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Students' Knowledge Concerning the Correct Squat and the Elements of the Methodology of Teaching It

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Abstract

Background: A squat is one of the exercises commonly applied in sport, in school physical education classes, among amateurs practising recreational sport as well as in rehabilitation of children and elderly people. The role of the preventive effect of the correctly performed squat on the musculo-skeletal system is particularly highlighted, while threats posed by an incorrect performance of the exercise are simultaneously indicated. The aim of the work was to define the knowledge of students concerning the methodology of teaching the correct squat and to present methodological fundamentals in this field. **Material/Methods:** The research involved 412 students of physical education and of a special course for personal trainers. The diagnostic poll method with the use of two techniques, i.e. a questionnaire and knowledge test, was applied. The collected data were analysed statistically with the use of the Excel packet. **Results:** Over a half of the students examined in the test admit that they do not know what the correct squat looks like. The subjects also indicate the lack of knowledge concerning the methodology of teaching it. Over 86% of the respondents admit that during classes included in the studies curriculum they had no opportunity to observe the methodology of teaching the squat. Simultaneously, nearly 71% of the students indicate that an incorrect performance of this exercise may bring about negative effects in the musculo-skeletal system of a person practising sport. **Conclusions:** The knowledge of students concerning the methodology of teaching the correct squat is insufficient.

Keywords

squat, teaching methodology, knowledge, students

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Authors' Contribution:

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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Introduction

A squat is perceived as one of the most efficient exercises developing both strength and power [1, 2, 3, 4, 5]. It is a functional exercise which requires proper mobility of an ankle joint, hip joint and joint of the thoracic segment of the spine while sustaining the stability of feet, knee joints and the lumbar spine [6, 7, 8].

A squat is one of the exercises commonly applied in sport, in school physical education classes, among amateurs practising recreational sport as well as in rehabilitation of children and elderly people [7, 9]. It is also frequently used during everyday life activities [10]. A proper methodology of teaching the squat is broadly described in specialist literature, mainly in the English language, concerning professional and recreational sport. What is particularly highlighted is the role of the preventive effect of the correctly performed squat on the musculo-skeletal system, while at the same time threats occurring when the exercise is performed incorrectly are indicated [3, 6, 11]. Simultaneously, a low level of knowledge concerning the methodology of teaching the squat is highlighted in literature [8]. Paradoxically, it is simple and according to Rippetoe [8] it takes only 10 minutes to explain a correct model of the squat to people who practise both professional and recreational sport. What also draws attention is the fact that there are no systemised methodological clues in this field in Polish scientific and methodological journals.

An optimal model of the squat may be described as a movement performed without pain and discomfort but also including a proper behaviour of joints, muscle coordination and sustaining a proper body posture [12]. An incorrect performance of the squat leads to disturbing the balance and to limiting a proper support of joints by muscles, while repeating it regularly leads to consolidating a bad movement habit in the nervous system [13, 14].

A squat may be performed in numerous ways. Differences may occur in the size of external load, angular range of movement in particular joints, sustaining or not the axis of lower limbs, the position of feet or the width of their gauge. However, not all strategies (patterns) of performing a squat are safe for the musculo-skeletal system activity [7]. An incorrect performance of the squat may bring about a range of dangerous phenomena, e.g. a rise in transverse forces leading to an overload of an anterior and posterior cruciate ligament or in compressive forces in the femoropatellar joint [3, 9].

The aim of the work was to define the knowledge of students concerning the methodology of teaching the correct squat and to present methodological fundamentals in this field.

Material and Method

The research included 412 students of physical education and of a special course for personal trainers. The examined group included last-year students of Bachelor and Master studies at the Faculty of Physical Education and Sport in Biala Podlaska and the State College of Computer Science and Business Administration in Lomza who received credits for all their subjects and practical training included in the programme of the 3rd year of Bachelor studies and the 2nd year of supplementary Master studies.

The diagnostic poll method with the use of two techniques, i.e. a questionnaire and knowledge test, was applied [15]. The knowledge test for students included open questions, whereas the questionnaire included disjunctive, alternative and open questions. The collected data were analysed statistically with the use of the Excel packet (Microsoft Office, 2007).

Results

While analysing the collected results, first the students' knowledge concerning the methodology of teaching the correct squat and the source of this knowledge were defined.

Nearly 51% of students involved in the knowledge test reveal that they do not know what the correct squat looks like and that they do not know the methodology of teaching it either as an independent exercise or as an element of other exercises. Every third student claims that they know the methodology of teaching this exercise but they cannot describe it or provide any element which is significant while performing it.

Nearly 19.2% (n=79) of the students involved in the knowledge test claimed that they know the methodology of teaching the correct squat and they know what elements are significant while teaching and performing this exercise. However, it must be noted that the answers also included incorrect elements (Table 1).

Tab. 1. The correct squat according to students (N=79)

Significant elements in teaching the correct squat	N	%
While bending knee and hip joints, knees (in the sagittal plane) should not cross the line of toes	21	26.6
A half-squat should be performed without a full squat	19	24.1
While bending knee and hip joints, knees (in the sagittal plane) should cross the line of toes	13	16.4
Straight back, abdomen slightly pulled in	12	15.2
While bending knee and hip joints, knees should be taken aside	8	10.1
Feet cannot be detached from the floor and should be set at the width of hips	6	7.6

Students declared that they gained the knowledge concerning the methodology of teaching a correct squat mainly while attending theoretical and practical classes included in the studies programme. Over 20% of the students could not indicate the source of their knowledge. The detailed results are presented in Table 2.

Tab. 2. The source of knowledge concerning the methodology of teaching the correct squat (N=79)

The source of knowledge		N	%
Classes at the university	Fitness	21	26.6
	Gymnastics	16	20.2
	Corrective exercises	9	11.4
	Sports medicine	6	7.6
	Postural education	3	3.8
I cannot indicate the source of my knowledge		16	20.2
Scientific articles		4	5.1
Internet		3	3.8
Television		1	1.3

Next, the respondents were asked about the consequences of performing the squat incorrectly. Nearly 71% of the students answered that incorrect performance of this exercise might bring about negative effects in the musculo-skeletal system of a person exercising but they were not able to indicate what effects.

Over 8% of the students claimed that every squat is correct and its performance does not bring about negative effects in the musculo-skeletal system. Only every fifth subject (n=85) indicated negative consequences of an incorrectly performed exercise. However, it should be emphasised that there also occurred incorrect answers (Table 3).

Tab. 3. Negative consequences of an incorrect squat according to students (N=85)

Negative consequences	N*	%*
Knee joints overload	46	54.1
Ankle joints overload	31	36.5
Spine overload and spinal pains	12	14.1
Round back	4	4.7
Flat foot	2	2.4
The deepening of lumbar lordosis	1	1.2

* It does not add up to 100 (N%), as the subjects were allowed to indicate more than one answer

In the further part of the research students were asked to present their opinion on the knowledge and skills concerning the methodology of teaching the correct squat which they gained

in the course of studies. They were also asked what knowledge concerning the correct squat children, youth and people practising sports have.

Over 86% of the respondents admitted that they had not participated in classes during which a teacher, trainer or a person conducting the classes would teach children and youth how to perform the correct squat.

Nearly 13% of the respondents claimed that the knowledge concerning the methodology of teaching the correct squat which they gained in the course of studies was sufficient. Over a half (63.3%) of the students included in the research indicated that they were not prepared to educate other people in this area. Simultaneously, the majority of the subjects (87.4%) indicated that a squat is often used during physical education lessons as a separate exercise or as an element of other exercises. It must be highlighted that 82% of the respondents claim that getting to know the methodology of teaching the correct squat would be useful in the work of a trainer and physical education teacher as well as of a free time animator.

Methodology of Teaching the Squat

Stage 1 – hinge movement in hip joints

According to Cook's concept [6] the squat requires mobility in an ankle joint, hip joint and joint of the thoracic segment of the spine as well as the stability of feet, knee joints and the lumbar spine. He suggests that learning the squat should start from gaining a skill of a correct isolated movement in hip joints (i.e. hip hinge).

However, it must be remembered that this movement is not a forward trunk flexion. It is rather a hip hinge with a maximal transfer of body mass backwards on heels, while sustaining physiological curvatures of the spine. It is especially important to sustain a neutral position of the lumbar segment of the spine [16] (Fig.1).

In order to raise the effectiveness of this exercise, it is recommended to perform it on one leg. In the first phase it is recommended to perform this exercise with a simultaneous movement of both upper limbs (Fig. 2). Next, this exercise is performed with a simultaneous movement of the opposite upper limb. It should be straight in the elbow joint and should be held in the position between an interior and exterior rotation. It is also vital to avoid pelvis rotation [16].



Fig. 1. Hip hinge



Fig. 2. Hip hinge performed on one leg

Additionally, a load held in both hands or in one hand can be used. In the first case an exercise will be directed at the development of strength, while in the second one, with regard to the

opposition to the rotary force brought about by an external load (kettle-bells, dumb-bells, barbell), mainly stabilisation will be shaped [6, 16].

Stage 2 – the correct squat

After learning a proper movement in hip joints the second stage can be commenced. The correctly performed squat has got the following features:

- head – in a neutral position (gaze directed horizontally or slightly up),
- thoracic segment of the spine – slightly straight, mobile,
- lumbar segment of the spine – in a neutral position, stable,
- hip joints – bent, moved backwards, mobile,
- knee joints – set in a line between hips and feet, stable,
- feet – set at the width of shoulders, in a neutral position or 7°-10° aside, heels touching the floor, stable,
- the trunk angle during the squat should be stable in every phase,
- optimal depth of the squat: the angle of the bend in a knee joint – 90° (Fig. 3),
- maximal depth of the squat: 115°-125° (thighs are parallel to the floor),
- the performance of a squat is commenced from a bend in hip joints and then in knee joints [3, 7, 17, 18].

Stage 3 – functional exercises with the use of the correct squat

At a further stage, dynamic exercises, frequently directed at particular physical skills useful in particular sports, are performed. The basis for each exercise is obeying the rules presented in the 1st and the 2nd stage. In Figure 4 an example of a more difficult exercise using the squat is presented [19, 20, 21].



Fig. 3. The correctly performed squat



Fig. 4. The squat performed on an unstable surface

Discussion

According to students, the squat is a frequently used form of movement both as a separate exercise and as an element of other exercises. They also recognise the usefulness of the knowledge of the methodology of teaching the correct squat, especially in the aforementioned context of using it frequently during physical education classes and in sports training.

However, it is worrying that the students' knowledge in this field is insufficient. From among 412 students involved in the research only 79 people claim that they know the methodology of teaching the correct squat. However, it should be highlighted that all the elements indicated by the students may be accepted as correct ones as far as teaching the squat is concerned. 60% of the students who claimed to know the methodology of teaching the squat indicate their university classes as a source of knowledge, whereas 86% of the respondents highlight that they did not participate in practical classes during which a person conducting them (academic teacher, physical education teacher, trainer) would use the elements of the methodology of teaching the correct squat. It should be highlighted that the students involved in the research attended all the theoretical and practical classes, physical education lesson observations, sports training sessions or School Sports Club classes included in the studies programme, assisted in such classes or underwent teaching practice in schools, kindergartens and sports clubs.

The presented results comply with the research conducted in the group of 467 students of the last year at the faculty of physical education, which indicated gaps in knowledge and preparation of prospective physical education teachers, trainers and free time animators as far as the harmful influence of incorrectly performed exercises on the musculo-skeletal system of children and youth is concerned [22]. However, it seems significant to spread the research to students of various universities educating physical education teachers or trainers, which would allow gaining a full picture of knowledge and skills in the field of the methodology of teaching the correct squat.

The correctly performed squat brings a variety of benefits for a person exercising, i.e. it positively influences the speed of running, it improves the height of a jump-up and the length of jump. It is a functional exercise and brings about a tension of hamstring muscles twice as big as during exercises in the open kinematic chain. With a proper performance technique it constitutes an ideal element preventing the musculo-skeletal system overloads [3, 23]. Additionally, a single-leg squat positively influences the shaping of stabilisation [21]. Correct squat exercises are also significant as far as the prophylaxis of spinal pains is concerned since these are caused by an improper way of lifting and picking up objects [24].

In order to make use of the benefits of this exercise a key aspect is to avoid mistakes during its performance. The most common mistakes include:

- setting feet broader than the width of shoulders. It leads to a higher activity of a long adductor muscle and, as a consequence, to raising the moments of forces affecting knee and hip joints [10, 25];
- raising heels during the squat. A common reason for raising a heel during the squat is the shortening of a soleus muscle. As a consequence, knee joints lack stability [6, 14];
- an incorrect position of knee joints in the coronal plane (valgity or varus deformity in knee joints). The lack of proper control over the position of knee joints usually results from disorders in the activity of diarticular muscles surrounding this joint, i.e. hamstring muscles, calf muscle, straight muscle of thigh and disorders in muscles stabilising the pelvic girdle in the coronal plane, i.e. the weakness of a middle gluteal muscle and/or the contracture of a hip joint adductor [5, 6, 7, 9, 12, 13, 14, 26, 27, 28];
- the lack of control over the position of knee joints in the sagittal plane resulting in an excessive protrusion of knees over the line of toes. Presently a protrusion of joints over the line of feet by a few centimetres is recommended [9];
- the lack of control over a deep squat (an excessively dynamic way of performing the exercise) leading to the situation in which the anterior surface of a thigh touches calf muscles. It leads to the transfer of the rotary axis in the knee joint backwards and to the occurrence of dislocating forces as well as to the excessive stretching of an anterior crucial ligament [7];
- the lack of control over a neutral position of the lumbar segment of the spine. A typical strategy during the squat is a posterior inclination of a pelvis and a bend in the lumbar segment of the spine [7, 29];
- the lack of control over a neutral or slightly straight position of the thoracic segment of the spine (the deepening of thoracic kyphosis) [6, 13, 14, 29, 30];

- not sustaining a constant angle of the trunk inclination in every phase of the squat, which indicates the lack of control and stability in the lumbar segment of the spine [6, 14, 29];
- a bend of the cervical segment with the head bent leading to the deepening of thoracic kyphosis [7, 31].

The aforementioned facts indicate that there are numerous possibilities of making a mistake during the squat. Thus it is more important to teach the technique of performing the squat properly already in primary school and during physical education classes. Also sports training, especially in the case of beginners, should take into consideration the proper methodology of teaching it. Improper movement habits may lead to a higher frequency of injuries in the future. Therefore, it sets proper requirements for physical education teachers, trainers and sports instructors.

According to the proper methodology of teaching the squat, in the first phase mainly a proper hip hinge should be taught. The aim of this is to transfer the movement (and as a consequence to take away the load) from knee joints which are frequently incorrectly engaged during the squat. This movement improves muscle strength, body awareness and in the case of a single-leg performance it allows for catching and then reducing the left-right asymmetry. It is significant that this movement activates both local and global muscles [21].

It is equally important that antagonistic muscles cooperate during the squat. A quadriceps muscle of the thigh (especially the lateral and medial vastus muscle) serves as the so-called primary mover. A peak activity of this muscle occurs with the angle 90° in knee joints without a further growth in bigger angles of bend. This fact is supported by the opinion that a half-squat to the bend angle 90° is an optimal depth of the squat [32]. A significant role during the squat is also played by the greatest gluteal muscle and hamstring muscles. The training of only quadriceps muscles without activating antagonists may lead to the muscle misbalance and, as a consequence, to a greater risk of injury [32]. The role of hamstring muscles is bigger during eccentric action since their activity grows as the centre of body mass lowers and reaches maximum when thighs are set parallel to the ground [32, 33].

As far as prophylaxis is concerned, it is significant that transverse forces occurring during a squat and leading to the transfer of tibia forwards with regard to the femoral bone and raising the tension of the anterior cruciate ligament are juxtaposed by the activity of hamstring muscles. It can be achieved in co-contraction by applying a proper model of the squat based on beginning the movement from bending hip joints transferring them backwards and bending the trunk forwards [21, 33, 34].

As it was mentioned before, the squat is used not only during sports activity but also in numerous everyday activities. Its correct performance provides the person exercising with numerous benefits and constitutes a significant element of health prophylaxis [6, 13, 14]. Therefore, taking into consideration the advantages of the correct squat, negative consequences of its incorrect performance and a low level of students' (future physical education teachers and trainers) knowledge, it is crucial to fill the existing gap in the field of the methodology of teaching the correct squat.

Conclusions

1. The knowledge of students concerning the methods of teaching the correct squat is insufficient.
2. Students recognise a significant role of the squat during physical classes. Simultaneously, they highlight the need for learning the methods of teaching it, which indicates the necessity to implement issues connected with the methods of teaching the correct squat during theoretical and practical classes in the course of studies.
3. The correct performance of the squat constitutes a significant element of the prevention of musculo-skeletal system injuries.

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