# Wrist biomechanics during handstands: extension angle increases with training regularity

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## Summary

Performing a handstand is a skill that requires a person to carry their body weight through their upper limbs. This study investigates how handstand training regularity affects wrist extension angle. Extension angles were obtained during unassisted handstands and compared with unloaded ranges of motion. Active (regularly training) and occasional participants were recruited. The more regularly a person trains, the greater their extension angle is, which may result in greater ligament laxity and the potential for wrist pain.

## Introduction

The handstand is defined as the vertical alignment of the body on the hands. This skill can be found in many sports, such as calisthenics, yoga, and gymnastics. It is estimated that 46% to 88% of gymnasts experience wrist pain [1]. It is believed that this high prevalence may be related to the use of the upper extremities for weight bearing. During weight bearing, the wrist can be subjected to hyperextension and high compressive forces. To date, neither wrist extension during weight bearing nor how training frequency affects wrist range of motion (ROM) have been quantified in gymnasts. Thus, the objective of this study was to quantify wrist extension angle during unassisted handstands and to determine if training regularity increases wrist ROM.

## Methods

Twenty participants (8 female and 12 male, 23.8 ± 5.26 years old) took part in this experiment. By combining a motion capture system (Qualisys AB, Gothenburg, Sweden) with force plates (Kistler Holding AG, Winterthur, Switzerland), wrist angles [2] and ground reaction force were determined during four unassisted handstands. Participants' passive unloaded wrist ROMs were obtained after the handstand tasks.

Participants were divided into two groups: active (11 participants that train/perform handstands at least weekly) and occasional (9 participants that train/practice handstands less frequently). For each task and participant, the hand under greater load (bearing side) was determined from the vertical ground reaction force [3]. Based on the results of Shapiro-Wilk tests for normality, unpaired t-tests or Mann-Whitney U tests were performed to compare wrist extension angles as a function of training frequency and limb loading. Significance was defined as $p < 0.05$.

## Results and Discussion

No differences in wrist angle were found due to limb loading. The active group had greater wrist extension angles compared to the occasional group ($p < 0.001$, Figure 1).

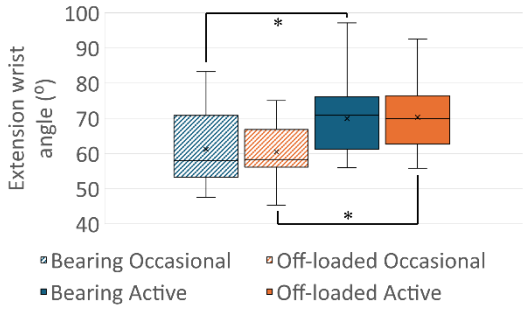


**Figure 1**: Wrist extension angles according to frequency of training (solid bars are participants who train more frequently) and ground reaction force magnitude (blue bars are hands that bear greater load) during unassisted handstands. * indicates $p<0.001$.

Unloaded wrist extension ROM also differed with training frequency ($p \leq 0.027$); the active population had a higher baseline for wrist extension, which could come from the regular training and loading. As ROM can be an indicator for ligament laxity, the active population's greater extension angle may be the result of over-stretching the ligaments when performing handstands. This can be corroborated by the fact that 69% of the trial's participants were hyperextending their wrists while in the handstand position; i.e., they were over the extension value obtained during the ROM trials. When the wrist is hyperextended, the length of the palmar ligaments increases by up to 25%, which puts the ligaments under greater tension [4] and may make them more prone to injuries. Regularly pushing the joint to extreme extension and having more lax ligaments could lead to conformational changes in the contact location between the carpal bones, which may be one the reason for the high incidence of wrist pain observed in populations of gymnasts.

## Conclusions

Handstand training appears to lead to greater wrist extension angles, which may indicate greater ligament laxity and may be a source of the frequent wrist pain reported by gymnasts.

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