International Journal of Physiotherapy and Research,
Int J Physiother Res 2017, Vol 5(4):2265-70. ISSN 2321-1822
***DOI:** https://dx.doi.org/10.16965/ijpr.2017.184*

Original Research Article

THE CORRELATION BETWEEN ANKLE RANGE OF MOTION AND DYNAMIC BALANCE ABILITY IN RHYTHMIC GYMNASTS

Inci Kesilmis *, Mehmet Melih Kesilmis, Manolya Akin.

Mersin University, Department of Physical Education and Sports, 33343, Mersin,Turkey.

ABSTRACT

Objective: The purpose of this study was to investigate the relationship between plantar flexion and dorsiflexion range of motion with dynamic balance ability in rhythmic gymnastics athlete and also to compare with the sedentary.

Material and Methods: This study included 17 female rhythmic gymnasts aged 8,82±1,42 years and 19 female sedentary aged 8,73±1,36 years. All participants' 3 sets of active dorsiflexion and plantar flexion range of motion were measured in both ankles using a goniometer. Monoaxial dynamic balance scores were evaluated for right-left foot with monoaxial base for anteroposterior sway by using Prokin Tecno Body. And also slalom test with 30sc was used.

Results: There was statistically significant correlation between slalom perimeter length with right dorsi flexion and left plantar flexion in rhythmic gymnasts. But there was no correlation between balance and ankle range of motion in sedentary. Rhythmic gymnasts' bipedal perimeter length ($p<.05$), right foot perimeter length ($p<.05$), right plantar-dorsal flexion ($p<.001$), left plantar flexion ($p<.05$), left dorsal flexion ($p<.001$) were significantly different in favor of gymnasts according to the independent samples t tests.

Conclusion: It can be concluded that rhythmic gymnastics trainings improves dynamic balance ability and ankle range of motion and also wide ankle range of motion influences dynamic balance.

KEY WORDS: Rhythmic Gymnasts, Dynamic Balance, Plantar Flexion, Dorsal Flexion.

Address for correspondence: Inci Kesilmis, Department of Physical Education and Sports, Mersin University,33343 Mersin, Turkey. **E-Mail:** incikesilmis@mersin.edu.tr

Access this Article online

Quick Response code	International Journal of Physiotherapy and Research ISSN 2321- 1822 www.ijmhr.org/ijpr.html	
DOI: 10.16965/ijpr.2017.184	Received: 06-06-2017 Peer Review: 06-06-2017 Revised: None	Accepted: 19-06-2017 Published (O): 11-08-2017 Published (P): 11-08-2017

INTRODUCTION

Rhythmic gymnastics has multiple positive effects on a child's body. Beside the positive effect on already mentioned motoric development of children, it also contributes to the regular biological growth and development of the body [1]. Among the ages of 7-10 balance control usually built up and the most significant improvements emerge in the first decade of life [2,3]. Maintaining postural control and its ability to stabilize body during dynamic movements, are vital to the successful implementation of fundamental movement skills like kicking and jumping [4]. Gymnastics training focuses on the development of physical fitness of young athletes in a comprehensive manner. In the ability to perform motoric skills such as skipping, jumping, standing on one foot, forward-backward movements and pirouettes, not only balance ability should be improved but also flexibility [5]. The correlation between morphological characteristics and motor abilities with performance of specific skills, the creation of sports in rhythmic gymnastics at the beginning of the selection process and the training process can be very useful [6].

Balance control is a complicated fact that is associated with several human functions. It has been suggested that posture preservation requires sensory information to detect orientation and motion, choosing the appropriate response to sustain balance and activation of the muscles that can overcome balance deformities [7]. Balance trainings are substantial in cautionary the improvement of vestibular function and proprioceptive sensation and finally resulted in a rapid recovery of the functions on the balance system [8].

Behavioral goals of the postural control systems that fine postural control, orientation and balance are necessary for gymnastics [9]. Balance characterizes as dynamic when performing a task ability meanwhile maintaining a stable position and static when stand in a fixed manner on the base support with very little movement [10]. This talent is influenced by a complexity of determinants, that are sensory information (from somatosensory, visual and vestibular systems), joint range of motion and strength [11,12,13,14] and it is responsible for the correct execution of complex sport movements, such as protection against injuries. Many functional task in daily routines such as walking, rising stairs, stand from a sofa are significant contribution to the safe conduct and they are results of flexibility at the ankle joints. Insufficient balance and sustained falls are directly as a result of inadequacy of movement at ankle joint [15]. Active and passive dorsiflexion range of motion arises during stance and swing phase [16]. At the same time it is characterized by plentiful of motor knowledge. The information obtained between the ages of 5 and 8 makes a significant contribution to the success of this sport [6].

Dorsiflexion is a forward-upward movement of the foot in the sagittal plane, so that the dorsal surface of the foot approaches the anterior surface of the leg. Plantar flexion a forward downward movement of the foot in the sagittal plane, so that the dorsal surface of the foot moves away from the anterior surface of the leg. Apparently, the bones are being moved by the function of the joints [17]. The stability is the part of balance ability. On the anteroposterior sway, ankle range of motion not only prevents injury but also increases balance ability. Sports training improve neuromuscular coordination, range of motion and joint strength are also likely mechanisms that lead to improved balance [18, 19]. The gold standard to evaluate static balance is considered as postural sway variables from a force platform [20] but for dynamic balance more sophisticated techniques are available and there was no gold standard [21]. Ankle movements are also necessary for muscular responses used to maintain perturbations to balance, such as rapid compensatory stepping movements [15]. In the light of these informations the aim of this study was to investigate the relationship between plantar flexion and dorsiflexion range of motion with dynamic balance ability in rhythmic gymnastics athlete and also to compare with the sedentary.

MATERIALS AND METHODS

Participants: This research includes 17 rhythmic gymnasts who participated in rhythmic gymnastics training for daily 3 hours and five days in a week and 19 sedentary that attending regular school program. Rhythmic gymnasts ages, body height, body weight, training year were 8,82±1,42 year, 135,12±19,80 cm, 28,04±6,66 kg, 2,88±1,63 year, respectively. And sedentary participants ages, body height, body weight were 8,73±1,36 year, 134,41±8,48 cm and 30,61±6,28 kg, respectively. Informed consent form signed by all of the participants, their parents and the trainer prior to the study.They gave their informed constant for the experimental procedure as required by the Helsinki declaration. And also, this study was approved by the University Scientific Ethics Committee (58242520-050.01.04). All participants presented normal motor function and without any neurological or motor disorders suspected. Participants' height, body weight, bipedal-right-left foot monoaxial dynamic balance, right-left plantar flexion and dorsiflexion range of motion measured in the first day of the weekly training period.

Data Collection

Dynamic Balance: Tecno Body (PK200WL, Italy) dynamic balance measurement disequilibrium test and slalom tests were used. For both measurement participants' with thin sportswear and bare foot removed on the Tecno Body and were asked to stop to establish the position of the balance and the test was started after providing the balance. For both disequilibrium test and slalom test with 30sc monoaxial base was used. To determine anteroposterior sway monoaxial dynamic balance scores, measurements were recorded bipedal (30 seconds), right-left foot (10 seconds). The test consists in trying to move in a reference circle defined by the user in time.

In slalom tests with 30 second time the participant sees some ball-objectives that come against. The participants were asked to touch the objectives and follow the blue ideal line. The software provides two results: catch up objectives and perimeter error. The blue line shows the ideal path. When the participant touches a square, it becomes green, otherwise it becomes red. The perimeter error shows the participants ability to stay on the blue ideal line.

When the participant loses balance and fall in case of time run out, the measurement was repeated. The participants' informed about the contents of the test and necessary pre-notifications. After trying once, the monoaxial dynamic balance measurement was made twice and recorded for each participant.

Dorsi Flexion and Plantar Flexion: The usual way assessing a joint's range of motion is to measure the number of degrees from the starting position of the segment to its position at the end of its maximal movement. This would be the way of measuring flexion [17]. The participant on the bed in long sitting was the starting position, reclined to about 45 degrees. The axis of the goniometer was placed approximately 1.5cm inferior to the lateral malleolus. Parallel to the longitudinal axis of the fibula, lining up with the fibula head. Parallel to the longitudinal axis of the 5th metatarsal. Then the researcher asked the participant to pull their foot towards them for dorsiflexion range of motion and asked the participant to point their foot away for the plantar flexion. Researcher measured and recorded the angle between the movable and stationary arms in degrees. Patterson Medical, Sammons Preston, Six-Piece Goniometer Set was used in our study.

Statistical Analyses: After descriptive demographic statistics to evaluate the association between dynamic balance ability and plantar dorsal flexion range of motion correlation analyses was used. And also, to compare rhythmic gymnasts and sedentary participants independent samples t test was used.

RESULTS

Table 1: Dynamic balance tests correlations with plantar and dorsal flexion in rhythmic gymnasts.

	Bipedal PL (cm)	Right Foot PL (cm)	Left Foot PL (cm)	Right PF	Right DF	Left PF	Left DF	Slalom PL (cm)
Bipedal PL (cm)	1	-,214	-,131	,119	-,167	-,246	-,468	,042
Right Foot PL (cm)		1	**,718****	-,333	,349	,226	,281	-,214
Left Foot PL (cm)			1	-,036	**,493***	,410	,327	-,407
Right PF				1	-,004	,448	-,373	,154
Right DF					1	**,700****	**,642****	**-,706****
Left PF						1	,095	**-,497***
Left DF							1	-,459
Slalom PL (cm)								1

Note PL= Perimeter Length, PF=Plantar Flexion, DF=Dorsal Flexion **p<,001, *p<,05.

As shown in Table 1, correlations between right dorsal flexion range of motion and left plantar-dorsal flexion and dynamic balance ability (slalom test) were significant in rhythmic gymnasts. Also correlation between left plantar flexion and dynamic balance ability (slalom test) was significant in rhythmic gymnasts.

Table 2: Dynamic balance tests correlations with plantar and dorsal flexion in sedentary participants.

	Bipedal PL (cm)	Right Foot PL (cm)	Left Foot PL (cm)	Right PF	Right DF	Left PF	Left DF	Slalom PL (cm)
Bipedal PL (cm)	1	,355	-,244	,184	-,044	,197	-,056	,443
Right Foot PL (cm)		1	,199	,083	-,172	,186	-,065	,172
Left Foot PL (cm)			1	-,136	-,445	-,125	-,441	-,105
Right PF				1	-,390	**,982****	-,225	-,034
Right DF					1	-,423	**,962****	,161
Left PF						1	-,283	-,064
Left DF							1	,165
Slalom PL (cm)								1

Note PL= Perimeter Length, PF=Plantar Flexion, DF=Dorsal Flexion, **p<,001.

As shown in Table 2, correlation between right plantar flexion and left plantar flexion is significant in sedentary participant. And also correlation between right dorsal flexion and left dorsal flexion is significant. But there wasn't any correlation between dynamic balance and ankle range of motion.

This study included 17 female rhythmic gymnasts aged 8,82±1,42 years and 19 female sedentary aged 8,73±1,36 years. There was statistically significant correlation between slalom

Table 3: Independent Samples t Test of rhythmic gymnasts and sedentary.

	Group	N	Mean	Std. Deviation	t	Sig. (2-tailed)	Cohen's d	Effect Size r
Bipedal PL	Rhythmic	17	500,38	197,17	-2,545	0,016*	-0.843	-0.388
	Sedentary	19	648,92	152,29				
Right PL	Rhythmic	17	188,86	50,15	-2,591	0,014*	-0.87	-0.399
	Sedentary	19	237,81	61,72				
Left PL	Rhythmic	17	189,12	57,35	-1,69	0,1	-0.577	-0.277
	Sedentary	19	259,60	162,92				
Right PF	Rhythmic	17	174,70	6,99	5,813	,000**	1.954	0.698$^{\Phi}$
	Sedentary	19	159,10	8,86				
Right DF	Rhythmic	17	73,47	10,46	-4,963	,000**	-1.617	-0.628
	Sedentary	19	86	3,26				
Left PF	Rhythmic	17	152,05	9,94	-2,21	0,034*	-0.737	-0.345
	Sedentary	19	159,05	9,03				
Left DF	Rhythmic	17	62	10,88	-9,126	,000**	-2.975	-0.829
	Sedentary	19	86,05	3,51				
Slalom Test	Rhythmic	17	272,65	86,73	1,676	0,103	0.558	0.268$^{\Phi}$
	Sedentary	19	323,19	94,21				

**p<.001, *p<.05, Effect size, Cohen's *d*. $^{\Phi}$ *p* < .001.

perimeter length with right dorsi flexion and left plantar flexion ($R_{slalom-rightdorsalflexion}$=-.706, p<.001; $R_{slalom-leftplantarflexion}$=-.497, p<.05) in rhythmic gymnasts (Table 1). But there was no correlation between dynamic balance and ankle range of motion in sedentary (Table 2). Rhythmic gymnasts' bipedal perimeter length (p<.05), right foot perimeter length (p<.05), right plantar-dorsal flexion (p<.001), left plantar flexion (p<.05), left dorsal flexion (p<.001) were significantly different in favor of gymnasts according to the independent samples t tests (Table 3).

As shown in Table 3, rhythmic gymnasts' dynamic balance ability and ankle range of motion significantly different than sedentary participants.

DISCUSSION

Ankle range of motion is a significant contributor to many functional tasks that carried out in a safe manner (eg walking, ladder negotiation, rising from a chair) and also contributes to maintaining the continuity of postural stability [22]. In addition balance, proprioception, and muscle strength in lower extremity are important factors. Ankle joint plays a very critical role while balance required walking and standing [15]. Thus, the aim of this study was to investigate the relationship between ankle ranges of motion with dynamic balance ability in rhythmic gymnastics athlete and also to compare these parameters with the sedentary. According to the findings of this study correlation between right dorsal flexion and slalom perimeter length was statistically significant in rhythmic gymnasts and this results showed that the less dorsal flexion range of motion the better monoaxial dynamic balance. These findings are in accordance with our prior study as conducted in swimmers [23].

Additionally, correlation between left plantar flexion and slalom perimeter length was statistically significant in rhythmic gymnasts and so this results showed that the wide dorsal flexion range of motion the better monoaxial dynamic balance. For sedentary participants there was no correlation between ankle range of motion and dynamic balance parameters. This result may be due to the fact that rhythmic gymnasts are constantly stretches their ankle during training and attach importance to balance trainings. According to literature two year training has had a beneficial effect on the ability to maintain balance in gymnasts aged 7 – 12 years [5]. This results in agreement with Suryavanshi, Kumar, Kulkarni, Patel (2015) who conducted a study to find out the correlation of ankle dorsiflexion range of motion with dynamic balance in young normal individuals. In anterior and postero lateral direction there was significant positive correlation between dorsiflexion range of motion and star excursion balance test [24].

Similarly; Hoch, Staton, McKeon (2010) conducted a study to examine the relationship between dorsiflexion range of motion on the weight-bearing lunge test and normalized reach distance in three directions on the Star Excursion Balance Test. Their findings indicated that there was a significant correlation between maximum weight-bearing dorsiflexion range of motion and performance on the anterior direction of the Star Excursion Balance Test [25]. At the same time, Rein Fabian, Zwipp, Rammelt, Weindel (2011) compared the postural control and functional ankle stabilization between the professional and amateur dancers and the control group and found that professional dancers significantly improved the plantar flexion of professional dancers and providing better postural control in all tested positions [26]. Jain and Rathod (2015) emphasized that decreased in the ankle range of motion may result in decreased balance control and function [27].

When rhythmic gymnasts compared to sedentary participant for bipedal and right perimeter length, right-left plantar flexion, right-left dorsal flexion and slalom tests there were statistically significant difference. For all of the parameters rhythmic gymnasts had better performance. Despite the fact that they have similar age and body characteristics, the rhythmic gymnasts have better performance in all parameters can be the result of their balance and stretching trainings. Dynamic balance and flexibility, which are essential and crucial throughout life, were in favor of rhythmic gymnasts. Similarly to our results; Martin (1988) find out that trained participants had better dynamic and static balance than untrained participants at 7-10 years of age [28]. Additionally; Kioumourtzoglou, Derri, Mertzanidou, Tzetzis (1997) determined experience with perceptual and motor skills in rhythmic gymnastics and analysis showed that scores on measures of whole- body coordination, dynamic balance, and static balance were higher for elite groups of athletes than for corresponding control groups [29]. It has been proved by many studies that the gymnasts exhibit better dynamic balance performance than sedentary and even when compared to the sportsmen in other branches [30,31].

Based on this study findings it can be concluded that rhythmic gymnastics trainings improve monoaxial dynamic balance ability and plantar dorsal flexion range of motion significantly and this finding may result a positive effect on daily life among individuals with even similar physical characteristics and same age group. And also in light of the results of the present study, it can be concluded that plantar and dorsal flexion range of motion can influence dynamic balance and so ankle-stretching trainings can be included to programs. Further studies should be done in larger samples to find out the exact correlation between dynamic balance and ankle range of motion.

Conflicts of interest: None

REFERENCES

[1]. Aleksic D, Stankovic S, Milenkovic V. Examination of effects of rhythmic gymnastics on balance development at the school classes of young elementary school female pupils. Crnogorska Sportska Akademija 2013; 432-435.

[2]. Roncesvalles M, Woollacott M, Jensen J. Development of lower extremity kinetics for balance control in infants and young children. Journal of Motor Behavior 2001; 33(2): 180-192.

[3]. Ferdjallah M, Harris GF, Smith P, Wertsch JJ. Analysis of postural synergies during quiet standing in healthy children and children cerebral palsy. Clinical Biomechanics 2002;17: 203–210.

[4]. Faigenbaum AD, Myer GD, Fernandez IP, Carrasco EG, Bates N, Farrell A, Ratamess NA, Kang J. Feasibility and reliability of dynamic postural control measures in children in first through fifth grades. The International Journal of Sports Physical Therapy 2014; 9(2): 140-148.

[5]. Poliszczuk T, Broda D, Poliszczuk D. Changes in somatic Parameters And Dynamic Balance In Female Rhythmic Gymnasts Over A Space Of Two Years. Polish Journal of Sport & Tourism, 2012; 19: 240-252.

[6]. Miletic D, Katic R, Males B. Some Anthropologic Factors of Performance in Rhythmic Gymnastics Novices. Coll. Antropol 2004; 28(2): 727–737.

[7]. Enoka RM. Neuromechanics of human movement. Champaign, IL: Human Kinetics, 2001.

[8]. Boraczynska S, Boraczynski T, Boraczynski M, Michels A. Dynamics of comprehensive physical fitness in artistic gymnasts aged 7-10 years. Pedagogics, psychology, medical-biological problems of physical training and sports 2014; 12, 58-64.

[9]. Horak FB, Macpherson JM. Postural orientation and equilibrium, in: L.B. Rowell, J.T. Shepard (Eds.), Handbook of Physiology, Oxford University Press, New York, pp. 1996; 255–292.

[10]. Winter DA, Patla AE, Frank JS. Assessment of balance control in humans. Medical Progress through Technology. 1990; 16: 31-51.

[11]. Grigg P. Peripheral neural mechanisms in proprioception. Journal of Sport Rehabilitation 1994; 3:2–17.

[12]. Nasher LM, Black FO, Wall C. Adaptation to altered support and visual conditions during stance: patients with vestibular deficits. Journal of Neurosciences 1982; 2:536-544.

[13]. Palmieri RM, Ingersoll CD, Stone MB, Krause BA. Center-of-pressure parameters used in the assessment of postural control. J Sport Rehabil 2002;11:51–66.

[14]. Palmieri RM, Ingersoll CD, Cordova ML, Kinzey SJ, Stone MB, Krause BA. The effect of a simulated knee joint effusion on postural control in healthy subjects. Arch Phys Med Rehabil 2003; 84:1076–1079.

[15]. Gaur D, Ashutosh D. Comparision of Ankle Joint Range of Motion on Balance Score in Healthy Young and Adult Individuals. Journal of Exercise Science and Physiotherapy 2014; 10(1): 25-30.

[16]. Richard J, Kasser PT, Pridmore K, Hoctor K, Loyd L, Wortman A. Comparison of Stretching Versus Strengthening for Increasing Active Ankle Dorsiflexion Range of Motion. Topics in Geriatric Rehabilitation 2009; 25 (3): 211–221.

[17]. Wells KF, Lutgen K. Kinesiology-Scientific Basis of Human Motion, 6th edition. WB Saunders, London, 1976.

[18]. Khuman PR, Kamlesh T, Surbala L. Comparison of static and dynamic balance among collegiate cricket, soccer and volleyball male players. International Journal of Health & Allied Sciences 2014; 3(1): 9-13.

[19]. Lephart SM, Giraldo JL, Borsa PA, FU FH. Knee joint proprioception: a comparison between female intercollegiate gymnasts and controls. Knee Surg Sports Traumatol Arthrosc 1996; 4:121–124.

[20]. Riemann BL, Guskiewicz KM, Shields EW. Relationship between clinical and forceplate measures of postural stability. Journal of Sport Rehabilitation 1999;8(2): 71-82.

[21]. Bressel, E, Yonker, JC, Kras, J, Heath, EM. Comparison of static and dynamic balance in female collegiate soccer, basketball and gymnastics athletes. Journal of Athletic Training 2007; 42(1): 42-46.

[22]. Nitz JC, Low CN. The relationship between ankle dorsiflexion range, falls and activity level in women aged 40 to 80 years. New Zealand Journal of Physiotherapy 2004; 32(3): 121-125.

[23]. Akin M, Sallayici M, Kesilmis I, Kesilmis MM. Determining the Correlation Between Dynamic Balance Ability to Plantar Flexion and Dorsiflexion Range of Motion in Swimmers. Turkish Clinics Journal Sports Sci 2016; Article in press, DOI: 10.5336/sportsci.2016-54131.

[24]. Suryavanshi P, Kumar A, Kulkarni P, Patel P. Correlation of ankle dorsiflexion range of motion with dynamic balance in young normal individuals. International Journal of Physiotherapy and Research 2015; 3(4): 1184-1187.

[25]. Hoch MC, Staton GS, McKeon PO. Dorsiflexion range of motion significantly influences dynamic balance. Journal of Science and Medicine in Sport 2011; 14(1): 90-92.

[26]. Rein, S, Fabian, T, Zwipp, H, Rammelt, S, Weindel, S. Postural control and functional ankle stability in professional and amateur dancers. Clinical Neurophysiol. 2011; 122, 1602–1610.

[27]. Jain, H, Rathod, SA. Correlation between balance and ankle range of motion in community dwelling women having fear of fall aged 60 to 80 years. Journal of Exercise Science and Phsiotherapy 2015; 11(1): 22-28.

[28]. Martin D. Training im Kindes- und Jugendalter. Schorndod, Deutsland: Karl Holfmann. 1988; 85-96.

[29]. Kiomourtzoglou E, Derri V, Mertzanidou O, Tzetzis G. Experience With Perceptual and Motor Skills in Rhythmic Gymnastics 1997; 84: 1363-1372.

[30]. Erkmen N, Suveren S, Goktepe AS, Yazicioglu K. The comparison of balance performance of the athletes who are in different branches. Spormetre Beden Eðitimi ve Spor Bilimleri Degisi,2007; 5(3): 115-122.

[31]. Aydin T, Yildiz Y, Yildiz C. Proprioception of the Ankle: A Comparison Between Female Teenaged Gymnasts and Controls. Foot and Ankle International 2002;23(2):123-129.

How to cite this article:

Inci Kesilmis, Mehmet Melih Kesilmis, Manolya Akin. THE CORRELATION BETWEEN ANKLE RANGE OF MOTION AND DYNAMIC BALANCE ABILITY IN RHYTHMIC GYMNASTS. Int J Physiother Res 2017;5(4):2265-2270. **DOI:** 10.16965/ijpr.2017.184