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THE EFFECT OF POSTURAL DEVIATIONS IN THE OCCURENCE OF SPORTS INJURIES IN GYMNASTS

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SUMMARY

The development of gymnastics, with a continuous increase in the difficulty of the gymnastics combinations and the great static and dynamic loading of the body, rises the question of preventing sports injuries. The relationship between postural deviation and sports injuries was investigated in this study. A total of 17 gymnasts and 15 sedentary girls (control group) were examined. New-York Posture Rating Test and Posture Screen was used for posture analysis and a questionnaire has been used to gather information on former sports injuries. Sedentary girls had more postural deviations. However there was no statistically significant difference between groups. Lower extremity injuries were more frequent in gymnasts, and most of them had pes planus and/or heel valgus-varus. The rehabilitation procedure was insufficient in most of them. Success in gymnastics can only be attained by the cooperation of all persons involved. Postural deviations must be diagnosed properly in this context to avoid any sports injuries. While learning the technique of the movement, the gymnast should be informed of the possible risks for injuries, the importance of postural deviations and the necessity of rehabilitation after injury. Further prospective and retrospective research is needed to address the problem of sports-related injuries. Such studies will require a multidisciplinary team of experts.

Keywords: Posture, gymnastics, injuries, epidemiology

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ÖZET

JİMNASTİKÇİLERDE POSTÜRAL BOZUKLUKLARIN SPOR YARALANMALARININ GELİŞİMİNDEKİ ETKİSİ

Jimnastikte kombinasyonların giderek ağırlaşması ve bedenin altında kaldığı yükün gittikçe artması, sporsal yaralanmaların etkin biçimde engellenmesi gerekliliğini ortaya çıkarmaktadır. Bu çalışmada, postüral bozukluklar ile sporsal yaralanmalar arasındaki ilişkinin incelenmesi amaçlanmıştır. Toplam 17 kız jimnastikçi ile 15 sedanter kız denek (kontrol grubu) bu çalışmaya dahil edilmiştir. Postür analizi için New York Postür Testi uygulanmış ve geçirilmiş sporsal yaralanmalara ilişkin veriler bir anket aracılığıyla elde edilmiştir. Sedanter kızlarda postüral bozukluklar daha fazla görülmüştür. Buna rağmen iki grup arasında anlamlı istatistiksel bir fark gözlenememiştir. Jimnastikçilerde alt ekstremite yaralanmaları daha sık olup çoğunda pes planus ve/ya da topuk valgus-varus bulunmaktaydı. Çoğunda yetersiz biçimde rehabilitasyon uygulanmıştı. Jimnastikte artık günümüzde başarıya ulaşabilmek için ekipte bulunan bireylerin işbirliği gerekmektedir. Bu çerçevede, sporsal yaralanmaların gelişiminin engellenmesi için, özellikle postüral bozuklukların erken tanısı gerekmektedir. Jimnastikçilere hareket eğitimi verilirken, hareketlerin olası tehlikeleri, postüral bozukluklar ve rehabilitasyonun önemi ve gerekliliği hakkında bilgi vermek gerekmektedir. Spora bağlı yaralanmalar sorununun tam olarak ortaya konulması için, prospektif ve retrospektif çalışmalara yer verilmelidir. Bu biçimdeki çalışmalar için mültidisipliner yaklaşım gerekli olacaktır.

Anahtar sözcükler: *Postür, jimnastik, yaralanma, epidemioloji*

INTRODUCTION

Artistic gymnastics is an especially traumatic sportive event. To prevent sports injuries, to diagnose them immediately, and to provide a successful and efficient rehabilitation; it is sufficient to analyze periodically the causes of sports injuries (22).

Participation to gymnastics has increased recently, and most of the acute injuries occur during falling. Chronic injuries result of repetitive traumas to the shoulder, elbow, wrist, knee and ankle joints (20). The risk of knee injury for female athletes is higher compared with

that in the males. The reasons for this fact are anatomic and structural differences. The factors related are low level of condition, high lower extremity laxicity, width of pelvis, tibia rotation and foot alignment. Knee injuries may occur in gymnastics and cheerleading (10).

The first step in reducing the frequency of injuries is to disclose their reasons. These reasons may be subjective (physical and physiological condition of the athlete) or objective. Subjective reasons are nervous or muscular weakness, lack of concentration, insufficient determination of the athlete's physical capacity, loss of automatic reflex action and inadequate warm-up processes. Insufficiently considering the characteristics or dimensions of the floor and/or apparatus, ground mattress, and expecting dynamic loading of the body are objective reasons of injuries. Furthermore, fall injuries, lack of comprehension, collision with the apparatus, co-ordination problems in gymnastics combinations may be considered as other factors. Also high speed rotation traumas must be added to these factors (5). Nervous or muscular weaknesses and postural abnormalities are the most important ones.

This study aims to address the problem of sports-related injuries and to point out the importance of posture in female gymnasts.

MATERIAL and METHODS

A number of 17 girls attending the School of Physical Education and Sports and participating two hours per week to a one year long rhythmic gymnastic course were taken as test subjects and 15 girls attending the Tourism Institution of Higher Education were taken as the control group. New-York Posture Rating Test has been applied to the students (12). A screen frame was used, which consisted of vertical and horizontal lines. Vertical lines were parallel to the gravity line and horizontal lines bisected the vertical lines at 90 degrees. The distances of the subject to the gravity line and of the researcher to the gravity line were 70 cm and 250 cm respectively. The researcher, the subject and the gravity line were on the same straight line. In this test 13 different parts of body; namely, from the posterior view, the appearance of head, vertebral column, pelvis, heels and foot bases; from the lateral view, the appearance of neck, breast, shoulders, back, body, abdominal

protrusion and waist were scored according to their symmetry and position to the body gravitation line. Normal posture (5 points), slight posture deficiency (3 points) and apparent posture deficiency (1 point) were recorded on the test form. Thus, in the postural view, the highest point was 30, and in the lateral view it was 35. Those who scored the lowest points in the postural test were also clinically examined. In the statistical analysis, the total points of the postural and lateral views were taken into consideration. By measuring the distances of the intercondyles and intermalleols; genu valgum and genu varum were evaluated. The existence of tibial torsion was determined according to the relationship of the line from the middle of the patella in the sitting position to the foot, to the position of the feet during ambulation and walking and the appearance of the patella. The Q angle between the rectus femoris and the patellar ligament was measured with the quadriceps in relaxed position, while standing (5,7).

In the posture test, the Feiss line (the line on a weight-bearing foot in standing position, starting right under the interior malleol reaching to the first metatarsophalengeal joint over the scafoid tubercle of the navicular bone) of the subjects were determined. It is graded according to the position of the floor to the scafoid tubercle that is on the Feiss line. When the distance the scafoid tubercle line and the floor is 1/3, it is classified as slight; when it is 2/3, it is classified as middle, and when the scafoid tubercle gets in touch with the floor, it is classified as severe pes planus (25).

Retrospectively, a questionnaire consisting of 35 questions was prepared to gather information about the types and location of the sports injuries, and the demographic characteristics and injury mechanisms; to determine the immobilisation period and medical treatment; and to evaluate if medical examinations have been performed before the activities. Measurements and evaluations were made by two different investigators.

Injuries were divided into two groups as chronic and acute. Acute injuries were regarded as sudden appearing, severe injuries. Chronic injuries were regarded to be the result of repetitive low threshold forces, which decreased with activity and warm-up, and where pain increased following activity. Chronic injuries were analysed according to their

anatomic places and their occurences. Fracture and dislocations were excluded, and only acute sprain, strain and overstress-overuse injuries were recorded. Measurements and evaluation were made by two different investigators. In the statistical analysis. non-paired t-test and Fisher khi square test were used.

RESULTS

Data for the subjects are given in Table 1. Though the control group was slightly younger, there were no significant statistical differences for height and weight between the two groups ($p > 0.05$). The degree of the Q angle was lower in the gymnastics group ($p<0.05$). There were no statistical differences between the groups ($p>0.05$) considering posterior and lateral posture scores.

Table 1. Demographic characteristics of groups and posture test scores

	Gymnasts n = 17	Controls n = 15	p value
Age (year)	20.4 ± 1.5	19.7 ± 0.8	0.055
Height (cm)	166.6 ± 5.2	167.3 ± 3.2	0.310
Weight (kg)	55.2 ± 4.7	54.5 ± 3.6	0.330
Right Q angle	17.1 ± 3.3	20.3 ± 3.6	0.007
Left Q angle	17.6 ± 4.1	19.1 ± 3.6	0.007
Posterior Posture Score	27.2 ± 2.4	26.1 ± 1.9	0.120
Lateral Posture Score	34.2 ± 1.1	33.3 ± 2.3	0.330

Shoulder asymmetry and protrusion, kyphosis, genu varum, internal tibial torsion, heel valgus and flattening of the metatarsal arcus were much more seen in the control group. However, only the occurence of flattening of metatarsal arcus revealed statistical difference ($p<0.05$) (Table 2). The frequency of increased lumbar lordosis was 41% in gymnasts, 20% in the control group, but no statistical significance was observed ($p>0.05$). In two students of the control group, abdominal protrusion and kyphosis were found. There were no kyphosis and abdominal protrusion in gymnasts. No statistical difference was found among the groups for these parameters.

Table 2. Postural deviations in the groups

	Gymnasts n (%)	Controls n (%)	p value
Shoulder asymmetry	2 (12)	3 (20)	0.44
Shoulder protrusion	-	3 (20)	-
Kyphosis	-	2 (13)	-
Incrased lumbar lordosis	7 (41)	3 (20)	0.18
Genu valgum	2 (12)	2 (13)	0.65
Genu varum	1 (6)	2 (13)	0.45
Internal tibial torsion	3 (18)	5 (33)	0.27
External tibial torsion	1 (6)	-	-
Flattening of longudinal arcus	14 (82)	14 (93)	0.78
Heel varus	2 (12)	2 (13)	0.65
Heel valgus	3 (18)	6 (40)	0.16
Hallux valgus	2 (12)	1 (7)	0.55
Flattening of mettarsal arcus	7 (41)	12 (80)	0.03

Gymnasts having normal foot and ankle appearances had no injury histories ($p<0.05$). Four of the gymnasts had acute injuries and ten of them had chronic injuries of the ankle and/or foot; and 14 (82%) had pes planus. None of the control group subjects had injuries but 93% had postural deviations in the foot and 47% in their knee (Table 2). About 79% of the subjects with pes planus had an ankle injury history.

Of the gymnasts, 35% had postural deviations in the knees. Four of them had ankle injury stories. Six of the gymnasts who did not have postural deviations in the knees had ankle injury histories. No knee injuries have been reported in both groups. In 47% of the control group, postural deviations of the knee were found. No significant relation was found among the postural deficiencies in the knees and the injury of the ankles and/or the lumbar area ($p=0.52$).

The Q angle was in the normal range in gymnasts, and statistical significance was apparent between groups (Table 2, $p<0.05$). Gymnasts had no knee injuries, so the effect of variations in Q angles on knee injuries was not investigated.

No information could be gathered according to the mechanism of the injury, because 11 students stated that they did not remember how the injury developed. Answers were not taken into consideration

because of lack of information about the beginning time of training, recurrence of chronic injuries, duration of warm-up and time of injury after beginning sports.

No rehabilitation was applied to 21% of the students after injury, 43% of the students ignored the rehabilitation program because of training and/or competition duties. Ankle rupture occurred in one of these students. Rehabilitation was applied to 29% by a masseur or by themselves, and to 7% by specialists.

Before participating to sports, 6% of the students had a detailed medical examination, 24% got their licence formular filled out, 47% got a medical certificate in the pre-school period and 6% were not examined.

DISCUSSION

We could not find significant differences between the gymnasts and the control group for the parameters assessed in our study. Because of the low frequency, there was no possibility to compare the different kinds of postural deviations. So, Fisher exact khi square test was chosen instead of khi square test and the groups were combined. In the literature between 1980-1995, gymnasts with postural deviations were compared with healthy ones, but no comparison with sedentary controls existed. Due to the similarity of age, sex, height, weight and sports branches between the subjects, a small sample of the population was selected. High level elit gymnasts were found to have higher injury rate than low level or non competing gymnasts (1,6,18,19). Andrish et al. (1) found in their study that 60% of knee injuries occured in the patellofemoral joint, 17.6% were ligament injuries and sprains, 14.1% were lacerations of menisci, 7.1% were contusions, 4.7% were Osgood-Schlatter, and 2.4% were strains.

It is emphasized that women with chondromalasia generally have medial femoral torsion, proximal tibia vara, external tibial torsion and that 30% of these athletes had postural deviations (13). Lumbar problems occurred in 38% of gymnasts (9). In ballet dancing, 65-80% of injuries occur in lower extremities, 10-17% in the vertebral column, and 5-15% in the upper extremities. The etiology of lower extremity injuries include mostly incorrect turnout, soft tissue imbalance, decrease in

quadriceps strength, foot rolling in, inversion sprain and frequent plies, the result of the point and demipoint work. Spinal injuries are the results of hyperflexion and hyperextension of the lumbar spine, and the insufficiency of psoas (16). In our subjects, 24% of injuries were concentrated in the lumbar part and %64.7 in the lower extremities. Especially the existence of pes planus increases the risk of ankle injuries.

Sports-related injuries occur mostly in artistic gymnasts (5, 20). Dixon and Fricker (4) state that in higher level and experienced male gymnasts, 33% have injuries in the lower extremities, 56% in the upper extremities and 11% in the vertebral column; whereas 55% of female gymnasts have injuries in the lower extremities, 29% in the upper extremities and 16% in the vertebral column. They stated furthermore, that gymnasts have slight and middle-level injuries with short-time recovery periods. Sands et al. (17) found that in collegiate women's gymnastics team, mostly repetitive stress syndromes occur especially during tumbling and also uneven bars, ground exercises, balance beam, vault and conditioning. They also pointed out that injury localisation most significantly is on the shoulder, waist and lower extremities. The injuries are mostly seen on the right side of the body. They occur during the preparatory and competitive periods (17).

Meeusen et al. (14) postulated that ankle injuries mostly occur in gymnastics. Furthermore, they emphasised the importance of completing a rehabilitation program in order to reduce the risk of re-injury following the acute injury. Keene et al. (11) had found that in college students the risk of injury is usually higher in football and gymnastics. Most of injuries occur as muscle strains and more often as acute back injuries. In our study, reliable and sufficient information could not be gathered because the exact movement that caused the injury could not be remembered. The basic reasons for injuries occuring in women are stress and trauma. Stress injuries such as stress fractures, muscle strains and tendinits are the result of repetitive low threshold stresses on the body. The reason of lumbar spondilolysis in female gymnasts is the recurrent stress on the pars interarticularis of the vertebra, due to repetitive hyperextension of the back (15, 20). About 24% of gymnasts who reported lumbar strain could not be evaluated radiologically. It was not possible to confirm the data of the questionnaire and the findings of clinical examination using laboratory techniques.

The information about the injuries were gathered from gymnasts about their injuries by question and answer technique. For this reason, information about the gymnasts' conditional situation, environmental conditions and the warm-up process and the effects of these factors on the injury could not be evaluated. Only 6% of the gymnasts were examined before the period. Also it is observed that the gymnasts were careless and reluctant in the application of rehabilitation, programs.

Preventing injuries is a lot easier than treating them. Further prospective and retrospective research is needed to emphasise the necessity of postural evaluation Besides cardiological, pulmonary, anthropometric, biochemical and physiological evaluations of amateur and elite gymnasts, postural examinations, corrective and restorative interventions should also be performed. The efficiency, sufficiency and applicability of a rehabilitation program is important for appropriate and timely returning to active sports and for gaining back former performance. An effective rehabilitation program can only be attained with the co-operation of the gymnast, the trainer and the medical team.

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REFERENCES

1. Andrish JT: Knee injuries in gymnasts. In: *Clinics of Sports Medicine.* Weiker GG, Ed, Philadelphia, WB Saunders Company, 1985, pp. 13-7.
2. Baxter JA, Maffuli N, Helms P. Low injury rates in elite athletes. *Arch Dis Child* **68**: 130-2. 1993.
3. Caine D, Cochrane B, Caine C, et al.: An epidemiologic investigation of injuries affecting young competitive female gymnasts. *Am J Sports Med* **17**: 811-9. 1989.
4. Dixon M, Fricker P: Injuries to elite gymnasts over 10 yr. *Med Sci Sports Exerc* **25**: 1322-9. 1993.
5. Fröhner G: The risk of injury in gymnasts: some remedial measures. *Symposium International,* Avignon, 1988.
6. Garrik JG, Requa RK: Girls sport injuries in high school athletics. *JAMA* **239**: 2245-8. 1978.
7. Hald RD. Dance injuries. *Prim Care* **19**: 393-411, 1992.

8. Hennessy L, Watson WS: Flexibility and posture assessment in relation to hamstring injury. *Br J Sports Med* **27**: 243-6, 1993.

9. Hoshizaki TB, Salmela JH, Petiot B: *Diagnostics, Treatment, and Analysis of Gymnastic Talent.* Montreal, Sport Psyche Editions, 1987, pp. 19-21.

10. Hutchinson MR, Ireland ML: Knee injuries in female athletes. *Sports Med* **19**: 288-302, 1995.

11. Keene JS, Albert MJ, Springer SL et al.: Back injuries in college athletes. *J Spinal Disord* **2**: 190-5, 1989.

12. Kelly LE: Body mechanics and posture. In: *Adapted Physical Education and Sport.* Kelly LE, Ed, Champaign, Il, Human Kinetics Books, 1990, pp. 335-48.

13. Lowry CB, LeVeau BF: A retrospective study of gymnastics injuries to competitors and noncompetitors in private clubs. *Am J Sports Med* **10**: 237-9, 1982.

14. Meeusen R, Borms J. Gymnastic injuries. *Sports Med* **13**: 337-56. 1992.

15. Micheli LJ: Back injuries in gymnastics. In: *Clinics of Sports Medicine.* Weiker GG, Ed, Philadelphia, WB Saunders Company, 1985, pp. 24-33.

16. Milan KR: Injury in ballet: a review of relevant topics for the physical therapists. *J Orthop Sports Phys Ther* **19**: 121-9. 1994.

17. Sands WA, Shultz BB, Newman AP: Women's gymnastics injuries. *Am J Sports Med* **21**: 271-6, 1993.

18. Snook GA: A Review of Woman Collegiate's Gymnastics. In: *Clinics of Sports Medicine.* Weiker GG, Ed, Philadelphia, WB Saunders Company, 1985, pp. 35-41.

19. Snook GA: Injuries in women's gymnastics. *Am J Sports Med* **7**: 242-4. 1979.

20. Takasawa H: Characteristics of traumatisms in gymnastics. *Symposium International,* Avignon, 1988.

21. Tenvergent EM, TenDuis HJ, Klasen HJ: Trends in sports injuries, 1982-1988: an in-depth study in four types of sports. *J Sports Med Phys Fitness* **32**: 214-20. 1992.

22. Toteva M: Injuries in gymnastics. *Symposium International,* Avignon, 1988.

23. Wadley GH, Albright JP: Women's intercollegiate gymnastics. *Am J Sports Med* **21**: 314-20. 1993.

24. Watson AWS. Posture and participation in sport. *J Sport Med* **23**: 231-9. 1983.

25. Wiliams M, Worthingham C: *Therapeutic Exercise.* Philadelphia, WB Saunders Company, 1957, pp. 335.