

# The impact of Chikungunya chronic arthralgia on women's upper limbs motor function: a cross-sectional study

*O impacto da artralgia crônica pós-Chikungunya na função motora dos membros superiores de mulheres: um estudo transversal*

*El impacto de la artralgia crónica poschikunguña en la función motora del miembro superior de mujeres: un estudio transversal*

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**ABSTRACT** | Post-Chikungunya chronic arthralgia (PCCA) may lead to musculoskeletal repercussions and functional loss. The objective was to assess the upper limb physical disability and symptoms during daily, work, and leisure activities of women presenting PCCA compared to healthy controls (HC). This was a cross-sectional study conducted with 52 women. The participants were divided into PCCA (37) and HC (15) groups. Handgrip strength, range of motion, level of pain (numerical rating scale), and participants' physical disability and symptoms (Disabilities of the Arm, Shoulder, and Hand Questionnaire – DASH) were evaluated. Differences between groups were evaluated using the Students t-test and Pearson's correlations. The chi-square test was applied for categorical variables. The significance was set at  $\alpha=0.05$ . The disease duration was  $19.5\pm 13.1$  months. We found no differences between groups for peak force (PCAA:  $23.6\pm 7.4$ kgf; HC:  $24.5\pm 6.2$ kgf;  $p=0.676$ ). The results showed a significant difference between groups regarding range of motion (PCCA:  $63.5\pm 17.3^\circ$ ; HC:  $77.2\pm 9.6^\circ$ ), level of hand pain (PCCA:  $5.8\pm 2.2$ ; HC:  $0.4\pm 1.5$ ), and upper limbs functional levels (PCCA:  $44.5\pm 17.4$ ; HC:  $16.2\pm 20.5$ ). Participants related severe difficulty or inability to perform

tasks such as opening a jar (78.4%), placing objects above head height (48.7%), doing heavy household chores (56.8%), and gardening (51.4%). Impairment in the upper limb physical function in daily, work, and leisure activities shows the higher prevalence in the long-term.

**Keywords** | Chikungunya Virus; Arthralgia; Upper Extremities; Functional Status.

**RESUMO** | A artralgia crônica pós-Chikungunya (ACPC) pode gerar repercussões musculoesqueléticas e perda funcional. Nesse sentido, o objetivo deste estudo foi avaliar a incapacidade física e os sintomas de membros superiores de mulheres com ACPC durante atividades diárias, laborais e de lazer comparadas aos controles saudáveis (CS). Para tanto, realizou-se um estudo transversal conduzido com 52 mulheres. As participantes foram divididas entre os grupos com ACPC (37) e CS (15). Foram avaliados força de preensão, amplitude de movimento (ADM), nível de dor (escala numérica de dor) e incapacidade física e sintomas por meio do *Disabilities of the Arm, Shoulder and Hand Questionnaire* (Dash). Diferenças entre os grupos foram avaliadas pelo teste t

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de *Student* e correlações de Pearson. O teste qui-quadrado foi utilizado para variáveis categóricas e  $\alpha=0,05$  foi estabelecido como nível de significância. Verificou-se que a duração da ACPC foi de  $19,5\pm 13,1$  meses. Não houve diferença entre os grupos para a força pico (ACPC:  $23,6\pm 7,4$ kgf; CS:  $24,5\pm 6,2$ kgf;  $p=0,676$ ). Os resultados demonstraram diferença significativa entre os grupos em termos de ADM (ACPC:  $63,5\pm 17,3^\circ$ ; CS:  $77,2\pm 9,6^\circ$ ), nível de dor nas mãos (ACPC:  $5,8\pm 2,2$ ; CS:  $0,4\pm 1,5$ ) e níveis funcionais dos membros superiores (ACPC:  $44,5\pm 17,4$ ; CS:  $16,2\pm 20,5$ ). As participantes relataram extrema dificuldade ou incapacidade para realizar tarefas como abrir um pote (78,4%), colocar objetos em um local acima da cabeça (48,7%), realizar atividades domésticas pesadas (56,8%) e atividades de jardinagem (51,4%). Conclui-se que a função física dos membros superiores durante as atividades diárias, laborais e de lazer constitui o maior comprometimento apresentado a longo prazo.

**Palavras-chave** | Vírus Chikungunya; Artralgia; Membros Superiores; Estado Funcional.

**RESUMEN** | La artralgia crónica poschikunguña (ACPC) puede tener como efecto repercusiones musculoesqueléticas y pérdida funcional. En este sentido, el objetivo de este estudio fue evaluar la discapacidad física y los síntomas de miembros superiores de mujeres con ACPC durante las actividades diarias, laborales y de

ocio en comparación con controles sanos (CS). Por ello, se realizó un estudio transversal con 52 mujeres. Las participantes se dividieron en los grupos ACPC (37) y CS (15). La fuerza de agarre, el rango de movimiento (ROM), el nivel de dolor (escala numérica de dolor), la discapacidad física y los síntomas se evaluaron mediante el *Disabilities of the Arm, Shoulder and Hand Questionnaire* (Dash). Las diferencias entre los grupos se evaluaron con la aplicación de la prueba t de Student y las correlaciones de Pearson. Se utilizó la prueba de chi-cuadrado para las variables categóricas y se estableció como nivel de significación  $\alpha=0,05$ . Se encontró que la duración de la ACPC fue de  $19,5\pm 13,1$  meses. No hubo diferencia entre los grupos para la fuerza máxima (ACPC:  $23,6\pm 7,4$ kgf; CS:  $24,5\pm 6,2$ kgf;  $p=0,676$ ). Los resultados mostraron una diferencia significativa entre los grupos respecto al ROM (ACPC:  $63,5\pm 17,3^\circ$ ; CS:  $77,2\pm 9,6^\circ$ ), el nivel de dolor en la mano (ACPC:  $5,8\pm 2,2$ ; CS:  $0,4\pm 1,5$ ) y los niveles funcionales de miembros superiores (ACPC:  $44,5\pm 17,4$ ; CS:  $16,2\pm 20,5$ ). Las participantes informaron una extrema dificultad o incapacidad para realizar tareas como abrir un frasco (78,4%), poner objetos en un lugar más alto (48,7%), realizar actividades domésticas pesadas (56,8%) y actividades de jardinería (51,4%). Se concluyó que la función física de los miembros superiores durante las actividades diarias, laborales y de ocio constituye el mayor compromiso a largo plazo.

**Palabras clave** | Virus Chikungunya; Artralgia; Miembros Superiores; Estado Funcional.

## INTRODUCTION

Chikungunya fever is an arboviral disease transmitted by infected mosquitos from the *Aedes aegypti* and *Aedes albopictus* species<sup>1</sup>. Chikungunya virus is geographically distributed throughout over 60 countries<sup>2</sup>, and from 2004 to 2011, it has affected almost 6.5 million people worldwide<sup>3</sup>. Chikungunya fever causes intense and debilitating joint pain with an inflammatory character, which may persist after the acute infection<sup>4</sup>. Up to 87% of patients may still have symptoms three months after diagnosis, and one out of eight have joint pain three years after Chikungunya infection<sup>1,5</sup>. Some factors have been associated with post-Chikungunya chronic arthralgia (PCCA), such as being female, older age, viral persistence, pre-existing autoimmune or joint diseases, and presence of comorbidities<sup>6</sup>.

PCCA is usually symmetrical and may affect one or more joints. Wrists and hands are the most affected sites<sup>7,8</sup>.

As a result, the patient's functional status and quality of life might be compromised<sup>6,9</sup>. Similar to Chikungunya, pathologies that affect peripheral joints—such as rheumatoid arthritis—increase the risks of developing incapacity and functionality loss<sup>10</sup>. In these cases, increased pain and reduced mobility, muscle strength, and agility might occur and may be related to patients' difficulty in maintaining independence levels<sup>9,11-13</sup>.

These studies also claim that such repercussions contribute to functional loss. Nonetheless, the literature does not specify the most impaired daily life, work, and leisure activities. Therefore, this study aimed to assess upper limb physical disability and symptoms during daily, work, and leisure activities of women presenting PCCA compared to healthy controls. Moreover, we compared self-perceived health status, handgrip strength, wrist range of motion (ROM), and hand joint mobility between groups. We hypothesized that, due to the disease impact, the PCCA group would present worse results.

## METHODOLOGY

### Study design, participants, selection criteria, and ethical aspects

In this cross-sectional study, 52 women aged 41 to 69 years were invited to participate. Among the total, 37 had a previous history of Chikungunya fever and current PCCA diagnosis (PCCA group) and 15 were healthy controls (control group). The sample was exclusively composed of women from the communities of Governador Valadares and Frei Inocêncio, Minas Gerais, Brazil. Participants were clarified about the study details and signed an informed consent form, in accordance with the Declaration of Helsinki, before their participation. Participants were recruited by social media divulgation and study flyers in Primary Health Care units.

PCCA was confirmed by a rheumatologist according to the Brazilian Society of Rheumatology criteria for diagnosis and treatment of Chikungunya fever. Briefly, the criteria state that—in epidemic situations—Chikungunya fever can be diagnosed if an individual presents symptoms and resides in or has visited an endemic or epidemic area within 15 days before symptoms start or if there is an epidemiological link with a confirmed case<sup>6</sup>. In both groups, those presenting previous severe joint diseases (such as rheumatoid arthritis, rhizarthrosis, and psoriasis), attention or speech disorders, or inability to perform the functional tests (according to clinical judgment) were excluded. The Mini-Mental State Examination (MMSE) was used to evaluate volunteers' cognitive state. Volunteers were included if they scored  $\geq 17$  (for illiterate) or 24 (for literate)<sup>14</sup>.

The sample calculation was based on a previous study. The sample size required was 45 participants for a 0.5 effect size, a 5%  $\alpha$  error, and a 95% confidence interval. The calculation was conducted using the G\*Power software program (Version 3.1.9.6 – Universität Kiel, Germany).

### Data collect

A standardized questionnaire was applied to assess the demographic profile, employment status, absence from work, and weight and height to calculate body mass index (BMI). Then, patients were requested to rate their self-perceived health status as “very good” or “good,” “fair,” “poor” or “very poor,” or “I do not know”.

The handgrip strength from the dominant upper limb was measured using a manual force transducer (sampling frequency: 2000Hz; nominal capacity: 200kgf;

EMG System Brasil<sup>®</sup>, São José dos Campos-SP, Brazil). The dominant upper limb was determined using the Edinburgh Handedness Inventory. Participants who scored from 40 to 100 were classified as right-handed and from -40 to -100 as left-handed<sup>15</sup>. Volunteers were comfortably seated, with their forearms flexed to 90° over a flat surface, and their wrists in a neutral position<sup>16</sup>. Participants were instructed and verbally encouraged to handgrip the dynamometer with maximum force for 10 seconds. Three attempts of maximal isometric effort within a 5-minute interval were performed. The peak force was considered the maximum value reached after all attempts. The average force was calculated as the average of the values recorded between the third and eighth seconds of each attempt.

The range of motion (ROM) of the wrists was evaluated by manual goniometry. Volunteers were comfortably seated with their forearm pronated and elbow flexed at approximately 90°. The axis of the goniometer was fixed on the medial surface of the wrist, just proximal to the ulnar styloid process. The fixed arm of the goniometer was placed over the medial surface of the ulna, and its movable arm was placed over the medial surface of the fifth metacarpal bone. Patients were asked to fully flex their wrists. Then, ROM was recorded.

Current level of pain on the hand was evaluated by the visual analog scale (VAS), ranging from 0 (lack of pain) to 10 (the worst pain ever felt). Specifically, the pain was classified as absent of pain (0), mild pain (1-3), moderate pain (4-6), and severe pain (7-10)<sup>17</sup>.

Participants' physical disability and symptoms during their daily, work, and leisure activities were evaluated using the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire (Spearman's correlation coefficients for interobserver evaluation: 0.762 to 0.995; intraclass correlation coefficients for interobserver evaluation: 0.97 to 0.99). DASH comprises 30 questions designed to measure the upper limbs' physical disability and symptoms based on patients' perspectives. Two items address physical function, six symptoms, and three assess social function. Additionally, an optional four-item work module was used. For such, questions were based on housework if the volunteer was currently unemployed<sup>18</sup>. They were asked to rate their ability to perform the activities described in each item using a 5-point Likert scale, considering only the last week. The total DASH score was calculated by summing the scores of the 30 items, subtracting by 30, and then dividing it by 1.2. For the work module, the total score was calculated

by summing all the scores, subtracting the result by 4, and dividing it by 0.16. Total scores range from 0 (no dysfunction) to 100 (severe dysfunction)<sup>19</sup>.

## Statistical analysis

Data were summarized as means and standard deviations or absolute frequencies and percentages. Differences between groups were evaluated using the Student's t-test for independent samples and Pearson's correlations. The chi-square test was applied for categorical variables. The significance was set at  $\alpha=0.05$ . All tests were

performed using the R Statistical program (R Core Team 2019, Vienna, Austria).

## RESULTS

### Participants

Table 1 shows the participants' characteristics. The groups were homogeneous regarding age, schooling years, skin-color, employment status, and body mass index, unless in the self-related health status and absence from work.

Table 1. Participants' characteristics

Characteristic	CG (n=15)	PCCA (n=37)	p-value
Age (mean±SD)	54.5±9.24	53.45±7.32	0.666
Schooling years			0.454
≤9 years	3 (20)	14 (37.8)	
10–12 years	9 (60)	15 (40.5)	
>12 years	3 (20)	8 (21.6)	
Skin-color			0.854
Black	4 (26.7)	9 (24.3)	
Mixed-race	8 (53.3)	17 (46)	
White	2 (13.3)	9 (24.3)	
Other	1 (6.7)	2 (5.4)	
Self-related health status			0.005
Good and very good	12 (80)	12 (32.4)	
Fair, poor, and very poor	3 (20)	24 (64.9)	
Not answered	0 (0)	1 (2.7)	
Employment status			0.297
Active and formal	7 (46.7)	10 (27.0)	
Active and informal	3 (20)	13 (35.1)	
Inactive with income	4 (26.7)	6 (16.2)	
Inactive without income	1 (6.7)	8 (21.6)	
Absence from work			0.021
<15 days	2 (13.3)	17 (45.9)	
>15 days	0 (0)	6 (16.2)	
Without absence	13 (86.7)	14 (37.8)	
Body mass index (mean±SD)	28.1±3.5	29.6±5.6	0.671
Disease duration (months) (mean±SD)	-	19.5±13.1	-

Values are presented with frequency (percentage) unless indicated otherwise. CG: control group; PCCA: post Chikungunya chronic arthralgia.

### Strength, range of motion, pain, and physical disability

We found no significant differences between groups for peak force and average force for the dominant hand, but regarding the wrist flexion ROM, results showed a significant difference between the CG and PCCA group. Similarly, the PCCA group presented the highest level of pain. Furthermore, the main DASH scores showed that participants in the CG had significantly better physical function levels than participants in the PCCA group.

On the other hand, PCCA participants related severe difficulty or inability to do tasks like opening a new jar (78.4%), placing objects above their head (48.7%), doing heavy household chores (56.8%), gardening (51.4%), carrying shopping bags (43.2%), and participating in different recreational activities. Moreover, the work module DASH score indicated that PCCA had much more difficulty during work activities, especially doing it as well as they would like to and spending the usual amount of time (Table 2). Table 3 shows the details of the answers to the DASH questionnaire.

Table 2. Strength, range of motion, pain, and functionality parameters

Parameter	CG (n=15)	PCCA (n=37)	p-value
Dominant peak force (kgf)	24.5±6.2	23.6±7.4	0.676
Dominant average force (kgf)	16.6±10.0	17.9±9.2	0.824
Range of motion wrist flexion (°)	77.2±9.6	63.5±17.3	0.005
Pain	0.4±1.5	5.8±2.2	<0.001
DASH score	16.2±20.5	44.5±17.4	<0.001
Work module DASH score	43.7±27.3	84.1±22.6	<0.001

Values are presented with mean±standard deviation unless indicated otherwise.

Table 3. Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH) – main module

DASH ITEMS	CG (n=15)			PCCA (n=37)			p
	NO AND MILD N (%)	MODERATE N (%)	SEVERE AND UNABLE N (%)	NO AND MILD N (%)	MODERATE N (%)	SEVERE AND UNABLE N (%)	
1. Open a tight or new jar	12 (80)	1 (6.7)	2 (13.3)	3 (8.1)	5 (13.5)	29 (78.4)	0.001
2. Write	14 (93.3)	1 (6.7)	0 (0)	20 (54.1)	10 (27)	7 (18.9)	0.021
3. Turn a key	15 (100)	0 (0)	0 (0)	26 (70.3)	7 (18.9)	4 (10.8)	0.049
4. Prepare a meal	13 (86.7)	1 (6.7)	1 (6.7)	23 (62.2)	10 (27)	4 (10.8)	0.235
5. Push open a heavy door	10 (66.7)	2 (13.3)	3 (20)	15 (40.6)	13 (35.1)	9 (24.3)	0.244
6. Place an object on a shelf above your head	11 (73.3)	3 (20)	1 (6.7)	14 (37.8)	5 (13.5)	18 (48.7)	0.020
7. Do heavy household chores	10 (66.7)	3 (20)	2 (13.3)	11 (29.7)	5 (13.5)	21 (56.8)	0.017
8. Garden or do yard work	10 (66.7)	3 (20)	2 (13.3)	13 (35.1)	5 (13.5)	19 (51.4)	0.043
9. Make a bed	12 (80)	1 (6.7)	2 (13.3)	23 (62.2)	10 (27)	4 (10.8)	0.288
10. Carry a shopping bag or briefcase	11 (73.3)	3 (20)	1 (6.7)	10 (27)	11 (29.7)	16 (43.2)	0.006
11. Carry a heavy object (over 10 lbs.)	11 (73.3)	2 (13.3)	2 (13.3)	11 (29.7)	9 (24.3)	17 (46)	0.014
12. Change a lightbulb overhead	9 (60)	2 (13.3)	4 (26.7)	10 (27)	9 (24.3)	18 (48.7)	0.095
13. Wash or blow dry your hair	10 (66.7)	3 (20)	2 (13.3)	14 (37.8)	9 (24.3)	14 (37.8)	0.142
14. Wash your back	12 (80)	2 (13.3)	1 (6.7)	21 (56.8)	4 (10.8)	12 (32.5)	0.148
15. Put on a pullover sweater	12 (80)	1 (6.7)	2 (13.3)	23 (62.2)	6 (16.2)	8 (21.6)	0.464
16. Use a knife to cut food	12 (80)	2 (13.3)	1 (6.7)	22 (59.5)	9 (24.3)	6 (16.2)	0.376
17. Recreational activities which require little effort	13 (86.7)	1 (6.7)	1 (6.7)	16 (43.2)	7 (18.9)	14 (37.8)	0.017
18. Recreational activities in which you take some force or impact through your arm, shoulder, or hand	9 (60)	1 (6.7)	5 (33.3)	9 (24.3)	10 (27)	18 (48.7)	0.034
19. Recreational activities in which you move your arm freely	11 (73.3)	1 (6.7)	3 (20)	10 (27)	10 (27)	17 (46)	0.004
20. Manage transportation needs	12 (80)	1 (6.7)	2 (13.3)	21 (56.8)	9 (24.3)	7 (18.9)	0.273
21. Sexual activities	12 (80)	1 (6.7)	2 (13.3)	23 (62.2)	6 (16.2)	8 (21.6)	0.493
<b>INTERFERENCE IN SOCIAL ACTIVITIES</b>	<b>NOT AT ALL AND SLIGHTLY N (%)</b>	<b>MODERATELY N (%)</b>	<b>QUITE A BIT AND EXTREMELY N (%)</b>	<b>NOT AT ALL AND SLIGHTLY N (%)</b>	<b>MODERATELY N (%)</b>	<b>QUITE A BIT AND EXTREMELY N (%)</b>	
22. During the past week, to what extent has your arm, shoulder, or hand problem interfered with your normal social activities with family, friends, neighbors, or groups?	13 (86.7)	2 (13.3)	0 (0)	18 (48.7)	9 (24.3)	10 (27)	0.032

(continues)

Table 3. Continuation

DASH ITEMS	CG (n=15)			PCCA (n=37)			p
	NOT AT ALL AND SLIGHTLY N (%)	MODERATELY N (%)	VERY AND UNABLE N (%)	NOT AT ALL AND SLIGHTLY N (%)	MODERATELY N (%)	VERY AND UNABLE N (%)	
23. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	13 (86.7)	1 (6.7)	1 (6.7)	16 (43.2)	8 (21.6)	13 (35.1)	0.014
SYMPTOMS SEVERITY IN THE LAST WEEK	NONE AND MILD N (%)	MODERATE N (%)	SEVERE AND EXTREME N (%)	NONE AND MILD N (%)	MODERATE N (%)	SEVERE AND EXTREME N (%)	
24. Arm, shoulder, or hand pain	13 (86.7)	2 (13.3)	0 (0)	6 (16.2)	12 (32.5)	17 (46)	0.001
25. Arm, shoulder, or hand pain when you performed any specific activity	11 (73.3)	3 (20)	1 (6.7)	9 (24.3)	15 (40.5)	11 (29.7)	0.003
26. Tingling (pins and needles) in your arm, shoulder, or hand	13 (86.7)	0 (0)	2 (13.3)	18 (48.7)	6 (16.2)	10 (27)	0.037
27. Weakness in your arm, shoulder, or hand	14 (93.3)	1 (6.7)	0 (0)	12 (32.5)	13 (35.1)	10 (27)	0.001
28. Stiffness in your arm, shoulder, or hand	12 (80)	1 (6.7)	2 (13.3)	11 (29.7)	12 (32.5)	12 (32.5)	0.008
SLEEP DIFFICULTY	NO AND MILD N (%)	MODERATE N (%)	SEVERE AND SO MUCH THAT I CAN'T SLEEP N (%)	NO AND MILD N (%)	MODERATE N (%)	SEVERE AND SO MUCH THAT I CAN'T SLEEP N (%)	
29. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder, or hand?	12 (80)	1 (6.7)	2 (13.3)	15 (40.5)	6 (16.2)	14 (37.8)	0.069
SELF-PERCEPTION OF HEALTH STATE	STRONGLY DISAGREE AND DISAGREE N (%)	NEITHER AGREE NOR DISAGREE N (%)	AGREE AND STRONGLY AGREE N (%)	STRONGLY DISAGREE AND DISAGREE N (%)	NEITHER AGREE NOR DISAGREE N (%)	AGREE AND STRONGLY AGREE N (%)	
30. I feel less capable, less confident, or less useful because of my arm, shoulder, or hand problem	12 (80)	0 (0)	3 (20)	14 (37.8)	4 (10.8)	17 (45.9)	0.016
WORK MODULE DIFFICULTY DURING WORK ACTIVITIES	NO AND MILD N (%)	MODERATE N (%)	SEVERE AND UNABLE N (%)	NO AND MILD N (%)	MODERATE N (%)	SEVERE AND UNABLE N (%)	
1. Using your usual technique for your work?	11 (73.3)	3 (20)	1 (6.7)	8 (21.6)	15 (40.5)	14 (37.8)	0.005
2. Doing your usual work because of arm, shoulder, or hand pain?	11 (73.3)	2 (13.3)	2 (13.3)	8 (21.6)	12 (32.4)	17 (46)	0.006
3. Doing your work as well as you would like?	11 (73.3)	3 (20)	1 (6.7)	5 (13.5)	14 (37.8)	18 (48.7)	0.001
4. Spending your usual amount of time doing your work?	10 (66.7)	1 (6.7)	4 (26.7)	5 (13.5)	13 (35.1)	19 (51.4)	0.001

DASH: Disabilities of the Arm, Shoulder, and Hand Questionnaire; CG: control group; PCCA: post Chikungunya chronic arthralgia.

## Correlation

Moderate negative correlation and significant association were found between Work Module DASH score and wrist flexion ROM (Figure 1).

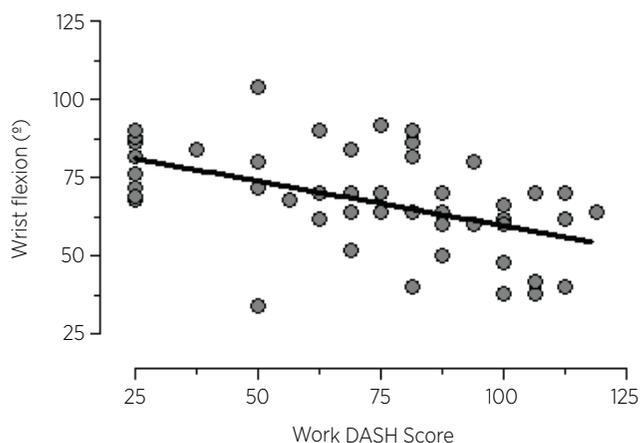


Figure 1. Correlation between Work Module DASH Score and wrist flexion range of movement

## DISCUSSION

This study aimed to evaluate upper limb physical disability and symptoms during daily, work, and leisure activities of women presenting PCCA. Moreover, the study compared handgrip strength, ROM, and pain of adult women with PCCA with healthy controls. The results indicated no difference between groups regarding handgrip strength. On the other hand, we observed worse wrist flexion range of motion, severe levels of pain, impaired upper-limb physical function, and difficulty during work activities in the PCCA group.

Regarding handgrip strength, our finding goes against Forechi et al.<sup>13</sup>, who compared the handgrip strength of older adults with and without Chikungunya fever for almost three months. The results showed impaired bilateral force in those with Chikungunya fever<sup>13</sup>. In their study, the PCCA group had almost 19 months of disease, emphasizing that the reduction of handgrip strength is not the most compromised ability in the long-term. The levels of handgrip strength of the participants of our study are similar to the reference values of healthy adults proposed by Schlüssel et al.<sup>20</sup>. However, the upper-limb physical function in daily life activities is impaired even in the late chronic phase of the disease.

Despite having similar handgrip strength to individuals in CG, PCCA participants presented some musculoskeletal complications. The PCCA group had a worse wrist flexion ROM than CG. Although the isolated analysis of this movement is clinically common, the coupling pattern between flexion-extension and radio-ulnar deviation is more reliable for performing daily life tasks<sup>21</sup>. Generally, limited ROM leads to functional

disability<sup>22,23</sup>. However, we must consider the coupling of movements and other factors, such as pain, which confuses the link between kinematics and wrist function<sup>24</sup>.

Joint pain is the most typical clinical manifestation of Chikungunya fever and can last for months or years<sup>25,26</sup>. Our results show a moderate pain level in the PCCA group, similar to Tritsch et al.<sup>5</sup>. Joint pain may limit activities, lead to disability, and contribute to worse mental aspects, such as depression states<sup>27</sup>. Soumahoro et al.<sup>28</sup> identified that the persistent disabilities caused by Chikungunya fever generate a moderate effect on quality of life. Similarly, Watson et al.<sup>26</sup> showed that musculoskeletal stiffness caused by Chikungunya fever is a quality of life determinant. Although we did not assess the quality of life, we found that PCCA participants presented poor auto-related health status. In contrast, most CG participants considered their health status as good or very good.

Chikungunya fever interferes with the individual's work and health status and daily activities. Most PCCA participants missed work for some days in this study. Besides absence from work, PCCA participants related difficulties performing work activities with the same efficiency before Chikungunya fever. This difficulty may contribute to decreasing work productivity and lead to a negative effect on the social security system and economic aspects. Studies showing the effects of Chikungunya fever on work are scarce. Bastos, Abreu, and Silva Jr.<sup>29</sup> showed that in 2017, each public servant of two public institutions in Ceará State had, on average, 20.6 missing days of work due to Chikungunya fever. Although data about this subject are scarce, Chikungunya fever has clinical manifestations that mimic rheumatoid arthritis<sup>30</sup>. This condition, in turn, is related to disabilities that may interfere with seeking employments and opportunities and maintaining good performances at work<sup>31</sup>.

Regarding the effect of Chikungunya fever on work, we found a moderate negative correlation and a significant association between wrist flexion ROM and work module DASH score. In other words, less wrist flexion is associated with an increased work module DASH score. Notably, higher work module DASH scores represent greater difficulty in carrying out work activities as well as carrying them out on adequate time and with the desired quality. This suggests that wrist mobility, especially in flexion, is essential for performing work tasks.

This study main limitations include the study design that does not allow cause-effect inferences. Thus, future studies in three principal areas (prevention, assessment, and treatment) are necessary. Studies on prevention

and control strategies can prevent new outbreaks of Chikungunya. Studies on assessment strategies allow a correct evaluation of all aspects involved in the chronicity of the disease. And finally, studies portraying treatment measures can reduce the effect of long-term symptoms on individuals' functionality and productivity. This study also has methodological limitations, like the imbalance between groups and the sample exclusively composed of women. Despite these limitations, this study contributes to the Chikungunya Fever's discussion and its repercussions on the motor function of the upper limb. Moreover, this study may support the debate on the main aspects involved in the physical assessment of individuals with post-Chikungunya chronic arthralgia and then guide the rehabilitation process.

## CONCLUSION

Women with almost 20 months of Chikungunya arthralgia showed similar handgrip strength compared to healthy women. On the other hand, they showed a worse range of motion on wrist flexion and greater hand pain level than healthy women. In addition, the participants showed severe difficulty or inability to do tasks like opening a new jar, placing objects above their heads, doing heavy household chores, gardening, carrying shopping bags, and participating in different recreational activities. These findings demonstrate that other aspects besides strength, range of motion or pain, need to be evaluated and considered in the therapeutic approach. Upper limb physical function in daily, work, and leisure activities showed the worst results in the long-term.

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