Clinical and Experimental Rheumatology 2024; 42: 174-177

Sex and body mass index impact on digit circumference for Leeds Dactylitis Index calculation

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Received on May 6, 2023; accepted in revised form on October 5, 2023.

Key words: psoriatic arthritis, dactylitis, digital circumference, Leeds Dactylitis Index, Body Mass Index

Competing interests: non declared.

ABSTRACT

Objective. *To estimate digit circumference and the impact of sex and body mass index (BMI) for the calculation of the Leeds Dactylitis Index (LDI) in psoriatic arthritis (PsA) patients with bilateral dactylitis.*

Methods. *Digit circumference of the hands and the foot were measured with a dactylometer and were studied according to sex and BMI (divided in 4 weight categories) in healthy Portuguese subjects, using Student's t-test and One-way ANOVA, respectively. The effect size of sex and BMI were calculated using Cohen's d test and Eta squared, respectively. Multiple linear regression was used to calculate the effect of sex and BMI, as well as their interaction, to create a formula to predict digit circumference.*

Results. *Fifty-nine participants (33 women, 26 men) with a mean BMI of 24.8 were included. Men's mean digit circumferences were statistically higher than those of women ($p<0.001$), with a large sex effect size in most of the digits. Differences in the mean circumference between the four BMI categories were statistically significant ($p<0.05$) for all digits, with a large BMI effect size. Sex and BMI were independent variables to predict mean digit circumference ($p<0.001$). A new tool (based on regression analysis) allowing to estimate the circumference of digits for males and females of different BMIs is presented.*

Conclusion. *Our data allows the calculation of digit circumference for males and females of different BMIs in the Portuguese population; and shows that BMI influences digital circumference supporting BMI inclusion in LDI references tables.*

Introduction

Dactylitis is a hallmark manifestation of psoriatic arthritis (PsA) that occurs in 16–49% of the reported cases (1, 2). Clinically, it corresponds to a diffuse swelling of a digit of the hands or feet. Although its precise pathogenic mechanisms remain unknown, it can be considered as a pandigital inflammatory manifestation involving one or more tissue compartments: tenosynovitis, joint synovitis, enthesitis, soft-tissue and bone marrow oedema and erosive bone damage (1, 3-5).

Dactylitis can present as two forms: acute and tender or chronic non-tender (1-3, 5). The first is associated with increased disease activity, risk of joint damage and overall disease burden, whereas the chronic form might have less clinical impact (1, 3). Dactylitis integrates the Classification Criteria for Psoriatic arthritis (CASPAR) and is a relevant outcome of PsA associated with local erosive structural damage (6, 7).

Despite the diversity of outcome measures used to assess dactylitis activity mainly in the context of clinical research, including clinical trials, the Leeds Dactylitis Index (LDI) is becoming widely accepted as a more objective measure for determining dactylitis activity in PsA (2, 3, 8-12). The LDI is a validated instrument for assessing dactylitis that includes the measurement of the circumference of the digits, determined by a dactylometer, and the severity of pain upon palpation. The affected digit circumference is compared with the healthy contralateral digit circumference. Dactylitis is defined when a 10% difference in the ratio of the circumference of the affected digit occurs (2, 3). In the presence of bilateral dactylitis, however it is necessary to compare the obtained values with the standard references of digit circumferences of individuals without dactylitis. These data are available for the United Kingdom population (1, 13) but have not been studied in other countries, despite LDI being used in several clinical trials worldwide (9-12). Furthermore, it is also unknown if different anthropometric measures can influence the LDI score, particularly obesity, which is one of the most prevalent comorbidities (40–50%) in the PsA population (14).

The primary objective of this study was to obtain the estimated digit circumference of the Portuguese population for female and male subjects as a reference to allow for the calculation of the LDI. Secondarily, we studied sex and body mass index (BMI) as variables that can influence digit circumference.

Table I. Description of finger and toe circumference according to sex and BMI (in millimeters).

Digital circumference	Number of individuals	Fingers					Toes				
		Thumb	Index	Middle	Ring	Little	Great toe	Second	Middle	Fourth	Fifth
Sex											
Total (mean ± SD)	59	64.6 ± 5.9	64.2 ± 6.2	61.7 ± 6.1	58.2 ± 5.8	54.9 ± 5.8	77.5 ± 6.5	53.5 ± 4.6	51.2 ± 4.1	49.5 ± 4.7	50.0 ± 4.4
Sex											
Females (mean ± SD)	33	61.7 ± 4.9	61.4 ± 5.4	58.8 ± 5.1	55.6 ± 4.9	52.1 ± 4.9	74.1 ± 4.8	51.4 ± 3.6	49.6 ± 3.4	48.0 ± 4.2	48.7 ± 4.0
Males (mean ± SD)	26	68.3 ± 5.0	67.8 ± 5.3	65.5 ± 5.2	61.4 ± 5.4	58.5 ± 4.9	81.9 ± 5.6	56.1 ± 4.4	53.2 ± 4.0	51.3 ± 4.7	51.7 ± 4.4
p-value		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cohen's d		-1.106	-1.028	-1.095	-0.994	-1.097	-1.214	-1.014	-0.883	-0.698	-0.687
BMI											
Underweight (mean ± SD)	2	57.5 ± 3.5	55.3 ± 1.7	52.5 ± 1.9	51 ± 2.2	48 ± 3.8	68.5 ± 2.6	47.8 ± 2.1	45.6 ± 2.1	46 ± 0	47 ± 2.4
Normal weight (mean ± SD)	32	62.3 ± 4.7	61.7 ± 4.7	59.3 ± 4.4	55.9 ± 4.2	52.5 ± 4.6	75.3 ± 5.7	51.7 ± 3.7	50.1 ± 3.6	48.5 ± 4.6	48.7 ± 4.0
Overweight (mean ± SD)	19	67.6 ± 5.7	67.7 ± 5.8	64.9 ± 5.2	61.1 ± 5.2	58 ± 4.7	80.7 ± 4.9	55.9 ± 4.0	53.1 ± 3.5	50.9 ± 3.9	51.5 ± 3.6
Obese (mean ± SD)	6	69.8 ± 5.2	69.45.8	68.0 ± 7.0	63.3 ± 7.8	60.4 ± 6.3	82.7.8 ± 7.4	56.8 ± 5.6	53.1 ± 5.2	51.8 ± 6.7	53.7 ± 6.2
p-value		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001
Eta-squared		0.293	0.333	0.365	0.295	0.334	0.276	0.274	0.195	0.098	0.175

SD: standard deviation.

Methods

Participants and clinical assessments

Healthy individuals, white race, aged between 18 and 65 years, from across mainland Portugal (north, centre and south regions) were invited to participate. The exclusion criteria included pregnancy and musculoskeletal diseases with joint involvement of fingers or toes, such as rheumatoid arthritis and osteoarthritis.

The circumferences of the ten digits of the hands and the ten digits of the feet were assessed using a dactylometer, as described by the manufacturer (3). The circumference of each finger was measured twice applying the dactylometer around the base of the digit adjacent to the web space, and the mean of the two evaluations, in millimetres, was calculated and recorded. Then, the mean value of the two fingers, right and left side, was determined for each finger and reported here. Demographic data concerning age, sex, weight, height and previous or concomitant diseases were collected and registered.

The Ethics Committee of Centro Académico de Medicina de Lisboa approved this study (number 463/20), and informed consent was obtained from all individuals.

Statistical analysis

Continuous variables were described by mean and standard deviation. Digit circumference was studied according to sex and BMI, using Student's t-test and One-way ANOVA, respectively. The Cohen's d test was used to calculate sex effect size and Eta squared to calculate BMI effect size (15). Multiple linear regression was used to calculate the effect of sex and BMI, as well as their interaction, to predict digit circumference. BMI categories were considered as follows: underweight <18.5; normal weight 18.5–24.9; overweight 25–29.9; and obesity ≥30. SPSS v. 24 was used for statistical analysis.

Table II. Calculation of the circumference of digits for males and females across different BMIs.

	Finger	Reference (females/normal weight in mm)	Male	Underweight	Overweight	Obese
Hand	Thumb	60.9	5.0	-3.4	3.0	6.4
	Index	60.5	4.4	-5.2	4.0	6.7
	Middle	57.9	4.8	-5.4	3.4	7.7
	Ring	54.8	4.1	-3.8	3.3	6.5
	Little	51.1	4.7	-3.1	3.5	6.9
Foot	Great toe	73.4	6.5	-4.9	2.5	6.0
	Second	50.8	3.4	-3.0	2.6	4.4
	Middle	49.4	2.6	-3.9	1.8	2.4
	Fourth	47.7	2.6	-1.7	1.3	2.7
	Fifth	48.0	2.2	-1.0	1.8	4.5

Results of the regression analyses. To use the table, add the values for the line of the digit of interest and the columns for the subject. For example, the index finger of an overweight male is predicted to be (on average) 60.5+4.4+4.0=68.9 mm. Note that the reference level for the analyses is "females of normal weight" (first column). mm: millimeters

Results

Fifty-nine participants (33 women, 26 men) with a mean age of 41.5±10.6 (min 20, max 62) years, mean BMI 24.8 (min 17.4, max 37.5) were included.

Overall, the mean circumference of the thumb was found to be the highest (64.6±5.9 mm) on the hands but very similar to the index circumference (64.2±6.2 mm). On the digits of the foot, besides the great toe circumference (77.5±6.5 mm), the mean circumferences of the remaining digits were numerically very close (min 49.5, max 53.5mm). For both hands and feet, men's mean digit circumferences were statistical higher than those of women (p<0.001). Sex effect size was large in the majority of digits (-0.994<d<-

1.214) and medium in the middle, fourth and fifth fingers of the feet (-0.687<*d*<-0.883). Table I describes the digit circumference for fingers and toes according to sex.

Taking into consideration BMI, the lowest digit circumferences were found in the underweight group (n=2) and the highest in the obese group (n=6). Differences in all digit mean circumference between the four BMI categories were statistically significant in all digits (p<0.05). The BMI effect size was large in all digits ($0.175<\eta^2<0.365$), except in the fourth finger of the feet ($\eta^2=0.098$). Table I describes the digit circumference according to BMI.

Sex and BMI were independent variables to predict all mean digit circumference, (p<0.001), but the interaction between these variables was not significant for any digit.

We used multiple linear regression to calculate the average circumference of the digits for males and females with different BMIs. The results of this regression analysis are presented in Table II. The reference level for the analyses is "females of normal weight". To estimate the digit circumference in case of a female patient for each selected finger (line), the females value (base) is added to the value according to BMI of the individual. For a male patient, for each selected finger (line), the females value (base) is added to the male factor plus the value according to BMI of the individual.

Discussion

The LDI is a quick, easy and objective score to assess dactylitis activity in PsA patients. When dactylitis is symmetrical, the calculation of the LDI score requires the use of digital circumference normative values. These data are available according to sex from two different populations in the United Kingdom but has not been studied for other populations. For the fingers, results from a study of a sample of 600 British workers has been published in the 1980s (13). In 2005, Helliwell *et al*. during the development of LDI, recorded also anthropometric data for the toes circumference of a small sample of 52 individuals (1). Anthropometric measures however can vary across populations. Comparing to the reference tables of the United Kingdom population, the mean digital circumference of our sample was numerically superior, except for the men's thumb, great toe and fifth fingers (1, 13). The reasons for the variability in comparison to the United Kingdom population may be due to constitutional differences in the digital circumferences between populations. However, we cannot exclude that these differences were influenced by the small sample size of both studies and may reflect individual variations which is a limitation from our work that requires further validation in larger populations.

The results from our work further allowed to estimate the digit circumference for males and females of different BMIs, in our population, based on the data from the regression analysis. Our data shows that in addition to sex, BMI can influence the digital circumference with a large effect size (15). This is particularly relevant as LDI is mostly applied to PsA patients that often have obesity as a comorbidity (14).

Considering that LDI is used worldwide, hand and feet anthropometric differences across populations, can impact on the definition of dactylitis and even treatment efficacy/effectiveness assessment of this PsA manifestation. A rational for assessing digit circumferece in other populations is therefore herein unveiled. Estimating digit circumference for other populations could be of benefit, in particular, when participating in PsA clinical trials using LDI as an endpoint. Our work also emphasises the fact that in patients with symmetrical dactylitis, where the application of reference tables is required for the calculation of LDI, in addition to sex, BMI needs to be taken into consideration as it can influence digital circumference.

Key messages

- In PsA patients the calculation of the LDI score in the presence of bilateral dactylitis requires the use of digital circumference normative values only available according to sex for the United Kingdom population.
- Anthropometric measures however can vary across populations and impact LDI calculation.
- The mean digital circumference of the majority of digits in our sample was numerically superior comparing to the reference tables of the United Kingdom population.
- Further to sex, BMI influenced the digital circumference of healthy subjects, with a large effect size.
- A new tool that allows the calculation of the digit circumference for males and females of different BMIs was developed .

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Acknowledgments

The authors would like to thank the Portuguese Society of Rheumatology for assistance in GO-DACT trial implementation (reference 10) which motivated this study.

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