of PWD-M[19-21].

C-reactive protein is an acute-phase biomarker with low specificity and was the only one biomarker in the intergroup that showed improvement after the WB intervention. Conversely, it was attenuated in the intergroup comparison at post-intervention of the WB intervention. The practice of PE for more than 6 weeks of intervention[20], as well as associated health care contributed positively with a better prognostic adaptation of the anti-inflammatory response and lower UTI rates in PWD[21,22].

Compared with our results, a few PWD studies find difficulty in equalizing participants at baseline and in accessing and transporting participants. Several changes such as locomotion, collection error by PWD-M[23], a lack of hygiene, difficulty in raising awareness on non-reuse of probes on self-catheterism, and insufficient places for the collection were some of the limitations of this study.

CONCLUSIONS

The *follow-up* showed that WB practice reduced UTI as well as improved the prognosis of inflammatory biomarkers in PWD-M. As a result, further training on current recommendations/consensus on the particular management of UTI in people with PWD-M is required. Furthermore, due to the scarcity of evidence-based knowledge, more well-designed research is urgently required.

AUTHORS' CONTRIBUTIONS

RNC: Data curation, Writing – original draft. **ACSS:** Investigation, Visualization. **RASR:** Software, Validation. **ACBN:** Investigation, Data curation, Visualization. **SOB:** Writing – review & editing. **BRMA:** Investigation, Visualization. **CAF:** Investigation, Visualization. **AAZZ:** Investigation, Visualization. **KA:** Writing – review & editing. **RGO:** Conceptualization, Funding acquisition, Methodology, Project administration, Software, Supervision.

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