

# Assessment of torque values of muscles acting on hip joint among women in age groups of 19-29 and 56-65 years

## Ocena wartości momentów sił mięśni działających na staw biodrowy wśród kobiet w grupie wiekowej 19-29 oraz 56-65 lat

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**Wstęp.** Choroba zwyrodnieniowa stawu biodrowego wiąże się z istotnym bólem, niesprawnością i obniżoną jakością życia. Wdrożenie skutecznej profilaktyki rozwoju zmian zwyrodnieniowych bioder, możliwość kontrolowania zmian w procesie rehabilitacji oraz diagnozowanie zagrożeń wynikających z osłabienia siły mięśni działających w obrębie stawu biodrowego, w znacznym stopniu zmniejszy występowanie tej choroby.

**Cel badań.** Określenie średnich wartości i norm momentów sił zewnętrznych stawu biodrowego. Porównanie zależności momentów sił mięśni antagonistycznych działających na staw biodrowy. Porównanie zmian średnich wartości momentów sił mięśni działających na staw biodrowy.

**Materiał i metoda.** Badana grupa obejmowała 116 kobiet. Pacjentki zostały podzielone na dwie grupy wiekowe (I grupa: 19-29; II grupa: 56-65). Badania przeprowadzone zostały w Zamojskiej Klinice Rehabilitacji WSZiA na stanowisku SPB2-FM.

**Wyniki.** Analiza wyników wykazała, iż najwyższe średnie wartości momentów sił wszystkich zespołów mięśniowych charakteryzują kobiety należące do grupy wiekowej 19-29 lat. Określono normy siły mięśniowej dla poszczególnych ruchów w stawie biodrowym w obydwu grupach wiekowych. Stwierdzono znaczny spadek średnich wartości momentów sił w porównaniu do grupy pierwszej. Zmiany inwolucyjne w największym stopniu dotyczą grupy mięśni prostujących staw biodrowy.

**Wnioski.** Siła mięśniowa najniższa jest w grupie mięśni rotujących staw biodrowy na zewnątrz, natomiast najsilniejszą grupą mięśniową są mięśnie przywodzące w stawie biodrowym. Szczególną uwagę w procesie usprawniania należy zwrócić na prostowniki stawu biodrowego. SPB2-FM jest stanowiskiem, które pozwala kontrolować zmiany w procesie rehabilitacji oraz diagnozować zagrożenia wynikające z osłabienia siły mięśni działających w obrębie stawu biodrowego.

**Słowa kluczowe:** siła mięśniowa, staw biodrowy, wiek, kobiety

**Introduction.** Osteoarthritis of the hip is associated with significant pain, disability and reduced quality of life. The implementation of effective prevention of development degenerative changes in the hips, the ability to control changes in the rehabilitation process and to diagnose risks of weakening muscle strength acting on the hip will significantly reduce the incidence of this disease.

**Aim.** The determination of the mean values and norms of external torques of the hip. The comparison of relations of torques value of antagonistic muscles acting on the hip joint. The comparison of changes of mean torques value muscles acting on the hip joint depending on the age.

**Material & methods.** The examined group comprised 116 women. The patients were divided in two age groups (group: 19-29 years; group II: 56-65 years). They conducted research at the Zamość Clinic of the WSZiA Rehabilitation on the position SPB2-FM.

**Results.** The analysis of the results showed that the highest mean torques value of all muscle teams are characteristic of women of the age group of 19-29 years. The norms of muscle power were determined for individual movements in the hip joint in both age groups. A decrease in the mean values torques was reported in comparison with the first group. The involution changes mostly concern the hip extensor muscles.

**Conclusions.** Muscle strength is the weakest in the group of muscles rotating the hip joint on the outside, while the strongest muscle group are adduction muscles. Particular attention should be paid to the rehabilitation process for hip extensors. SPB2-FM is a position which lets the rehabilitation control changes in the process and to diagnose threats resulting from weakening strength of muscles acting within the hip joint.

**Key words:** muscle power, hip joint, age, women

## Background

Already 30 years ago, in an article published in "Sports Medicine", it was pointed out that an athlete with a imbalance of hip joint muscle strength of more than 13% was 2.5 times more exposed to injuries [1]. About 65% of all injuries caused by sports, as well as those resulting from everyday life, were caused by overloading of a motor organ. Those overburdens are caused by repeating forced movement standards because of badly balanced muscle groups. A specified muscle (or a muscle group), as well as its antagonist, should work together. They must be balanced with regard to strength and flexibility. Everyday chores, as computer work, long lasting, forced static positions or repeated activities can evoke a muscular imbalance. It can be found in all people, regardless their age, profession and physical fitness. Exercise and appropriate prevention can improve mobility of the hip joint and thus reduce the number of injuries and in consequence reduce the incidence of hip osteoarthritis [2-5].

Hip joints are among the most important joints in a human body. In normal conditions they let us move the body with no excessive effort. Nevertheless, if a pathological process appears in a hip joint, it causes changes in movement patterns, which results in overloading within the spine and other joints in legs. The research authors have unanimously proved that pain problems within hip joints influence limitations in its mobility. That, in turn, influences a disadvantageous position of the spine and lower limb. This mechanism results in relieving of the aching limb by its bending, adduction and rotation to the outside, which, in turn, causes overloading of other anatomical structures. Such setup of a lower limb causes a muscle spasm, changing of setup and a natural movement pattern of the pelvis and sacro-iliac joint, forcing hypermobility of the opposite hip joint. Obviously all those changes in the pelvic setup exert a direct influence upon changes of the spine setup, especially its lumbar region, which, in turn, causes its secondary scoliosis. On the side of the affected hip joint there occurs also a functional limb shortening and a forced setup of a knee in flexion [6-8].

Further progress of the illness results in fixing of a cramp and appearing of degenerative changes in the knee joint. Together with progressive degeneration of hip joint, an inside rotation and extension becomes limited, which, in turn, causes lameness and hinders locomotive function [9]. The consequences of an untreated illness may cause ankylosis of the hip joint in a flexion-adduction position and outside rotation [10]. It results in generalized static-dynamic changes, which significantly handicap freedom of movement and affect the patient's whole life. In source materials one can find research results, confirming the influence of degenerative changes within the hip joint upon the

quality of life in affected people. According to Starowicz, patients had problems with fulfilling everyday chores, as well as with walking. Persistent pain affected also the emotional state of patients. It hindered their fulfilling the basic social functions, including the family and professional ones [11-13].

## Aim

The purpose of the present paper was the determination of average values of moments of outsider forces affecting the hip joint. The following research questions were formulated:

1. How are the average values of torques affecting the hip joint changing, according to the patient's age?
2. Which interdependences occur between the torques of antagonistic muscles affecting the hip joint?
3. What are the standards for the outside force moments for separated muscle groups in the hip joint, according to the patient's age?

## Materials and methods

The tested group consisted of 116 women. The patients were divided into two age groups, of 58 women each. The age group I consisted of women aged between 19 and 29 years (the average value amounted 23.12 years). The group II consisted of women aged between 56 and 65 years (the average age of 59.93 years).

To the study qualified were persons who did not suffer from any dysfunctions of hip or knee joints, any pain ailments of hip joints or lower fragments of the spine. Excluded were also women after the sciatica attacks. The subjects showed correct mobility ranges in hip joints, measured by a goniometer according to the rules of International Standard Orthopedic Measurements and mobility range standards by Zembaty.

The stand SPB2-FM may serve as a modern device for assessing, in the conditions of an isometric cramp, the torques of flexors and rectifiers, adductors and abductors, as well as outside and inside rotators of the hip joint. An examination carried out using that device enables us to assess effectiveness of rehabilitation of many hip joint ailments (for example the osteoarthritis). During that examination it is essential to create comparable conditions for all study subjects. Particular attention should be paid to the patient's position, preserving the angle of 135 degrees. Even within an ailment-affected joint a painless application of an isometric tension is possible, the patient can be stabilized, an axis of rotation of the hip joint can be set, the stand can be adapted for the patient's length of legs and the patient can be informed about the examination procedures before its beginning.

The course of examination: 3 trials were carried out for each kind of movement. The measurement time was fixed to 5 seconds, whereas after each trial a 30-second break was made.

The research was conducted in the Zamość Rehabilitation Center. The women declared being aware of their consent for participation in examinations. The tests were also accepted by the Bioethical Committee of Medical University at Lublin. The Statistica 10 program was used for the statistical analysis.

## Results

The highest average values of torques of all muscular bands were found in the women of the I age group. Also the deterioration of average values of torques was found as compared with the II age group. This phenomenon concerns all tested muscular bands affecting the hip joint. The strongest muscular band in both groups proved the adductors, whereas the weakest proved muscles rotating the thigh to the outside (tab. I, II, III, IV, V, VI).

The percentage juxtaposition of average values of torques in hip joint among the tested women, where

Table I. Mean of moments of power for movement of extension and their norm

Tabela I. Średnie wartości momentów siły dla ruchu wyprostowania i ich normy

Age group /Grupa wiekowa	x	s	Norm /Norma	
			From(x-s) /Od(x-s)	To(x-s) /Do(x+s)
19-25	59.28	33.79	25.49	93.08
56-65	21.27	8.76	12.50	30.03

x – average /średnia arytmetyczna

s – standard deviation /odchylenie standardowe

Table II. Mean of moments of power for movement of bend and their norm

Tabela II. Średnie wartości momentów siły dla ruchu zgięcia i ich normy

Age group /Grupa wiekowa	x	s	Norm /Norma	
			From(x-s) /Od(x-s)	To(x-s) /Do(x+s)
19-29	50.47	16.77	33.70	67.23
56-65	37.12	8.57	28.55	45.70

Table III. Mean of moments of power for movement of adduction and their norm

Tabela III. Średnie wartości momentów siły dla ruchu przywodzenia i ich normy

Age group /Grupa wiekowa	x	s	Norm /Norma	
			From(x-s) /Od(x-s)	To(x-s) /Do(x+s)
19-29	81.69	29.91	51.78	111.60
56-65	50.51	20.26	30.25	70.77

Table IV. Mean of moments of power for movement of abduction and their norm

Tabela IV. Średnie wartości momentów siły dla ruchu odwodzenia i ich normy

Age group /Grupa wiekowa	x	s	Norm /Norma	
			From(x-s) /Od(x-s)	To(x-s) /Do(x+s)
19-29	74.25	22.97	51.28	97.22
56-65	44.23	15.99	28.24	60.22

the value of torques in the I age group was assumed as 100%, shows the deterioration of muscular powers for all muscular bands. The greatest decrease was observed for the group of muscles straightening the hip joint – by 64.22%. The lowest decrease was noted for the group of bending muscles, reaching 26.45%. The deterioration of muscular power for outside rotators reached 46.10, whereas for the inside ones 43.74%. In the group of adductors of the hip joint the observed decrease reached 38.17%, whereas in abductors 40.43% (tab. VII, VIII, IX).

The greatest imbalance of power of the antagonistic muscles was noted for the group of muscles bending and straightening the hip joint. The difference between those values in the II age group amounted to about 2/3 of the initial value (tab. VII). In the remaining juxtapositions of antagonistic muscular bands the difference was low and amounted to 2.36% for the rotators of hip joint and 2.26% for the groups of adductors and abductors of the hip joint (tab. VIII, IX).

Table V. Mean of moments of power for movement of outside rotation and their norm

Tabela V. Średnie wartości momentów siły dla ruchu rotacji zewnętrznej i ich normy

Age group /Grupa wiekowa	x	s	Norm /Norma	
			From(x-s) /Od(x-s)	To(x-s) /Do(x+s)
19-29	28.98	7.27	21.71	36.25
56-65	15.62	6.47	9.15	22.09

Table VI. Mean of moments of power for movement of inside rotation and their norm

Tabela VI. Średnie wartości momentów siły dla ruchu rotacji wewnętrznej i ich normy

Age group /Grupa wiekowa	x	s	Norm /Norma	
			From(x-s) /Od(x-s)	To(x-s) /Do(x+s)
19-29	47.21	14.13	33.08	61.33
56-65	26.56	11.32	15.24	37.88

Table VII. Percentage comparison of mean of moments of strength of antagonistic muscles, with strength of muscles of women of I age group as 100%

Tabela VII. Zestawienie procentowe średnich wartości momentów sił mięśni antagonistycznych u kobiet, gdzie wartość momentu siły mięśni z grupy wiekowej 19-25 przyjęto jako 100%

Age group /Grupa wiekowa	Wyprost/Extension		Zgięcie/Flexion	
	Nm	%	Nm	%
19-25	59.28	100.00	50.47	100.00
56-65	21.27	35.88	37.12	73.55

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Age group /Grupa wiekowa	Adduction /Przywodzenie		Abduction /Odwodzenie	
	Nm	%	Nm	%
19-25	81.69	100.00	74.25	100.00
56-65	50.51	61.83	44.23	59.57

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Age group /Grupa wiekowa	Outside rotation /Rotacja zewnętrzna		Inside rotation Rotacja wewnętrzna	
	Nm	%	Nm	%
19-25	28.98	100.00	47.21	100.00
56-65	15.62	53.90	26.56	56.26

## Discussion

The hip joint is the most exploited joint of our body. All dysfunctions in its functioning hinder the static-dynamic work, not only in hip joints, but also in other joints, causing degenerative changes. Currently the hip joint is placed second as mostly affected by degenerative changes in elderly people [14]. Patients are informed too late about the diagnosed osteoarthritis in hip joint, which often results in a delayed certification for rehabilitation centers. In such advanced state there is hardly a chance for physical improvement of such patients, which, in turn, could improve their quality of life. The increase of the elderly people population caused the increase of patients suffering from coxarthrosis, subsequently named the “civilization ailment”. It shows that scientific studies contributing to the prevention of this problem and searching for the optimum rehabilitation methods are purposeful [2, 5, 8-10, 15, 16].

The analysis of the research conducted proved that the muscle power deterioration is associated with age and takes place in all muscular bands of the hip joint. The lowest muscle power occurs in the group of muscles rotating the hip joint to the outside, whereas the strongest muscle group are the adductors in the hip joint. Similar results were obtained by Mroczek and Siwek, who examined the patients in the age group of 20-25 years. They observed that the lowest average values of torques in the outside of hip joints occurred in the outside rotators, whereas the highest ones – in the group of adductors and abductors. Moreover, their research proved that torques in rectifiers are significantly higher than in flexors [17].

Our own study in the age group of 19-25 years showed that the greatest differences in the power of antagonistic groups of muscles occurred in rotating muscles of the hip joint. Nevertheless, in the age group of 56-65 years the higher differences were found in the group of hip joint flexors and rectifiers. It was observed that involution changes mostly affected the rectifiers of hip joint, as well as the greatest imbalance in power found was between rectifiers and flexors of the hip joint. Shortening of pace length, according to Horst, is one of the main results and symptoms of beginnings

of osteoarthritis in hip joint. It also indicates insufficiency of abductors, as well as decrease of power of hip joint rectifiers, as symptoms of degenerative changes of this joint [18].

Other scientists, such as Rasch et al., measured the muscular power during the maximum isometric cramp in knee and hip joints, then subsequently analyzed movements in separate phases of walking. Their research results proved that imbalance of muscular power during the extension and flexion of a hip joint caused incorrect locomotion and a limited range of mobility in joints during walking [19]. A similar comparison of values of muscular powers was also conducted by Whittington et al. They checked interdependences and changes regarding the power of muscles in hip joint, knee and ankle when standing, marching or running. They also found a significant advantage in the power of hip joint flexors [20]. According to Pingot et al., an imbalance in power of muscles extending and flexing of hip joints can influence the scoliosis. Exercises directed at strengthening of weakened muscles exert an influence upon the posture correction and can play a significant role in treating scoliosis [21].

The diagnostics of degenerative changes within a hip joint is currently conducted by the method of image examination, characterizing passive joint structures, as well as by the clinical assessment, requiring broad knowledge and experience from a diagnosing person. It does not, however, give a 100% secure result. According to Ziemiańska et al., who compared clinical symptoms and X-ray images in patients with degenerative changes in hip joints, it indicated lack of possibilities of assessing a clinical state of a patient on the basis of a radiogram [22]. The evaluation and diagnostics, with the use of such a sufficiently constructed measuring device as the SPB2-FM stand, enables us to conduct an objective and exact diagnostic examination. Moreover, it enables us to exert a controlled and informed influence on the correct course of medical rehabilitation process, deciding about the fitness regaining degree.

## Conclusions

1. The analysis of results showed that the highest average values of torques of all muscular bands occurred in women of the age group of 19-29 years.
2. The lowest muscle power was found in the group of muscles rotating the hip joint to the outside. It was slightly higher for the muscles rotating the hip joint to the inside; next were the muscles controlling the extension, flexion and abduction, whereas the most powerful were the adducting muscles in the hip joint.

3. It was found that the average values of torques decreased with age.
4. The SPB2-FM stand is a device which enables us to control changes during the rehabilitation process, as well as to diagnose threats resulting from weakening of the muscle power within the hip joint.
5. The present research, conducted on the group of healthy people, made an initial comparative basis for further examinations of persons suffering from pathological changes of the hip joint. It can also be used as an introduction to elaborating standards of muscle power of a pelvic girdle.

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