

# BIOMECHANICAL ANALYSIS OF THE BACKBONE IN THE FIBULA PLANE FOR MEMBERS OF THE NATIONAL JUDO TEAM

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## INTRODUCTION

The shape of a backbone of an adult person in the fibula plane is curved and the curvatures can be characterized by their following angular values: neck lordosis - 18 degrees, chest kyphosis - 42 degrees, loin lordosis - 80 degrees, lower-back kyphosis - 125 degrees (Lewit, 1994). Most frequently, the top of chest kyphosis is the seventh chest vertebra and the top of loin lordosis - an inter-vertebra disk between the 3<sup>rd</sup> and the 4<sup>th</sup> vertebra. The following factors have an influence on the physiological curvature of the backbone: passive elements - bone system and dynamic elements - muscular system. The complex biodynamics of this system requires the application of an approach closely related to lower limbs, pelvis, head support as well as the muscle state and activity.

The aim of this paper was to determine the angle and line values of front-back curvatures of the backbone in normal posture and after a standard load and their changes under the influence of endurance training among members of the national wrestling team.

## METHODS

The examinations involved 27 selected members of the national wrestling team between the ages of 16 to 26 during a training camp which took place in Zakopane. The methods included examinations of the front-back curvatures before and after a 90 min. endurance training session in normal posture and with a standard 30 sec load (1/3 of the body weight of the examined) placed on the shoulders.

For evaluation of the results of selected parameters describing physiological curvatures in the examined wrestlers, a computer stand for evaluation of body posture - Posturometer M was used. The method and technique of examination conformed with generally applied principles (Mrozkowiak, 2002). The obtained results in the form of a 3D graphic allowed for a quantitative description of examined parameters.

Linear values are described by the distance between selected anthropometric points on the backs of the examined wrestlers, and the angle values of physiological curvatures of the backbone define differences between horizontal contours of spines tops of the vertebrae in chest and loin section. Statistical analysis was applied to the following values:

1. Angular (degrees): Alfa – inclination of loin-lower back section, Beta – inclination of chest-loin section, Gamma – inclination of upper chest section, Delta – the sum of angle curvature values, KLL – angle of loin lordosis ( $KLL=180-(Alfa+Beta)$ ), KKP – angle of chest kyphosis ( $KKP=180-(Beta+Gamma)$ ), KPTt – angle of trunk straightening in fibula plane, KPTp – angle of trunk bend in fibula plane.

2. Linear (millimeters): DCK – the distance between spines of the seventh of neck vertebra (C7) and the first of low back (S1), measured along the profile of the backbone. The percentage value is related to the height of the examined competitor (WDCK), DLL – the distance between the top of chest kyphosis (KP) and S1, RLL – the distance between point of transition of kyphosis into loin lordosis (PL) and S1, GLL – the depth of loin lordosis, the difference between contours of the top of the loin

lordosis and (LL) and PL, DKP – the distance LL – C7, RKP – the distance C7 – PL, GKP – the depth of chest kyphosis, the difference of contours KP – PL  
3. Indicators: WKP = GKP/RKP (ratio: depth to length of chest kyphosis), WLL = GLL/RLL (ratio: depth to length of loin lordosis), WDCK = distance LL – C7 in relation to height (%).

## RESULTS

The results were divided into two groups: results obtained before physical exertion and results after exertion. Within each examination there were two levels distinguished: 1 measurement in normal posture, 2 in a posture with standard load. This allowed the results to be processed statistically with respect to: average value, maximal and minimal, standard deviation, coefficient of variation for every examination class and level as well as for all measurements. The following grades were introduced for significance of difference between examinations: very high significance of difference  $\text{Alfa} < 0.001$ , average significance of difference  $\text{Alfa} < 0.01$ , significant difference to the small extent  $\text{Alfa} < 0.05$ , insignificant difference  $\text{Alfa} > 0.05$ .  
Angular parameters

**(2)Beta** – very significant difference: between measurement after physical exertion in normal posture and a posture with load; between measurement before physical exertion in the posture with load and after physical exertion in the normal posture; between measurement in the normal posture and the posture with load; between measurement before physical exertion in normal posture and after exertion.

**(7)KPTt** – very significant difference: between measurement before physical exertion in normal posture and with load; between measurement in normal posture and in posture with load after exertion; between measurements in normal posture before physical exertion and in posture with load after physical exertion.

**(8)KPTp** – very significant difference: between measurement before physical exertion in normal posture and the posture with load; between measurements after physical exertion in normal posture and posture with load, between measurement before exertion in the posture with load, between measurement in normal posture before exertion and the posture with load after exertion.

Linear measurements

**(9) DCK** – very significant difference: between measurements before physical exertion in the posture with load and in the normal posture after exertion.

**(10)DLL** – very significant difference: between measurements before physical exertion in the posture with load and in the normal posture after the physical exertion.

**(12)GLL and (15)GKP** – very significant difference: between measurements in normal posture and the posture with load before physical exertion, between measurements in the posture with load before exertion and in normal posture after exertion, between measurements in normal posture and in the posture with load after physical exertion, between measurements in normal position before exertion and in the posture with load after exertion.

**(13)DKP** – very significant difference: between measurements in posture with load before physical exertion and the normal posture after the exertion.

Indicators

**(16)WKP** – very significant difference: between measurements in normal posture and the posture with load before and after physical exertion.

**(17)WLL** – very significant difference: between measurements in normal posture and the posture with load after the physical exertion.

**(18)WDCK** – very significant difference: between measurements in normal posture and in the posture with load before and after physical exertion, between measurements in normal posture before exertion and in posture with load after physical exertion.

The differences between the average values of parameters in normal posture and those given by Neumann are due to different methods of examinations and the material specifically selected by the author.

Also important are significant differences between the results of examined features before exertion: (2)Beta, (5) KILL, (6)KKP, (7) KPTt, (8)KPTp, (10)DLL, (12)GLL, (13)DKP, (15)GKP, (16)WKP, (17)WLL, (18)WDKP, and after exertion: (2)Beta, (3) Gamma, (5)KLL, (6)KKP, (7)KPTt, (8)KPTp, (10)DLL, (11)RLL, (12)GLL, (13) DKP, (15)GKP, (17)WLL, (18)WDCK.

## DISCUSSION

The most significant differences indicating the influence of physical exertion on the examined values are the differences between parameters before and after exertion in normal posture ((9)DCK, (10)DLL, (11)RLL and (13)DKP) and between parameters before and after physical exertion in the posture with load ((8)KPTp, (9)DCK, (10)DLL and (18)WDCK). Also important were the differences of repeated parameters in the experiment before physical exertion in the posture with load and after physical exertion in the normal posture and before physical exertion in normal posture and the posture with load after exertion. As a rule, the results obtained after physical exertion are usually worse than those obtained before exertion although the difference is not significant ((2)Beta, (5)KLL, (6)KKP, (7)KPTt, (8)KPTp, (12)GLL, (15)GKP, (17)WLL and (18)WDCK.

There were no significant differences between the average values before and after physical exertion for normal position parameters: inclination angle of loin-lower back section (1) Alfa and the distance from spines of the seventh of neck vertebra until the transition of chest kyphosis into loin lordosis (14)RKP. Due to the application of a new method of the evaluation of body posture (Posturometer M), there were no references in the scientific literature to be compared.

An analysis of obtained results produced the following conclusions:

1. The greatest decrease in the value of the examined parameters as the result of endurance exertion in normal posture was found for the linear parameters: the distance between the spines of the seventh of neck vertebra and the first lower-back vertebra, measured vertically (9.DCK) - to an average degree; the distance between the top of chest kyphosis to the spine of the first lower-back vertebra (10.DLL) - to an average degree; the distance from the transition of chest kyphosis into lordosis to the first lower-back vertebra (11.RLL) - to an average degree.
2. The greatest decrease in the value of the examined parameters as the result of endurance exertion in the posture with load was found for the following parameters: the distance between the spines of the seventh of neck vertebra and the first lower-back vertebra, measured vertically (DCK) - to an average degree; the distance between the top of chest kyphosis to the spine of the first lower-back vertebra (10.DLL).
3. The endurance exertion clearly most negatively influenced the length of a backbone measured vertically (9.DCK) and the distance between the top of kyphosis to the first spine of lower-back vertebra (10.DLL) and the angle of trunk bend in the fibula plane (8KPTp).

4. The standard load and endurance exertion had the lowest effect on the following parameters: the angle of inclination of loin-lower back section (1. Alfa) and the distance between the seventh spine of neck vertebra to the transition of kyphosis into loin lordosis.
5. The applied 30-second standard load before and after the endurance exertion had considerably greater effect on the linear than angular parameters of the loin section causing additional small backbone inclination. This is backbone biomechanical adaptation to physical load.
6. The most highly significant changes in the examined parameters before endurance exertions were observed for: (2) Beta, (7)KPTt, (8)KPTp, (12)GLL, (15)GKP, (16)WKP and averagely significant for: (10)DLL and (13)DKP.
7. The most highly significant changes in the examined parameters after endurance exertions were observed for: 2) Beta, (7)KPTt, (8)KPTp, (12)GLL, (15)GKP, (17)WLL and (18)WDCK and averagely significant for (3) Gamma, (5)KLL, (11)RLL, (13)DKP and slightly significant for: (6)KKP and (10)DLL.
8. The examined backbone parameters of the wrestler before endurance exertion in the fibula plane in normal posture had the following angle values (in degrees):

Alfa = 7.02, Beta = 10.66, Gamma = 13.07, Delta = 30.74, KLL = 162.29, KKP = 156.28, KPTt = 1.5;

and linear (mm): DCK = 363.54, DLL = 246.16, RLL = 135.54, GLL = 17.85, DKP = 318.38, RKP = 226.90, GKP = 21.11;

and indicators: WKP = 0.09, WLL = 0.12, WDCK = 87.80.

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