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ENHANCING BALANCE AND NEUROMUSCULAR COORDINATION THROUGH AGILITY TRAINING IN YOUNG ADULTS

Mazahir Zia[1*], Basit Ansari[2], Muhammed Zubair[3], Ayesha Saleem[4], Prem Lata[5], Shamsa Abdul Rehman[6]

[1*,2]University of Karachi
[3,6]Isra University, Hyderabad
[4]Mamji Physiotherapy & Rehabilitation Center
[5]Bahria University Health Sciences campus

***Corresponding Author:** Mazahir Zia
*Email: mzia@uok.edu.pk

Abstract:
The study aimed to investigate the effects of an 8-week agility training program on balance and neuromuscular coordination in young adults. A quasi-experimental design with pre- and post-testing was used. Participants were randomly assigned to either the agility training group (n=90) or the control group (n=90). The agility training group underwent twice-weekly agility training sessions for 8 weeks, while the control group maintained their normal daily activities. The results showed that the agility training group exhibited significant improvements in both left and right leg balance as measured by the Stork Stand Balance Test. Additionally, the agility training group demonstrated significant enhancements in neuromuscular coordination, as assessed by the McDonald Soccer Test, compared to the control group. In contrast, the control group did not show any significant changes in balance or neuromuscular coordination over the 8-week period. These findings suggest that the agility training protocol was effective in improving balance and neuromuscular coordination in the young adult participants. The study highlights the potential benefits of incorporating agility training into exercise and rehabilitation programs to enhance essential physical and neuromuscular attributes, which are crucial for overall health, athletic performance, and injury prevention.

Key Words: Agility training, Balance, Neuromuscular coordination, young adults, Physical fitness, Motor skills, Quasi-experimental study

Introduction

The maintenance of overall health and well-being in human biology necessitates a specific amount of physical activity. Adapting to a lifestyle with reduced physical activity takes several generations for biological changes to manifest. **(1)** Balance is the person's capacity to sustain balance and manage their body correctly during the performance of motor skills. It involves controlling the athlete's center of gravity. Include sprint, agility training, plyometrics, and strength and power training specialized balance training using unstable equipment, and certain sports to improve balance. Full motor coordination refers to a person's ability to perform motor movements with precision, alignment, and accuracy. Key concepts that the capacity to rapidly change direction

without compromising speed, balance, or body control. Similar training methods, such as those used for balance, can be used to improve coordination. Certain sports also play an important role because repetition of different movement patterns is important to improve motor coordination. **(2)** For many years, agility was defined as the ability to execute movements and the capacity to stop and restart quickly (3). A quick, whole-body movement that involves changing direction or speed in response to a stimulus. Agility training methods primarily target its physical components, such as running speed and explosive strength. (4-7). Agility training includes active workouts (indoor workouts) and workouts that require the athlete to feel, adjust, and react (outdoor workouts), it plays important role for fitness. In natural agility refers to a person's capacity to rapidly change direction without compromising speed, balance, or body control. Agility requires strength, power, coordination, balance, speed, agility, neuromuscular control and anticipation. **(2)** Neuromuscular coordination is a crucial skill for successfully performing motor tasks that require precision and efficiency. Developing coordination thoroughly is vital for improving other physical attributes like speed, jumping ability, and agility, and it can also enhance the learning of movement techniques essential for all sports disciplines. (8) Neuromuscular coordination is crucial for various human movements and becomes even more significant when learning and executing sports skills. It reflects the capability of the central and peripheral nervous systems to activate, control, or inhibit specific motor units, which is essential for precise and timely motor performance. (9) . Coordination among multiple limbs refers to the ability to synchronize the movements of a group of extremities simultaneously. The coordination between the eyes and hands, as well as the eyes and feet, is particularly vital for athletic performance. This involves the transmission of nerve signals between the nervous and muscular systems during individual sports movements. Neuromuscular coordination is essential for executing motor skills that require vision and precision, whether using the hands or feet in relation to visual input. (10) There is a strong connection between coordination and balance, speed, and agility, with a lesser link to strength. However, coordination shows no relationship with endurance, as indicated by previous studies.(11), Coordination is also related to the decline of harmonious capabilities with age, as well as to growth, particularly in bone development. The wrist and ankle bones are underdeveloped at birth but fully mature by puberty. In females, these bones typically become visible by the 51st month after birth, while in males, this occurs around the 66th month. (12)

Agility training on many components' physical fitness over an extended period can provide insights into the sustainability of the training's benefits. Long-term follow-up can help determine whether the improvements in many components of physical fitness are maintained or diminish over time. Investigating the dose-response relationship of agility training can help determine the optimal frequency, duration, and intensity of training sessions for maximizing the components outcomes of physical fitness like balance and neuromuscular coordination. This can lead to evidence-based recommendations for designing agility training programs. In this present study exploring the potential impact of agility training on balance and neuro-muscular coordination.

Methodology

Quasi experimental design was used for 8 weeks agility training with pre and post test experimental design. The participants were conveniently registered with age range from 18 years old to 25 years old, both gender male and female were given consent forms after which they filled the PAR-Q form, past medical history form after which 180 participants were screened out, Group A (Case) and Group B (Control) by simple random sample technique, 90 in each. Any history of injury within past six months, history of any systemic illness during last six months, Pregnancy and those having any physical disability were excluded. After the selection, both groups were assessed by balance and neuromuscular coordination before and after the duration of eight weeks training. The Group A (Case) were participated in 8 weeks of plan (Agility training) twice a week with the session of one (01) hour along with the warm up and cool down sessions), whereas the control group was engaged in normal activities of daily living.

Results

The mean value of Stork stand balance test of Left side in pre training was noted 10.5498±10.92397 and the post training data was noted 17.5357± 14.57102with significant value, 0.05<0.000. The mean value of Stork stand balance test of Right side in pre training was noted 11.4797±11.08911 and the post training data was noted 18.5739± 15.89692with significant value, 0.05<0.000. The mean value of McDonald Soccer test for Neuro muscular coordination in pre training was noted 10.4078±3.44854 and the post training data was noted 14.6014± 4.84229 with significant value, 0.05<0.000.

Table 1. Pre and post comparison of Agility training (Group A)

Particulars		**Mean**	**Std. Deviation**	**p-value**
Balance (Left Leg)	Pre	10.5498	10.92397	0.000
	Post	17.5357	14.57102	
Balance (Right Leg)	Pre	11.4797	11.08911	0.000
	Post	18.5739	15.89692	
Neuromuscular coordination	Pre	10.4078	3.44854	0.000
	Post	14.6014	4.84229	

The mean value of Stork stand balance test of Left side in pre training was noted 13.7592±6.48088and the post training data was noted 14.7702± 15.42672with significant value, 0.05<0.156. The mean value of Stork stand balance test of Right side in pre training was noted 13.4023±12.05336and the post training data was noted 13.8116± 15.89692 with significant value, 0.05<0.657. The mean value of McDonald Soccer test for Neuro muscular coordination in pre training was noted 11.1116±4.17658and the post training data was noted 11.4216± 4.62849with significant value, 0.05<0.359.

Table 2. Pre and post comparison of control group (Group B)

Particular		**Mean**	**Std. Deviation**	**p-value**
Balance (Left Leg)	Pre	13.7592	14.35569	0.156
	Post	14.7702	15.42672	
Balance (Right Leg)	Pre	13.4023	12.05336	0.657
	Post	13.8116	13.82275	
Neuromuscular coordination	Pre	11.1116	4.17658	0.359
	Post	11.4216	4.62849	

Discussion

Agility training program can be incorporated into the training schedule on a regular basis for taekwondo players to enhance their overall performance. This highlights the importance of agility and lower limb strength in improving athletic abilities in the context of taekwondo, a martial art sport that demands high levels of physical prowess.(13) The maintenance of overall health and well-being in human biology necessitates a specific amount of physical activity. Adapting to a lifestyle with reduced physical activity takes several generations for biological changes to manifest. **(1)** A study conducted by Mesfar A et al., and reveal that contrast strength training significantly improved the dynamic balance, one repetition maximum lower-limb back squat, single-leg hop, and countermovement jump height following 8 weeks of training, with notable effect sizes. However, no substantial changes were observed in lower-limb asymmetry. The training group exhibited greater enhancements in all assessed variables compared to the control group. Consequently, engaging in training twice a week for 8 weeks appears to be a valuable supplement to volleyball training, particularly for enhancing skill-related fitness measures in young volleyball players, though its impact on lower-limb asymmetry may be limited. (14) In the same eight weeks of functional training (FT) and traditional resistance training (TRT) on biomotor capacities in elite

female taekwondo athletes. Despite non-significant differences between FT and TRT groups, both interventions led to significant improvements in various time-related outcomes, aerobic power, muscle power, speed, agility, reaction time, strength, and dynamic balance. Notably, the FT group exhibited significant enhancements in peak and mean power. Given the importance of muscle power in taekwondo success, the study recommends incorporating functional training into the taekwondo workout program to optimize the development of biomotor abilities in elite female athletes. (15) A study was compared the impact of 12 weeks of high-speed bodyweight resistance training (HS-BT) and normal-speed bodyweight resistance training (NS-BT) on static and dynamic balance in community-dwelling older women. The results indicated that participants in the HS-BT group showed a significant improvement in the Timed Up and Go (TUG) test, reflecting enhanced dynamic balance, while no significant changes were observed in the NS-BT group. Interestingly, the One Leg Stance (OLS) test did not exhibit significant changes in either group. These findings suggest that high-speed bodyweight resistance training may be more effective in improving dynamic balance, as evidenced by TUG, in community-dwelling older women compared to normal-speed bodyweight resistance training over a 12-week intervention period. (16) 12-week multicomponent exercise program, aligned with osteoporosis guidelines, significantly improved muscle strength, dynamic balance (Four Square Step Test), arm curl performance, and 30-second sit-to-stand test in older women with osteoporosis and vertebral fractures. Although habitual walking speed did not show a statistically significant difference between the intervention and control groups, the exercise program demonstrated positive effects on fear of falling. These results emphasize the potential benefits of a supervised multi component resistance and balance exercise program in enhancing key health outcomes for individuals with osteoporosis and a history of vertebral fractures. (17) The study underscores the potential of slackline training in mitigating the decline in physical activity, particularly among young individuals. Findings revealed a moderate energy expenditure level during supervised sessions, indicative of its feasibility for regular practice. Moreover, significant improvements in both static and dynamic balance parameters highlight the efficacy of slackline training in enhancing stability and preventing injuries. These results align with WHO recommendations on physical activity and underscore the value of incorporating unconventional yet engaging forms of exercise into wellness routines to promote better overall health. (18) This study underscores the beneficial effects of creative dance on proprioception and rhythmic synchronization in preschool children, as evidenced by significant improvements in these areas compared to a control group. While static balance did not show significant changes, the findings highlight the potential of creative dance to enhance key aspects of motor development crucial in early childhood. Integrating creative dance into early childhood curricula could offer a holistic approach to fostering physical and cognitive skills essential for young learners. Further research exploring the long-term impacts of creative dance in early childhood education could provide valuable insights into its role in promoting overall developmental outcomes. (19) The study highlights the efficacy of incorporating selective tibialis posterior strengthening and iliopsoas stretching alongside conventional exercises in improving navicular drop, dynamic balance, and lower limb muscle activity in individuals with pronated feet. Significant group differences were observed in muscle activity and dynamic balance parameters post-intervention, emphasizing the importance of targeted interventions for addressing biomechanical issues associated with flat feet. These findings offer valuable insights for designing comprehensive rehabilitation programs aimed at enhancing foot structure and function in young adults with pronated feet, potentially reducing the risk of related musculoskeletal complications. (20) The study demonstrates the effectiveness of integrating sports dance into fitness training programs for preschool-age children, showcasing significant improvements in physical condition parameters and posture. Positive changes in muscle strength, spinal flexibility, and balance were observed, indicating the holistic benefits of the program. Notably, significant enhancements in postural parameters and reduced postural sway highlight the potential of sports dance classes in fostering both static and dynamic balance control in children. These findings underscore the importance of incorporating diverse and engaging activities like sports dance to promote overall physical development in young children. (21) This

study examined the impact of combined aerobic and rebound therapy programs on physical and motor fitness in intellectually disabled girls. Two experimental groups with varying ratios of aerobic and rebound exercises were compared over 8 weeks. Results indicated significant improvements in endurance, balance, agility, and coordination for both experimental groups compared to the control. Interestingly, no notable differences were found between the two exercise program ratios. Overall, the findings suggest that tailored combined programs could effectively enhance physical and motor fitness in this demographic. (22) in present study agility training group showed significant improvements on both left and right sides balance. In the result of Neuromuscular coordination, training group exhibited a substantial improvement with a highly significant impact.

Conclusion

The Agility training group exhibited significant improvements in balance and neuro-muscular coordination. While the control group demonstrated less pronounced changes in mean but not found significant changes across these measures. These findings suggest that the Agility training protocol positively influenced the participants' balance and neuro-muscular coordination.

References

1. Christer Malm, Johan Jakobsson, and Andreas Isaksson. Physical Activity and Sports—Real Health Benefits: *Review with Insight into the Public Health of Sweden. Sports, 2019; 7(5), 127.* doi:10.3390/sports7050127
2. NICHOLAS RATAMESS Jr (Ed.) 2012. ACSM's Foundations of Strength Training and Conditioning, Department of Health and Exercise Science The College of New Jersey Ewing, NJ
3. Sheppard, J. M., & Young, W. B. (2006). Agility literature review: Classifications, training and testing. Journal of Sports Sciences, 24(9), 919–932. doi:10.1080/0264041050 0457109
4. Chaalali, A., Rouissi, M., Chtara, M., Owen, A., Bragazzi, N. L., Moalla, W., … Chamari, K. (2016). Agility training in young elite soccer players: Promising results compared to change of direction drills. Biology of Sport, 33(4), 345–351. doi:10.5604/20831862.1217924
5. Chaouachi, A., Chtara, M., Hammami, R., Chtara, H., Turki, O., & Castagna, C. (2014). Multidirectional sprints and small-sided games training effect on agility and change of direction abilities in youth soccer. The Journal of Strength & Conditioning Research, 28(11), 3121–3127. doi:10.1519/JSC.0000000000000505
6. Lehnert, M., Hůlka, K., Malý, T., Fohler, J., & Zahálka, F. (2013). The effects of a 6 week plyometric training programme on explosive strength and agility in professional basketball players. Acta Gymnica, 43(4), 7–15. doi:10.5507/ ag.2013.019
7. Thomas, K., French, D., & Hayes, P. R. (2009). The effect of two plyometric training techniques on muscular power and agility in youth soccer players. The Journal of Strength & Conditioning Research, 23(1), 332–335. doi:10.1519/JSC.0b013e318183a01a
8. Missitzi, J., Geladas, N., & Klissouras, V. (2004). Heritability in neuromuscular coordination: implications for motor control strategies. *Medicine & science in sports & exercise*, *36*(2), 233-240.
9. Khasawneh, A., Mousa, A., & Atiya, K. (2009). Evaluating Neuromuscular Coordination for Hands among Physical Education Students. The Shield, 4, 44-59
10. Magill, R. A. (2011). Motor Learning and Control: Concepts and Applications (9th ed., pp. 4). New York: McGraw-Hill
11. Spodek, B., & Saracho, O. N. (2006). Handbook of Research on the Education of Young Chidren (2nd ed., pp. 117). Abingdon-on-Thames: Routledgem
12. Getchell, N., & Whitall, J. (2003). How Do Children Coordinate Simultaneous Upper and Lower Extremity Tasks? The Development of Dual Motor Task Coordination. Journal of Experimental Child Psychology, 85, 120-140. https://doi.org/10.1016/S0022-0965(03)00059-6

13. Singh A, Sathe A, Sandhu JS. Effect of a 6-week agility training program on performance indices of Indian taekwondo players. Saudi J Sports Med 2017;17:139-43
14. Mesfar A, Hammami R, Selmi W, Gaied-Chortane S, Duncan M, Bowman TG, Nobari H, van den Tillaar R. Effects of 8-Week In-Season Contrast Strength Training Program on Measures of Athletic Performance and Lower-Limb Asymmetry in Male Youth Volleyball Players. Int J Environ Res Public Health. 2022 May 27;19(11):6547. doi: 10.3390/ijerph19116547. PMID: 35682140; PMCID: PMC9180623.
15. Khazaei L, Parnow A, Amani-Shalamzari S. Comparing the effects of traditional resistance training and functional training on the bio-motor capacities of female elite taekwondo athletes. BMC Sports Sci Med Rehabil. 2023 Oct 20;15(1):139. doi: 10.1186/s13102-023-00754-9. PMID: 37864229; PMCID: PMC10589965.
16. Jaque-Gallardo C, Véliz-Campillay P, Cancino-López J. Efecto de un entrenamiento con ejercicios de autocarga a alta velocidad en el equilibrio dinámico y estático en mujeres adultas mayores [Effect of a high-speed bodyweight resistance training on timed up and go and one leg stance in older women]. Rev Med Chil. 2019 Sep;147(9):1136-1143. Spanish. doi: 10.4067/s0034-98872019000901136. PMID: 33625447.
17. Stanghelle, B., Bentzen, H., Giangregorio, L., Pripp, A. H., Skelton, D. A., & Bergland, A. (2020). Effects of a resistance and balance exercise programme on physical fitness, health-related quality of life and fear of falling in older women with osteoporosis and vertebral fracture: a randomized controlled trial. *Osteoporosis international*, *31*, 1069-1078.
18. Rutkowski, S., Wrzeciono, A., Czech, O., Rutkowska, A., & Szczegielniak, J. (2022). Effects of a Short-Term Slackline Training Program on Energy Expenditure and Balance in Healthy Young Adults: A Preliminary Report of a Randomized Controlled Trial. *International Journal of Environmental Research and Public Health*, *19*(8), 4830.
19. Chatzopoulos, D., Doganis, G., & Kollias, I. (2018). Effects of creative dance on proprioception, rhythm and balance of preschool children. *Early Child Development and Care*.
20. Alam, F., Raza, S., Moiz, J. A., Bhati, P., Anwer, S., & Alghadir, A. (2019). Effects of selective strengthening of tibialis posterior and stretching of iliopsoas on navicular drop, dynamic balance, and lower limb muscle activity in pronated feet: A randomized clinical trial. *The Physician and sportsmedicine*, *47*(3), 301-311.
21. Andrieieva, O., Kashuba, V., Yarmak, O., Cheverda, A., Dobrodub, E., & Zakharina, A. (2021). Efficiency of children's fitness training program with elements of sport dances in improving balance, strength and posture. *Journal of Physical Education and Sport*, *21*, 2872-2879.
22. Haghighi, A. H., Mohammadtaghipoor, F., Hamedinia, M., & Harati, J. (2019). Effect of a combined exercise program (aerobic and rebound therapy) with two different ratios on some physical and motor fitness indices in intellectually disabled girl. *Baltic Journal of Health and Physical Activity*, *11*(1), 3.