

# FEDERACION DE MONTAÑISMO DEL PRINCIPADO DE ASTURIAS

## IX JORNADAS INTERNACIONALES DE MEDICINA Y SOCORRO EN MONTAÑA

IX CONGRESS OF MEDECINE AND ASSISTANCE ON THE MOUNTAIN

## CONGRESO INTERNACIONAL DE LA SOCIEDAD ESPAÑOLA DE MEDICINA Y AUXILIO EN MONTAÑA

INTERNATIONAL CONGRESS OF SPANISH ASSOCIATION OF MEDECINE  
AND ASSISTANCE ON THE MOUNTAIN



PRINCIPADO DE ASTURIAS



OVIEDO, DEL 12 AL 15 DE OCTUBRE DE 1989

RISK FACTORS OF OVERUSE INJURIES IN SPORT CLIMBERS. WHAT KIND OF RELATION IS BETWEEN THE SPORT CLIMBER'S BIOTYPE AND THE OCCURRENCE OF OVERUSE SYNDROMES IN UPPER EXTREMITIES?

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In order to establish the prevalence and development of overuse injuries in upper extremities 187 Czechoslovak climbers were interrogated using a modified anamnestic questionnaire (Bertschi, Radlinger) and subjected to physical orthopaedic examination of the hands during the period 1987 - 1989.

Twenty climbers complained about pain in the shoulders, 24 in the elbows, 42 in forearms, 33 in the wrists and 94 in fingers. Long-lasting pain in fingers was observed in 73% out of 94 climbers. The fourth and third fingers were the most affected.

Finger deformities were found in 111 out of 176 climbers (63%). The most affected was the third finger. The most frequent finger deformity was a fusiform swellings of the fifth finger was a very frequent finding.

Thirty-nine climbers had already been examined in 1987 and/or in 1988 and the repeated examination showed a deterioration of finger damage in 23 (60%) of them.

For more detailed analysis 144 men surmounting climbing difficulty-grade from 7 to 10 (UIAA) were selected. Using linear regression analysis significant but not strong relationships were found between climbers' age, number of painful fingers, and pain-score; body weight and number of nodes in climbers' fingers; body weight and number of flexion deformities; duration of climbing activity, number of painful fingers, pain score, and maximal performance; pain-score and number of all finger deformities, flexion deformities and maximal performance; maximal performance and number of all finger deformities, fusiform swellings, and pain score.

Concerning enormous strains which are put in on the climbers' fingers the extremely difficult climbing has come to the level of the top sport. Therefore selection and assessment of suitability (appropriateness) for these top loads have become up-to-date problems as a primary prevention of overuse injuries.

Primary prevention of overloading concerns not only the structure, frequency and intensity of training but also the determination of the "optimal biotype" for top sport climbing at the first instance.

For this purpose it is necessary to work a suitable biotypological methodology out, to establish possibilities of the applicability of the biotypology to characterize the sport climber, to create the most convenient method for examination of climbers and for classification of their finger damage, to determine the relation between the sport climber's biotype and the occurrence of overuse syndromes in upper extremities.

**FACTORES DE RIESGO DE LESIONES POR SOBRECARGA EN ALPINISTAS. QUE RELACION HAY CON EL DEPORTE DE LA ESCALADA BIOTIPO Y LA EXISTENCIA DE SÍNDROMES POR SOBRECARGA EN EXTREMIDADES SUPERIORES.**

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Para establecer la prevalencia y desarrollo de las lesiones por sobrecarga en extremidades superiores, 107 alpinistas checoslovacos fueron interrogados mediante un cuestionario anamnestico modificado (Bertchs, Radlinger) y sujetos a un examen físico ortopédico de las manos durante el periodo 1987-1989.

Veinte alpinistas aquejados de dolor en hombros, 24 en codo, 42 en antebrazo, 33 en muñeca y 94 en dedos. En 73% de los 94 alpinistas se ha observado dolor prolongado en dedos.

Se han encontrado deformidades de los dedos en 111 de los 176 alpinistas (63%). El más afectado ha sido el tercer dedo. La deformidad en dedos mas frecuente encontrada es una tumefacción fusiforme en el quinto dedo.

En 1987 y 1988 se han examinado 39 alpinistas encontrándose deterioro de los dedos en 23 (60%).

Se han seleccionado para un análisis con detalle 144 alpinistas superando grados de dificultad de 7 a 10 (UIAA).

Mediante un análisis de regresión lineal, número de dedos con dolor y grado de dolor; peso corporal y número de nódulos en los dedos; peso corporal y número de deformidades en flexión; duración de la actividad, número de dedos con dolor, grado de dolor, y función máxima; grado de dolor y número de dedos deformados, limitación de la flexión y función máxima; función máxima y número de dedos deformados, tumefacción fusiforme y grado de dolor.

Sobre o acerca de la enorme tensión que soportan en los dedos, escalando en extrema dificultad, ha ocurrido en éste deporte al más alto nivel.

Por lo tanto una selección y asesoramiento concerniente de las superficies de carga, ha favorecido una moderna prevención primaria de los problemas de lesiones por sobrecarga.

La prevención primaria acerca de la sobrecarga, no solamente de la estructura, frecuencia e intensidad del entrenamiento sino también de la determinación de un "biotipo óptimo" para el alpinista en primer lugar.

Para este propósito es necesario trabajar con una metodología biopatológica conveniente, para establecer la posibilidad de aplicación de la biopatología que caracteriza al alpinista; crear el método más conveniente para el examen de los alpinistas y para clasificar las lesiones de los dedos, determinar la relación entre el biotipo del alpinista y la existencia de síndromes por sobrecarga en extremidades superiores.

# **RISK FACTORS OF OVERUSE INJURIES IN SPORT CLIMBERS: WHAT KIND OF RELATION IS THERE BETWEEN THE SPORT CLIMBER'S BIOTYPE AND THE OCCURRENCE OF OVERUSE SYNDROMES IN THE UPPER EXTREMITIES?**

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## RISK FACTORS OF OVERUSE INJURIES IN SPORT CLIMBERS

### WHAT KIND OF RELATION IS THERE BETWEEN THE SPORT CLIMBER'S BIOTYPE AND THE OCCURRENCE OF OVERUSE SYNDROMES IN THE UPPER EXTREMITIES?

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#### ABSTRACT

In order to obtain an estimate of the prevalence and development of overuse injuries in the upper extremities, 187 Czechoslovak climbers were interrogated using a modified anamnestic questionnaire (Bertschi, Radlinger) and subjected to physical orthopaedic examination of their hands during the period 1987 - 1989.

Twenty climbers complained of pain in the shoulders, 24 in the elbows, 42 in the forearms, 33 in the wrists and 94 in the fingers. Long-lasting pain in the fingers was reported by 73% of the 94 climbers. The fourth and third fingers were the most frequently affected. Finger deformities were found in 111 out of 176 climbers (63%). The most frequently affected was the third finger. The most frequent finger deformity was fusiform swelling of the proximal interphalangeal joints. Flexion deformity of the fifth finger was a very frequent finding.

Thirty-nine of the climbers were examined in 1987 or 1988 and a repeated examination in 1988 or 1989 showed a deterioration of finger damage in 23 (60%) of them.

For more detailed analysis, 144 men climbing difficulty grade 7 to 10 (UIAA) were selected. Using linear regression analysis, significant but not strong correlations were found between climber's age, number of painful fingers, and pain score; body height and number of nodes in climber's fingers; body weight and number of flexion deformities; duration of climbing activity, number of painful fingers, pain score, and maximal performance; training and maximal performance; pain score and number of finger deformities, flexion deformities, and maximal performance; maximal performance and number of finger deformities, fusiform swellings, and pain score.

Modern extreme rock climbing is now a top performance sport, in which enormous strains are put on the climbers' fingers. Prevention of overuse injuries is now a priority requiring appropriate selection and assessment of fitness.

Primary prevention of overloading concerns not only the structure, frequency and intensity of training, but also determination of an "optimal biotype" for top performance sport climbing.

For this it is necessary to work out a suitable biotype method, to ensure the characteristics of sport climbers can be biotyped, to evolve a standardised method for the examination of climbers and the classification of their finger damage and to attempt to correlate sport climbers' biotypes with the occurrence of hand overuse syndromes.

#### INTRODUCTION

Rock climbing is currently on a steep rise in performance and interest. The introduction of organized competitions in free climbing has speeded up this process. At the same time many authors are reporting frequent injuries caused by chronic overloading of climbers' upper extremities (Table 1), particularly injuries of the finger tendons and joints (1-6,8,9,11,12,17-24).

Chronic overloading results in overuse injuries - which are as stress fractures, early or late muscular stiffness, inflammation (tendonitis) of tendons and their insertions. Cartilage and joint capsules may also be damaged.

Fusiform swellings of a joint are due to active inflammation in the various parts of the joint, particularly in the synovial membrane, the capsule, and the surrounding soft tissue. Nodes on small finger joints are signs of joint degeneration and represent hypertrophied bony outgrowths around the margins of the joint. Flexion deformities are usually caused by damage and shortening of flexor tendons (16).

Overuse injuries result from an imbalance between the load and the tissue tolerance to this load. Different risk factors are responsible for this imbalance. There is general agreement concerning the classification of risk factors into two categories: extrinsic risk factors, which are related to the type of sports activity and the manner in which the sport is practised, and the intrinsic risk factors, which stem from the individual's physical characteristics and psychological traits (13-15; Table 2).

Modern extreme rock climbing is now a top performance sport, in which enormous strains are put on the climbers' fingers (6,7). Prevention of overuse injuries is now a priority requiring appropriate selection and assessment of fitness.

#### METHODS

Since 1987 a working group of the Medical Commission of the Czech Mountaineering Association has been following up health complaints and signs of finger injuries and damage in sport climbers taking part in extreme climbing competitions. Until May 1989, 187 climbers were interrogated using the modified Bertschi and Radlinger's anamnestic questionnaire (2) and subjected to physical orthopaedic examination (25).

Body weight was assessed by Broca's method using the formula for calculating of desirable body weight [Broca's index = {body weight/(body height-100)\*100}].

At orthopaedic examinations, joint mobility and shape changes in the small finger joints were assessed.

In 187 climbers (158 males and 29 females) 191 variables were recorded and consequently 35 717 data items collected. About 40 climbers were examined twice or three times, once in every consecutive year.

For more detailed analysis 144 men climbing difficulty grade 7 to 10 (UIAA) were selected.

The data was processed by means of a statistical computer program, Statgraphics 2.1.

## RESULTS

Twenty climbers complained of pain in the shoulders, 24 in the elbows, 42 in the forearms, 33 in the wrists, and 94 in the fingers (Table 3). Long-lasting pain in the fingers was stated by 73% of the 94 climbers. The fourth and third fingers were the most frequently affected (Fig. 1).

Finger deformities were found in 111 out of 176 climbers, (63%). The most frequently affected was the third finger. The most frequent finger deformity was fusiform swelling of the proximal interphalangeal joints. Flexion deformity of the fifth finger was a very frequent finding (Fig. 2).

Repeated examination in 39 climbers showed an increase in the number of painful fingers in 11 cases and the number of finger deformities in 23 climbers (60%). At the same time, their climbing performance had increased in only 13 cases (33%).

A group of 144 men was characterized as follows: mean age 23 years, age range 16 to 37 years, mean body height over 177 cm, mean body weight over 68 kg, Broca's index 88 on an average, ranging from 72 to 110. The maximal difficulty grade had been reached in 5 years on an average (Table 4).

Using linear regression analysis significant but not strong correlations were found between

- climber's age, number of painful fingers, and pain score;
- body height and number of nodes in climber's fingers;
- body weight and number of flexion deformities;
- duration of climbing activity, number of painful fingers, pain score, and maximal performance
- training and maximal performance
- pain score and number of finger deformities, flexion deformities and maximal performance
- maximal performance and number of finger deformities, fusiform swellings, and pain score (Table 5).

## DISCUSSION

The prevalence of overuse injuries of the hand in sport climbers is extremely high. The results of this study confirm the majority of details found in other publications (1-6,8,9,11,12,17-24; Table 6).

This suggest that significant numbers of climbers involved in extreme rock climbing have to overload their bodies beyond their natural biological limits.

In contrast to findings made by other authors (11), a predominance of health complaints on the left hand was not observed. Pain and finger deformities were located mainly in the right hands.

It is probable that the great strain placed on climbers' fingers predisposes to premature degenerative changes (3).

In order to provide an insight into all possible factors related to the etiopathogenesis of the overuse injuries of the hand, the GUHA (1) method - Package of Programs for Exploratory Data Analysis - was used (22).

For example the relationship between climbing performance (climbing difficulty grade) and Broca's index of body weight was analysed. The program generated four hypotheses showing a significant positive or negative association between these variables. Climbers reaching difficulty grade 7+ to 9- had significantly more often Broca's index below 85. Their relative body weight was lower and their relative strength greater than in climbers reaching a lower grade of difficulty (Table 7).

The results obtained by the GUHA method have shown association between a high level of performance and the incidence of overuse injuries. This raises the question if whether an optimal biotype could exist for extreme rock climbing.

The only finding casting light in this direction seems to be a significant but not strong correlation between body height and number of nodes in climbers' fingers (correlation coefficient 0.207, statistical significance  $p < 0.05$ ; Fig. 3).

In order to determine a climber's biotype (somatotype) and to place him into Sheldon's triangle of somatotypes, measurements of body height and body weight are obviously insufficient.

The shape of the hand is characteristic for a man's biotype and the strain imposed on the climber's fingers during extreme climbing depends on the biomechanical properties of the hand. Biomechanical analysis of climbers' injuries is needed not only to improve the understanding of etiology of these injuries but also to develop a strategy for their management and prevention. There is a scarcity of reports on the correlation between biotype and performance that can be put into a meaningful application to extreme climbing.

Mrs. Leal and co-workers (12) have already measured some anthropometric parameters in the upper extremities in 30 climbers. They take account of the width and length of the right hand, the maximal circumference and length of the right forearm, and the circumferences of the proximal and distal interphalangeal joints. In comparison with other athletes, higher indexes for the forearm and for the distal interphalangeal joint have been found.

Lysens with co-workers (14) have established an overuse-prone profile in young athletes characterized by a combination of muscle weakness, ligamentous laxity and muscle tightness. In addition these overuse injuries were more frequent associated with a high body weight and height and by a lower score in the mesomorphic component of their somatotype. These findings argue that individuals with a better developed musculature have a higher load capacity, and thus stand a lower risk of overuse, even if their intrinsic load (weight and height) is high (15).

## CONCLUSIONS

1. The prevalence of overuse injuries of the hand in sport climbers is extremely high.
2. In addition to the extrinsic risk factors of hand overuse syndromes, there are certainly important intrinsic factors, especially genetic ones, that predispose a person to high climbing performance and/or are responsible for his susceptibility to damage resulting from chronic overloading in



extremely difficult climbing. Therefore more detailed studies on the role of the biotype and other predisposing factors are required.

3. Because of very difficult treatment of finger overuse injuries and damage, prevention is of paramount importance. Primary prevention of overloading concerns not only the structure, frequency, and intensity of training, but also the determination of an "optimal biotype" for top performance sport climbing.
4. For this it is necessary
  - to work out a suitable biotype methodology,
  - to ensure the characteristics of sport climbers can be biotyped,
  - to evolve a standardised method for the examination of climbers and the classification of their finger damage and
  - to attempt to correlate sport climbers' biotypes with the occurrence of hand overuse syndromes.

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TABLE 1.

specific traumatology in climbers

	acute injuries	overuse injuries
tendons	ruptures avulsion of pulleys	tendonitis and enthesopathies epicondylitis humeri radialis epicondylitis humeri ulnaris brachial tendonitis f.d.s. tenoperiostitis styloiditis radii
nerves		compressive syndromes syndrome canalis carpi sulcus ulnaris syndrome supinator syndrome
bones	fractures	stress fractures
joints		arthritis osteoarthrosis

(F.D.S. flexor digitorum superficialis)

[Bollen, 1988a, 1988b, 1989; Krause et al., 1986; et al.]

TABLE 2.

extrinsic and intrinsic risk factors in climbers' overuse injuries

exposure	physical characteristics
duration of climbing activity	age
climbing difficulty grade	sex
type of finger gripping technique	somatotype
biomechanics of climbing	state of health
	previous injuries
training	joint mobility
	muscle tightness
environment	ligamentous laxity
weather condition	fatigue and exhaustion
	climbing skill
equipment	
protective equipment	psychological characteristics
taping	

[According to Lysens et al, 1988, modified]

TABLE 3.

localization of pain in upper extremities in 184 climbers

	n	%
shoulder	20	11
elbow	24	13
forearm	42	23
wrist	33	18
fingers	94	51

long-lasting pain in fingers in 73 % of 94 climbers

finger deformities: 111 out of 176 climbers ( 63 % )

TABLE 4.

## characteristics of 144 male climbers

age <years>	23.1 + 5.0	range: 16 - 37
body height <cm>	177.4 + 6.2	161 - 194
body weight <kg>	68.3 + 7.6	47 - 95
broca index	88.2 + 7.0	72 - 110
climbing performance	8- + 2 (uiaa)	7- to 10-
climbing activity (years)	6.2 + 3.3	1 - 21
time to maximal performance	5.3 + 3.0	0 - 20
training (days a week)	2.9 + 1.9	0 - 7

TABLE 5. LINEAR REGRESSION OF CHARACTERISTICS IN 144 CLIMBERS

simple regression: correlation coefficients and statistical significance

dependent variable	finger deformities	nodes	fusiform swellings	flexion deformities	painful fingers (number)	pain score	maximal perform. (uiaa)
age	0.086 .	0.084 .	-0.032 .	0.153 .	0.226 **	0.191 *	0.015 .
body height	0.147 .	0.207 **	0.053 .	0.066 .	0.000 .	0.031 .	-0.051 .
body weight	0.083 .	0.142 .	-0.077 .	0.165 *	0.084 .	0.104 .	-0.117 .
climbing activity	0.154 .	0.110 .	0.065 .	0.136 .	0.173 *	0.215 **	0.196 **
training d.a.w.	0.099 .	0.000 .	0.074 .	0.101 .	0.087 .	0.109 .	0.256 ****
pain score	0.226 **	0.047 .	0.134 .	0.233 ***	x	x	0.266 ****
maximal perform.	0.261 ****	0.122 .	0.196 **	0.161 .	0.120 .	0.266 ****	x

. n.s.      \* p<0.1      \*\* p<0.05      \*\*\* p<0.02      \*\*\*\* p<0.01  
D.A.W. days a week      INDEP. INDEPENDENT VARIABLE      PERFORM. PERFORMANCE

TABLE 6.

incidence of pain and damage of the hand in free climbers

	group		incidence	
	n		number	%
Clarke, 1984	60		21	35
Krause et al., 1986	55		44	80
Burtscher and Jenny, 1986	29			47
Leal et al., 1986	30		23	77
Rotman and Pelikan, 1986	80			> 40
Bertschi and Radlinger, 1986	76			91
Bollen, 1988	87		43	49
Rotman et al, 1988	69		52	75
Della Santa and Kunz, 1989	23			80
Rotman et al, 1989	173		136	79

TABLE 7.

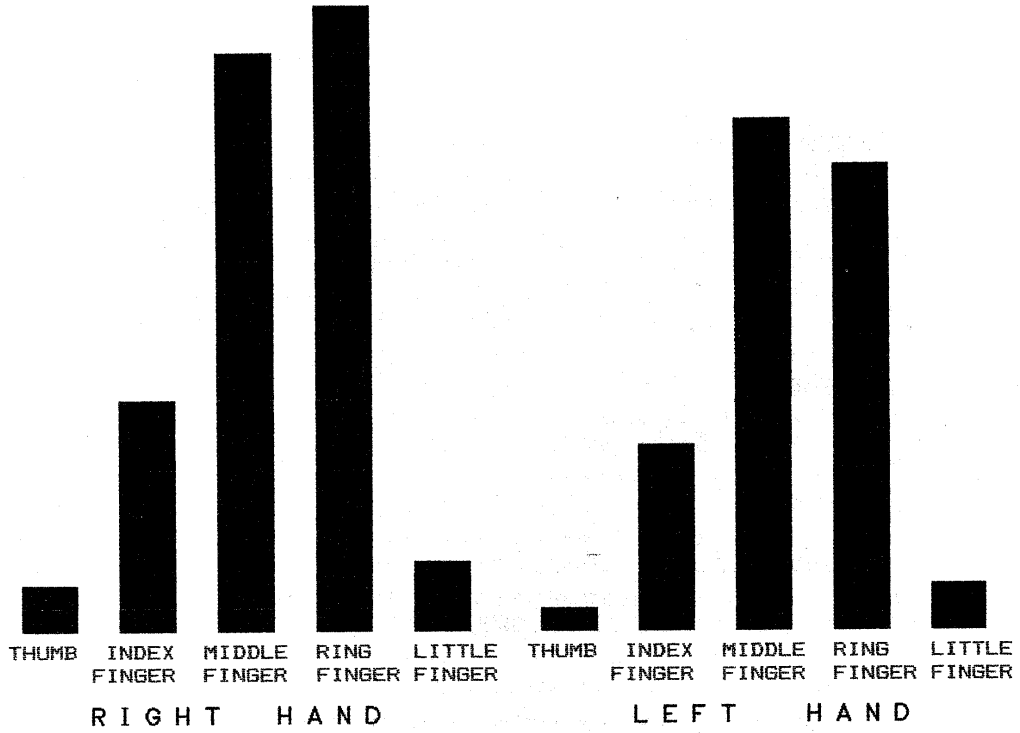
correlation between climbing difficulty grade  
and Broca's index of body weight  
in 100 Czechoslovak climbers

broca's index	climbing performance (difficulty grade uiaa)								
	4+	-	7	7+	-	9-	9	-	10-
< or = 85	NO			YES					
> or = 86	YES			NO					

[GUHA results, 1987]

FIGURE 1.

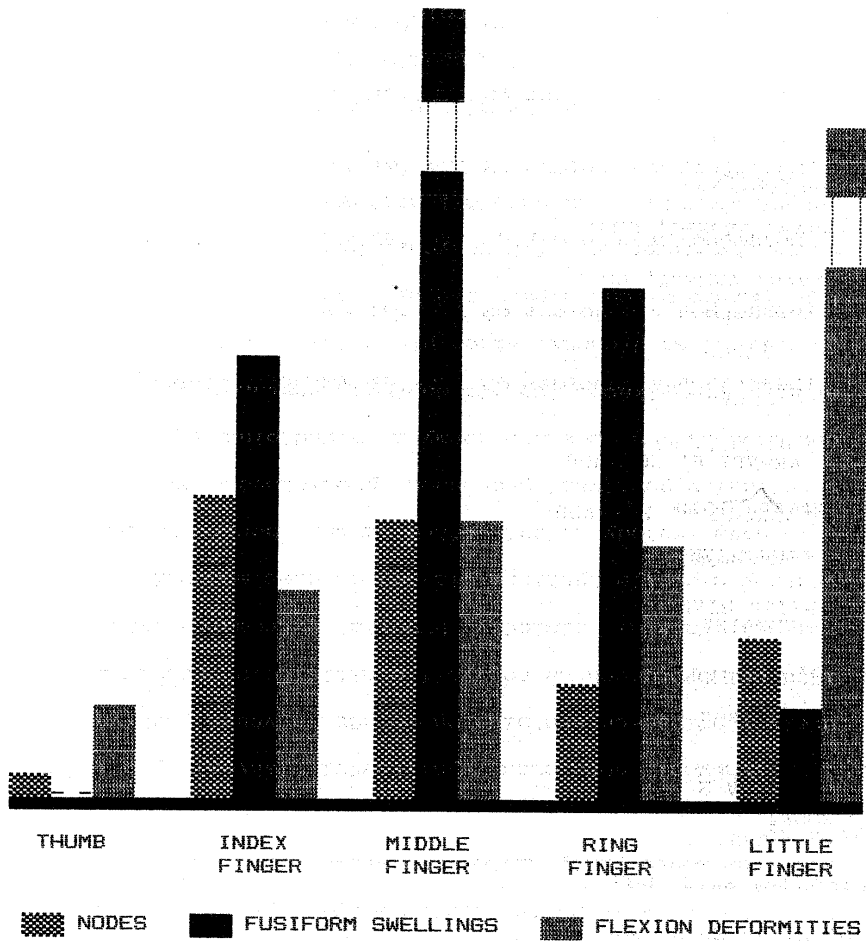
PAIN IN CLIMBERS' FINGERS (n = 176)



diaM.CHI

FIGURE 2.

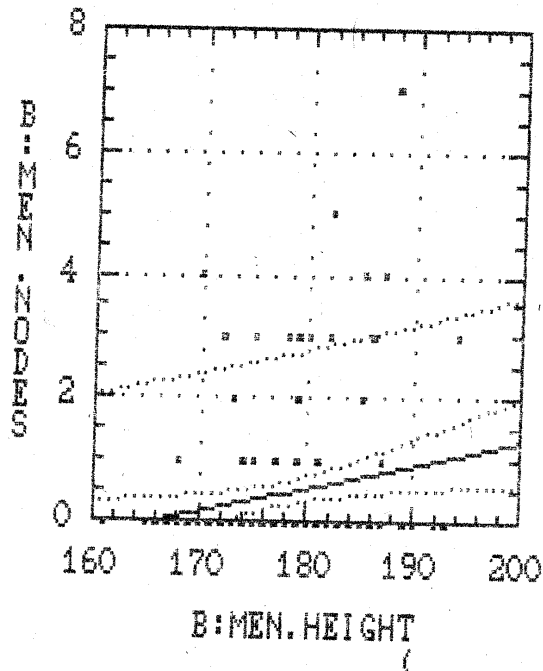
FINGER DEFORMITIES IN 176 CZECHOSLOVAK CLIMBERS



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FIGURE 3.  
REGRESSION OF FINGER NODES ON BODY HEIGHT

Regression of B: MEN. NODES on B: MEN. HEIGHT



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