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Original Article

Comparison between q angle measurements and their relationship with knee health in women practicing and not practicing futsal

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Abstract:
Introduction: Futsal is a sport that requires technical gestures that overload the knee, increasing the risk of injury in these regions. Apparently, the quadriceps angle may have some influence on the health of the knee. Therefore, further investigations are important to quantify and qualify the postural profile of athletes in this modality. **Objectives:** To verify how the strengthening of the muscles that involve the hip joint, as well as the stabilizing muscles of the knee joint, can interfere in the treatment of patellar instability. **Methods:** The knees of 16 young women were evaluated (NPG = 8 physically inactive; and GFP = 8 futsal players). To verify the disorders related to the knees, a Lysholm Knee Score Scale questionnaire was applied, then, using reflective markers, photogrammetry was used to analyze the deviations of the lower limbs. The comparison between the measures of postural deviations of the lower limbs and the scores obtained by a questionnaire was analyzed using the test of comparison of independent means. Pearson's correlation was performed to verify the relationship of data between the two groups. **Results:** In the trained group, no significant correlations were observed between the quadriceps angles and the scores obtained through the questionnaire. On the other hand, in the sedentary group, there was a high negative and significant correlation between the angle of the left quadriceps and the scores found in the application of the questionnaire. **Conclusion:** There are no differences in the indicators of knee discomfort between athletes and non-futsal athletes. However, the results suggest that there may be a protective effect on knee health in response to the practice of futsal by women.
Key Words: Performance evaluation, Sports, Rehabilitation, Biomechanics.

Introduction

The knee is a joint developed to support enormous loads. Thus, it provides an optimal performance in locomotion activities in daily life or in sport (Silva, 2012). It is located in the central region of the lower limbs, and has a wide range of movement, ranging from rolling, sliding, flexing/extending and internal and external rotation (Burmann et al, 2011). Silva (2012) characterizes the knee as a hinged synovial joint presenting two joint systems in its structure, they are: the tibiofemural joint complex and the patellofemural joint. The knee joint, due to its great utility, is predisposed to a greater number of injuries of mechanical origin, because of its anatomical characteristics. Anatomical characteristics, as well as neuromuscular and biomechanical characteristics, can predispose individuals to some types of injuries (Burmann et al, 2011; Schickendantz and Weiker, 1993).

Observing the joints that make up the knee terms, the patellofemoral joint is susceptible to suffer a higher rate of injuries of mechanical origin, affecting mainly women, in approximately 58% (Petri et al, 2015). Because of this, the lateral force on the patella can be changed according to two characteristics: hips slightly wider in relation to height (characteristic in women) and the femur in medial rotation position (Silva, 2012).

Powers et al, (2013) indicate that the Q angle is influenced by three movements that the lower limbs are capable of performing, they are: tibial rotation, femoral rotation and valgus knee. The Q angle will be influenced distally, through the movement of the tibia in relation to the femur, the lateral tibial rotation will cause the tibial tuberosity to move laterally causing an increase in the Q angle. The Q angle may also be increased when it is proximally influenced by the femoral rotation, caused by the increase in medial rotation of the femur, when observing the path that the patella performs in the flexion and extension movements that medially occur the anteroposterior iliac spine and the tibial tuberosity. The valgus knee may be the result of femoral adduction, tibial abduction, which predisposes the patella to the tibial tuberosity, or a combination of these factors (Belchior et al, 2006; Powers et al, 2013).

According to Stalker (1987), the Q angle would not be directly linked to patellofemoral pain and would contribute as a maintenance factor for patellofemoral pain syndrome (SDPF), in cases where it is already

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installed. In addition to the muscular imbalance of the vastus lateralis and vastus medialis muscles, the increased Q angle and consequently the valgus knee, other factors may be predisposing to SDPF such as femoral anteversion, external tibial torsion, subtalar hyperpronation, trochlear dysplasia, high patella, rigidity of the iliotibial tract and weakness of the abductor and lateral hip rotator muscles (Andrade et al, 2009; Lee et al, 2003; Powers et al, 2013; Witvrouw et al, 2000).

Based on what has been specified, several authors have suggested that there is an association between weakness or decreased motor control of the hip muscles and SDPF. As seen, a deficit in the control of the hip can cause an abnormal patellar sliding increasing stress on the patellofemoral joint leading to softening of the articular cartilage (Nakagawa, 2008; Powers, 2003). Therefore, an appropriate treatment for individuals with SDPF could include a training program aimed at improving the function of the abductor and lateral rotator muscles of the hip, in order to control the movement of the femur and prevent / minimize lateral forces acting on the patella (Nakagawa, 2008).

Sports practice is an external factor that has great potential for the adaptation of the soft tissues of the human body, including those responsible for motor and postural control (Cohen et al, 1997; Cronin et al, 2012). Demands related to different sports, whether individual or collective, direct the adaptation of muscles, and this adaptation tends to be related to the level of morphological requirement imposed by their practice (Cohen et al, 1997). The knee joint, due to its supportive characteristic weight and mobility, is one of the most affected by stress-related injuries (Cohen et al, 1997; Giglio, 2003). To date, few studies have been devoted to verifying the impact of women's postural profiles, and their relationship with the health of the knee joint, with these changes as a control factor.

Nowadays football needs physical qualities that are independent of the position in which the player occupies, such as: fast acceleration ability, good jumping ability, excellent performance in running speed, explosive strength preferably in the lower limbs, speed resistance are some factors constantly required for athletes (Silva, 2000). Soccer played by women has become more and more popular in several countries, demanding more and more of the athletes a preparation with reduction of risk factors for injuries. Among the most common in women who play soccer, the rupture of the anterior cruciate ligament stands out, as well as the recurrent pains reported in the knee joint as a whole.

To date, few studies have compared knee pain indicators and the relationship of these indicators with postural deviations from the Q angle, considering women athletes and non-athletes. Our hypothesis is that the practice of sport could influence, in some way, the quantity and quality of the postural profile observed in young futsal players, in comparison with their untrained counterparts. Thus, the objectives of the present investigation are: a) to compare the values of the quadriceps angle and the knee health score assessed by a questionnaire of university level futsal players in relation to their untrained counterparts and; b) verify the relationship between the quadriceps angle values and the score achieved by both groups (futsal and untrained).

Material & methods

Search and Sample

This investigation is characterized as a quantitative approach and with a cross-sectional design. The sample consisted of 16 young women, 8 of whom were part of a futsal team (GPF; N = 8) at university level, and the other half belonging to a control group that did not practice any type of physical or sports activity (GNP; N = 8), who accepted to participate in the study voluntarily. Participants were duly informed about the study, its objectives and procedures. Only participants who gave their consent were included, and they gave their written consent in accordance with the Declaration of Helsinki. All procedures followed the rules of the Ethics Committee on Human Trials of the Federal University of Pernambuco, being approved with the CAA: 37933420.9.0000.9430, with the number: 4.461.216.

Anthropometric measurements

To check the anthropometric profile, collections were performed by only one skinfold thickness assessor at the medial and proximal thigh, axillary, thoracic, vertical abdomen, suprailiac, subscapular, triceps, biceps and calf abdomen, and also from the thigh perimeter, according to procedures described by Petroski and Pires-Neto (1995). Body mass and height were collected in properly calibrated equipment and expressed in kilograms, with an accuracy of 0.01kg, and centimeters, with an accuracy of 0.1mm. The body mass index values were calculated and expressed as recommended by the World Health Organization (WHO), in kilogram per square meter (km/m^2).

Postural assessment of the patellofemoral joint

We chose to use the photogrammetry method to assess postural deviations in the lower limbs, with an emphasis on the diagnosis of the quadriceps angle (ÂQ), based on the marking of anatomical points according to the standardization required by the SAPO software version 3.0 (USP, Brazil). To check bone points, a palpatory method was used, with determination of the lateral, medial, upper and lower patellar borders, with subsequent intersection between the four points to determine its center, and the tibial tuberosity (Figure I, A). After locating the points, reflective markers were set for highlighting and analyzing the photos. The volunteers were

anatomically positioned, with their feet parallel and directed forward, separated by the same hip width. It was suggested that they maintain the posture in a "relaxed" way, avoiding contractions of the muscles of the lower limbs. The photos were collected in a digital camera with a resolution of 14 megapixels (Samsung, model ES75, Japan), being positioned and a standardized distance of 3 meters (Figure I, B).

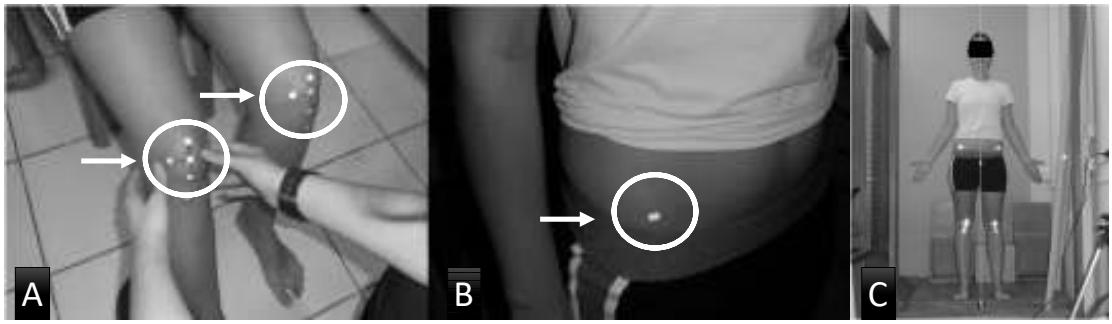

Fig. I Demarcation of bone points for fixing reflective markers (A and B); Visualization of a model of the photos used for analysis (C).

Evaluation of disorders and symptoms in the knee joints

To check for knee-related disorders, a Lysholm Knee Score Scale questionnaire was administered, duly validated for Portuguese by Peccin et al, (2006). The instrument consists of 8 multiple-choice questions, with closed-ended alternatives, the final result of which is expressed in nominal and ordinal scale, being “excellent” from 25 to 100 points; “Good”, from 84 to 94 points; “Regular”, from 65 to 83 points and “bad”, when the values are equal to or less than 64 points. All volunteers answered the questionnaire independently, with the possibility to mark the questions according to the signs and symptoms from both knees, dominant and non-dominant.

Statistical analysis

Preliminary exploratory analyzes were carried out to verify the assumptions of normality of the data, definition of measures of central tendency and variability. Initially, the measurements of postural deviations in the lower limbs and the scores achieved in the questionnaire were compared using the independent means comparison test. Then, in order to verify the relationship between postural deviations and the result (in the form of a score) of the questionnaire, Pearson's moment-product correlation coefficients were verified in both groups (trained and control). The data were analyzed using IBM SPSS Statistics version 26.0. (SPSS Inc., Chicago, IL). For all conditions, a value of $P \leq 0.05$ was considered significant.

Results

The descriptive data of the anthropometric characteristics of the volunteers, as well as the variables related to postural deviations of the lower limbs are shown in table I.

Table I. Descriptive values of the anthropometric, postural and knee health variables of the volunteers from both groups analyzed (N = 16).

Variables (U.M)	Group GFP				Group NPG			
	Average	DP	Minimum	Maximum	Average	DP	Minimum	Maximum
Weight (kg)	54,46	5,37	48,41	51,50	53,60	5,62	47,00	61,20
Height (m)	158,78	8,67	151,14	167,2	156,70	2,82	154,0	167,0
BMI ($kg.m^2$)	20,89	2,31	18,00	23,23	22,68	1,75	19,19	24,75
RQA (degrees)	17,63	6,21	10,10	27,10	10,24	6,01	1,20	18,20
LQA (degrees)	20,49	5,64	14,14	30,20	16,16	10,36	3,00	32,80
Lysholm (score)	75,25	19,03	42	100	80,63	9,59	66,00	95,00

Note: U.M (units of measure); GFP (group futsal players); NPG (non-practicing group); BMI (body mass index); RQA (right Q angle); LQA (left Q angle); SD (standard-deviation).

There were no significant differences in the quadriceps angle and knee health questionnaire variables ($P > 0.05$). Checked using the t test for independent samples. Table I and II show the values of Pearson's moment-product correlation coefficients between the knee postural deviation variables and the scores achieved in the knee health questionnaire in the trained (GFP) and sedentary group (NPG) groups, respectively.

Table II. Values of Spearman's correlation coefficients between postural variables and scores found in the Lysholm questionnaire for the sedentary group (n = 8).

	RQA (degrees)	LQA (degrees)	Lysholm (score)
RQA (degrees)	-----	0,11	-0,04
LQA (degrees)	0,11	-----	-0,93**
Lysholm (score)	-0,04	-0,93**	-----

Note: **p <0.01 (level of significance found in the statistical test); RQA (right Q angle); LQA (left Q angle).

Table III. Values of Spearman's correlation coefficients between postural variables and scores found in the Lysholm questionnaire for the trained group (n = 8).

	RQA (degrees)	LQA (degrees)	Lysholm (score)
RQA (degrees)	-----	0,34	-0,09
LQA (degrees)	0,34	-----	-0,67
Lysholm (score)	-0,09	-0,67	-----

Note: RQA (right Q angle); LQA (left Q angle).

In the trained group, no significant correlations were observed between the quadriceps angles and the scores obtained through the questionnaire. On the other hand, in the sedentary group, there was a high negative and significant correlation between the left quadriceps angle and the scores found through the administration of the questionnaire.

Discussion

The knee joint represents about 50% of the injuries that can affect the osteoarticular system of the human body. Among the problems that we can relate to the knee, the most common complaint is that of anterior knee pain (AKP). Research indicates that it constitutes 25% (twenty-five) of injuries that are related to the knee and 5% (five) represent sports injuries. It can be classified as the most common complaint in 20% of the population, affecting mainly women aged between 15 and 25 years. The most frequent complaints of individuals who present with patellofemoral dysfunction are: AKP, peripatellar edema, femoropatellar joint block and crackle. They usually present bilaterally, on both knees and may show periods of pain when the knee remains flexed for a long time, getting up from a sitting position, going up and down stairs, running or weight training (Belchior et al, 2006; Nakagawa, 2008). The aim of the present research was to verify possible differences between the quadriceps angles of both knees, as well as the scores obtained through the Lysholm questionnaire, duly validated for portuguese, between university level futsal players. There were no significant differences in the Q angles of both knees between the trained and sedentary groups.

Analyzing the groups individually, the correlation coefficient values showed that there are no associations between the right and left Q angles and the scores obtained in the Lynsholn questionnaire, for the trained group. Conversely, for the sedentary group, a high negative and significant correlation was observed between the values of the left Q angle and the scores obtained in the Lynsholn questionnaire ($r = -0,93$; $P<0,01$), showing an inversely proportional association between the Q angle and the score achieved by the questionnaire. This association may be related to a possible protective effect of the non-dominant limb in keeping the thigh-leg segment oriented towards smaller Q angles. The sedentary activities of the group of untrained women themselves may have influenced the mechanism of conservation and stability of the left knee joint, generating smaller values of angle Q. Still, further studies are necessary to verify biomechanical, anthropometric and postural characteristics in a jointly, allowing more accurate analyzes regarding the stability of the joints of the lower limbs in static and dynamic positions.

It is important to highlight that, although there were no significant correlations between the Q angle and the answers to the questionnaire for the group of indoor soccer players, the Spearman coefficient values point to a moderate, but not significant, negative correlation ($r = - 0,67$; $P>0,05$), a fact that somewhat approximates the results between the trained and sedentary groups. It is known that futsal is a collective invasion sport, which provides intermittent displacements in different directions of the court. The fact that they produce lateral and frontal displacements, in a sinuous way or in a straight line, requires the contribution of strength and resistance of the lower limbs to maintain balance and posture. The strengthening of some specific muscle groups could help prevent injuries related to the joints that support the loads of a match, with special attention to the patellofemoral joint. Recently, attention has been paid to strengthening and functional training of the muscle group involving the hip and lumbopelvic joint in the treatment of pathologies of the knee, more specifically of SDPF. Powers (2003) conducted a study using kinetic magnetic resonance in women diagnosed with SDPF and patellar subluxation. In the study, medial / lateral displacement of the patella, patellar inclination, patellar rotation and femoral rotation were evidenced during the extension of the knees with and without the use of overload.

Boling et al. (2006) analyzed the effect of a rehabilitation program on individuals with SDPF that contained exercises to strengthen the muscles of the hips and quadriceps using weight lifting exercises, the study duration was six weeks, on the electromyographic activity of the quadriceps and gluteus medius, as well as and with a functional questionnaire. The results showed a significant improvement in pain, in the functional questionnaire and in the difference in the time to start activation of the vastus lateralis and vastus medialis

muscles. Regarding the start time or duration of activation of the gluteus medius, no significant results were found. A limitation of the present study is the absence of data related to the strength of the adductor and abductor muscle groups, in order to quantify the impacts and associations of the posture deviations (notably the Q angle) in the respective values of muscle strength or in the indexes of symmetry for the antagonistic muscles. It is recommended that further studies be carried out in order to verify which relationships exist between the muscular strength of the lower limbs and other postural variables, such as patellar deviations (Boling et al, 2006).

Conclusions

In conclusion, we were able to verify that there are no differences in the indicators of discomfort in the knees when comparing women practitioners and non-practitioners of sedentary futsal. In contrast, take advantage of knee discomfort indicators and Q angle values for sedentary women. These findings may indicate that lower values of the Q angle for one of the limbs seem to have a greater protective effect on knee health, probably due to the decrease in asymmetry caused by bilateral sports, in this case, indoor soccer. However, further studies involving the systematic practice of futsal with follow-up in the medium and long term are necessary to ascertain causality assumptions between the practice of futsal and knee health in women.

Conflicts of interest If the authors have any conflicts of interest to declare.

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