Hand strength and dexterity in individuals with hand eczema

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Abstract

Background Patients with hand eczema often describe symptoms such as pain, clumsiness and difficulty flexing their fingers, thus impairing the function of the hand.

Objective The aim of this study was to investigate whether hand eczema is associated with a measurable impairment of hand strength and dexterity. We also studied the relationship between hand function and the ability to perform activities of daily living (ADL), pain level and quality of life measured with the Dermatology Life Quality Index (DLQI).

Methods Twenty-one participants with ongoing hand eczema were examined with well-established methods for measuring hand grip strength, pinch strength and dexterity. A questionnaire was designed to investigate perceived ability to perform ADL. The participants were also asked to grade their current pain level, and the DLQI was used to assess the participants’ quality of life. A group of 12 participants was reinvestigated when healed.

Results The participants demonstrated a significant improvement in all functional tests when healed. There was a strong correlation between ADL and both dexterity and hand grip strength. There was also a strong correlation between ADL and pain. All participants reported some difficulty performing ADL.

Conclusions Our results suggest that ongoing hand eczema may lead to a measurable decrease of strength and dexterity of the hand, leading to an impairment of the ability to perform ADL and consequently to a poorer quality of life.

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Conflicts of interest
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Introduction

Hand eczema is a common disease which often has a chronically relapsing course. The 1-year prevalence is around 9–10% in adults,1,2 but in occupational fields such as health care and industrial work, the prevalence of hand eczema is significantly increased.3–6

In a clinical setting, patients with hand eczema often describe symptoms such as pain, clumsiness and difficulty flexing their fingers, experiences which might impair the function of the hand. The hand has had a crucial role in the evolution of the human species; it can be seen as an extension of the brain, a pervasive and versatile tool that helps us realize our thoughts, big or small, from building monuments, performing arts to executing simple daily chores.7

In fields such as hand surgery and occupational medicine, the use of well-established instruments to assess hand function and perceived ability to perform activities of daily living (ADL) is part of the clinical investigation of the patient. These investigations provide useful information about patients’ performance and rehabilitation need.8 However, to the best of our knowledge, measuring the function of the hand has not yet been studied in individuals with hand eczema.

The aim of the present study was to investigate whether hand eczema is associated with measurable changes in strength and dexterity, measured with well-established instruments used in fields such as hand surgery and occupational medicine. First, the hand grip strength, pinch strength and dexterity in participants with ongoing hand eczema were compared with normative data. A follow-up was performed using the same test battery when the participants had healed, and each participant’s performance at baseline and follow-up was compared. Associations between hand grip strength, dexterity, perceived impairment in
performing ADL, pain level and the Dermatology Life Quality Index (DLQI) were also investigated.

**Materials and methods**

**Study population**

The study included 21 participants (14 women, seven men, mean age 47, range 22–62 years) diagnosed with hand eczema. All participants were recruited from planned visits at the Department of Occupational and Environmental Dermatology at Skåne University Hospital in Malmö, Sweden, during 2013–2015. The inclusion criteria were as follows: adults 18–65 years of age, speaking and writing Swedish fluently, with current eczema on the volar aspect of at least one of the hands, regardless of duration, and in need of further treatment. At the time of the first test occasion, 16 individuals were employed, three were unemployed and two were entrepreneurs. Six out of 21 participants were on sick leave due to their hand eczema.

**Design**

At a medical appointment at the Department of Occupational and Environmental Dermatology, 23 patients were asked by their occupational dermatologists to participate in the study. Two of those patients declined. Those who accepted were contacted by the same researcher (HMP) for information about the study and to schedule an appointment as soon as possible for an initial testing of the hand strength, dexterity, ADL, pain level and DLQI.

As a follow-up study, we retested enrolled participants when their hand eczema had completely healed, or when they stated that they had healed as much as they possible could. However, for practical reasons, the follow-up period was limited to 21 months. We had the opportunity to retest 12 of the 21 participants. Six participants did not heal during the time frame of the study, one participant declined to take part in the follow-up because of sick leave for other conditions, one participant was unreachable, and one participant was ineligible due to a hand injury.

**Assessments of hand functions**

Assessments were performed to quantify specific functions of the hand. Four well-established tests were used to physically measure the participants’ hand strength and dexterity. We used a Jamar dynamometer (kg) to measure the maximum isometric strength of the hand (Fig. 1a), a Pinch gauge (kg) to measure finger strength: palmar pinch (Fig. 1b) and key grip (Fig. 1c), and the Purdue pegboard (Fig 1d) to assess dexterity. The measurements were performed in accordance with standard procedures by the same researcher (HMP). The tests were conducted in a quiet room. Three trials per hand were performed, starting with the dominant hand. At the end of the test, the average score for each hand was calculated. All participants were given a standard encouragement to perform the test in the best way they could.

**Grip strength**

To measure the maximum isometric strength of the hand, we used a Jamar dynamometer (kg), as described by Mathiowetz. The handle was set at the second position for all participants; this is the recommended standard test position.

**Finger strength**

Finger strength was measured using a Pinch gauge, 0–27 kg B & L Engineering (Santa Ana, CA, USA). Two different grips were tested: palmar pinch and key grip. The instrument was used as described by Mathiowetz.

**Dexterity**

Finger dexterity was assessed using the Purdue pegboard test as described by the creator, industrial psychologist Joseph Tiffin. The participant’s task was to position as many pins as possible in 30 s with one hand at a time.

**Perceived ability to perform activities of daily living**

The participants were asked to answer a detailed self-assessment questionnaire to investigate their perceived ability to perform ADL. Available questionnaires to evaluate disability of upper extremity such as Disabilities of the Arm, Shoulder and Hand (DASH) are predominantly used for musculoskeletal disorders of the upper limb, and several questions are not relevant for individuals with hand eczema. Moreover, in the DASH questionnaire participants are asked to grade their perceived disability during the past week, whereas hand eczema may vary from day to day; the participants were therefore asked to grade their ability based on the severity of their hand eczema. The 26 questions were scored from 0 (no difficulty) to 3 (impossible to perform) and are summarized by a score, which is the mean of the scores for completed responses. The questionnaire included an alternative when a question was not perceived as applicable, and items that were not applicable to a particular subject were excluded when calculating the mean. The higher the score, the greater the impairment.

**Quality of life**

The participants’ quality of life was assessed using a standard questionnaire, the validated DLQI. DLQI is one of the most commonly used questionnaires in dermatology, measuring quality of life in individuals with skin diseases. The questionnaire contains 10 questions; answers score from 0 to 3. The
DLQI score is calculated by adding up the scores of each question. The higher the score, the greater the impairment of the individual’s quality of life. The maximum score is 30, corresponding to an extremely large effect on the patient’s life, and the minimum is 0, indicating no effect at all.

**Pain**  The participants were asked to grade the current level of pain in the hands caused by their hand eczema, before they performed the functional tests. The score ranged from 0 to 10, where 0 describes an absence of pain and 10 reflects a very strong feeling of pain.

**Ethics**  The study was approved by the ethical vetting board in Lund, Sweden. Written informed consent was obtained from the participants.

**Statistical analysis**  The participants’ scores from the functional tests at baseline were transformed into standardized z-scores using normative data. For the grip strength tests, we used normative data from and for the dexterity test. The z-score is a measure of how many standard deviations each individual test result deviates from the normal value for a given gender and age interval. This makes it possible to compare individuals independently of gender and age, which can be useful in a small study. A z-score below −1.96 or above 1.96 standard deviations was considered a statistically significant difference from normative data. Wilcoxon signed rank test was used to investigate changes in the functional test scores before and after the participants had healed. Spearman’s rank correlation coefficient was used to explore the relationships between the functional tests, ADL, DLQI and pain.

All analyses were performed using R Statistical Software, version 3.2.2. A P-value < 0.05 was considered statistically significant.

**Results**  

**Comparing hand strength and dexterity with normative data**  
At baseline, 21 participants with ongoing hand eczema were tested. Figure 2 illustrates z-score distributions for the participants’ results at the functional tests. The range within the group was large for all functional tests; however, the mean results for the study group did not differ significantly from the normative data in any of the functional tests. Finger strength was the function most affected by hand eczema compared to normative data, as measured with the palmar pinch test (left hand: mean 1.07, max 2.34).
Comparing hand strength and dexterity at baseline and follow-up when healed

At follow-up, a group of 12 participants was reinvestigated after they had healed. Hand grip strength measured with the Jamar dynamometer was significantly higher when the participants’ hand eczema had healed compared to baseline both for the left hand ($P = 0.011$) and the right hand ($P = 0.0092$; Fig. 3).

Finger strength measured with the palmar pinch test was significantly higher for both hands ($P = 0.013$) when the participants’ hand eczema had healed (Fig. 3). Finger strength measured with the key grip test was also significantly higher at the follow-up both for the left hand ($P = 0.0087$) and the right hand ($P = 0.0085$).

Dexterity measured with the Purdue pegboard test was significantly higher when the participants had healed both for the left hand ($P = 0.024$) and the right hand ($P = 0.0087$), (Fig. 3).

Association between ability to perform ADL, DLQI and the functional tests at baseline

A strong negative correlation was shown between the 21 participants’ ability to perform ADL and finger dexterity for the right hand ($\rho = 0.63, P = 0.0021$, Spearman’s rank correlation).

Figure 2  Comparing grip strength, pinch and dexterity with normative data. Box-and-whiskers plots of the z-score for measured hand strength (a), dexterity (b) and finger strength (both palmar pinch (c) and key grip (d)) in participants with hand eczema at baseline ($n = 21$). The z-score was calculated using normative data. It shows how much each participant’s score deviates from the normal given his/her gender and age. A z-score of 0 indicates the normative mean (orange line). The box-and-whisker plots show the median (black horizontal line), mean (dashed horizontal line), interquartile range (25–75%, box) and range (min/max, bars). The numbers represent anonymized seq. no. of the participants who scored the lowest at each test (same sequence no. was used across all tests). A z-score below $-1.96$ or above $1.96$ standard deviations was considered a statistically significant difference from normative data.

Figure 3  Comparing hand strength and dexterity at baseline and follow-up in 12 participants. Box-and-whiskers plots presenting follow-up data for the hand function tests: (a) Hand grip strength, (b) dexterity, (c) finger strength – palmar pinch test (d) finger strength – key grip test; $n = 12$). The box-and-whisker plots show the median (black horizontal line), interquartile range (25–75%, box) and range (min/max, bars).
and a moderate correlation for the left hand (rho = -0.52, P = 0.016). There was also a strong negative correlation between ADL and palmar pinch for the left hand (rho = -0.64, P = 0.0019). The weakest associations were between ADL and hand strength (Jamar dynamometer), for the right hand (rho = -0.33, P = 0.15) and for the left hand (rho = -0.40, P = 0.073; Table 1).

As for DLQI, the strongest association was with key grip for the left hand (rho = -0.61, P = 0.003) and the weakest association was with palmar pinch for the right hand (rho = -0.32, P = 0.15; Table 1).

**Associations between ability to perform ADL, DLQI and pain at baseline**

Spearman’s rank correlation showed a strong, positive monotonic correlation between the 21 participants’ ability to perform ADL and DLQI (rho = 0.72, P = 0.00022). The greater the perceived disability to perform ADL, the poorer the quality of life.

There was also a strong, positive monotonic correlation between perceived ability to perform ADL and pain (rho = 0.72, P = 0.00027).

All 21 participants reported some difficulty in performing ADL due to their hand eczema. The most challenging tasks involved contact with water, such as washing up the dishes, showering, washing their hands and cooking. Opening screw lids on cans and opening milk cartons were also among the tasks causing most difficulty (Fig. 4).

**Comparing ADL, DLQI and pain between baseline and follow-up**

At follow-up, the 12 participants’ perceived ability to perform ADL, their Quality of Life measured with DLQI and their pain caused by hand eczema had all changed significantly for the better compared to baseline, as shown by Wilcoxon signed rank test (P = 0.0024, 0.0038, and 0.0036, respectively).

**Discussion**

It has been pointed out that individuals with hand eczema experience diminished hand function due to their hand eczema. The present study is, to the best of our knowledge, the first attempt to use well-established instruments to measure the functional performance of the hand in individuals with ongoing hand eczema. Our results suggest that ongoing hand eczema may lead to a measurable impairment of strength and dexterity of the hand, and consequently to an impairment of the ability to perform ADL. We also found a strong correlation between ADL and DLQI. Additionally, our results suggest that pain may affect the ability to perform ADL in patients with hand eczema.

The functional tests used in this study have long been employed as standard investigation tools for various conditions, such as hand–arm vibration syndrome. These instruments are also used within various other fields. For example, the Purdue pegboard was originally designed for measuring the skills of applicants when hiring assembly line workers, and the Jamar dynamometer is regularly used to assess the fitness of athletes. Interestingly, a reduced hand grip strength measured with the Jamar dynamometer is associated with shortened life expectancy.

As a group, the participants’ finger and hand grip strength performance was low at baseline compared to normative data, particularly for the right hand, which could possibly be explained by the localization of fissures on the fingertips of some of the participants. Finger dexterity at baseline was within existing normative values. However, it should be pointed out that the study group was rather small and the participants’ results were widely spread above and below the normal value. To further evaluate the impact of the localization and character of the hand eczema on the function, more detailed studies with a larger number of participants are needed.

At follow-up, when the hand eczema had healed, the participants performed significantly better in all functional tests. These results support our hypothesis that ongoing hand eczema might cause a measurable decrease in strength and dexterity.

It should be noted that the participants performed better at follow-up not only compared to baseline, but also compared to normative data. Hypothetically, this could be explained by the fact that the majority of the study participants have physically

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**Table 1** Relation between ability to perform activities of daily living (ADL), Dermatology Life Quality Index (DLQI) and the functional tests in 21 participants with hand eczema

| Correlation       | Hand | Rho   | P-value |
|-------------------|------|-------|---------|
| **ADL**           |      |       |         |
| Dexterity         | Right| -0.63 | 0.0021* |
|                   | Left | -0.52 | 0.016*  |
| Hand grip strength| Right| -0.33 | 0.15    |
|                   | Left | -0.40 | 0.073   |
| Palmar pinch      | Right| -0.36 | 0.11    |
|                   | Left | -0.64 | 0.0019* |
| Key grip          | Right| -0.48 | 0.028*  |
|                   | Left | -0.62 | 0.0029* |
| **DLQI**          |      |       |         |
| Dexterity         | Right| -0.46 | 0.033*  |
|                   | Left | -0.39 | 0.08    |
| Hand grip strength| Right| -0.4  | 0.073   |
|                   | Left | -0.47 | 0.031*  |
| Palmar pinch      | Right| -0.32 | 0.15    |
|                   | Left | -0.46 | 0.035*  |
| Key grip          | Right| -0.48 | 0.029*  |
|                   | Left | -0.61 | 0.003*  |

Spearman’s rank correlation was used to explore the relationship between the results from the participants’ functional tests, their ability to perform ADL and DLQI.

*P ≤ 0.05.
demanding jobs that may involve heavy lifting and manual dexterity. This means that the participants’ impairment at baseline was actually greater than found by comparing their performance to normative data. It also means that each participant’s actual impairment can best be established by comparing their own performance before and after they have healed. Using this kind of functional tests, it is not uncommon to compare the test results from an individual’s injured hand with the healthy one. Studies show that the right hand is 10% stronger if dominant, while left-handed individuals often have bilateral equal strength measured with a Jamar dynamometer. However, it is not uncommon to be stronger in the non-dominant hand especially for left-handed individuals. The normative data given for these instruments are, however, often given for the right and left hand regardless of the individual’s dominant hand. In the present study, one in 21 individuals claimed to be left-handed and one to be ambidextrous.

The functional tests and ADL showed varying levels of correlation at baseline. However, the strongest correlations with ADL were seen in dexterity and finger strength measured with the palmar pinch test. This might be explained by the fact that a majority of the items in the ADL questionnaire were related to activities involving dexterity and finger strength. On the whole, the correlation between DLQI and the functional tests was consistent with the results obtained with ADL, but with weaker associations. This was expected, as the ADL questionnaire contains exclusive questions related to the hand function.

According to our observations, it is possible for a participant to make a temporary effort to complete a test in spite of pain. One of the participants strived to complete one of the tests although a fissure in her fingertip started bleeding. When the participants were asked to grade their pain level and their difficulty to perform ADL, the correlation between those estimates was strong. This could mean that careful attention regarding treatment should be paid to patients who report pain associated with hand eczema, since they likely also suffer from a reduced ability to perform ADL.
There was also a strong correlation between ADL and DLQI: the greater the perceived disability to perform ADL the poorer the quality of life. This might be due to the fact that several questions in the DLQI concern functional issues. Previous studies have shown that hand eczema affects the quality of life. Our results indicate that the degree to which quality of life is affected might be associated with the perceived disability to perform ADL due to hand eczema.

During the time of our study, a new questionnaire, the QOLHEQ, has been developed by an international expert group consisting of health scientists and dermatologists with special expertise in hand eczema. If QOLHEQ had been available when we started our study, we would have chosen to use it instead of the DLQI since the questions are more adequate for this study. The QOLHEQ questionnaire does contain questions regarding hand function. Our questionnaire, however, consists exclusively of questions specifically designed to investigate the participants’ ability to carry out ADL, similar to those found in questionnaires used in hand surgery. Furthermore, in individuals with hand eczema, the outcome of such questions has, to the best of our knowledge, never been compared with the traditional and well-established tests of the function of the hand as performed in our study.

The localization of the hand eczema might influence the performance at the diverse functional tests. For example, a fissure on the thumb might affect the performance in all functional tests, while a fissure in the palm mainly affects hand strength measured with the Jamar dynamometer and a number of different tasks measured with the ADL questionnaire. This could mean that some localizations of the hand eczema might be more important for the hand function than generally considered. It can also be suggested that measurement of hand function could be a valuable instrument for estimating a patient’s ability to perform tasks required at the workplace when considering notification of illness. These methods might also be useful for profiling the treatment and following its effects in a clinical setting during a rehabilitation process.

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