El entrenamiento continuo con línea de carrera mejora la resistencia cardiovascular en atletas con discapacidad visual Clasificación totalmente ciega

Continuous Training with Running Line Improve Cardiovascular Endurance in Visually Impaired Athletes Totally Blind Classification

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Abstract

This research purpose was testing the application of continuous training with running line to improve cardiovascular endurance in visually impaired athletes classified as totally blind. Three male 100 m sprint athletes with visual impairment classified as totally blind National Paralympic Committee Indonesia aged 20-30 years and weighing 65.33±4.93 kg. A one group pre-post design was used in this experimental study. Each participant underwent 3 weekly sessions for 6 weeks of continuous training with a running line. The data collected were cardiovascular endurance data using distance-based walk and run tests. The results showed an increase in the average VO_{2max} in visually impaired athletes after continuous training with running line, which was initially 47.36±2.40 ml/kg/min then increased to 50.66±1.65 ml/kg/min. There is a difference in VO_{2max} of blind athletes between before and after continuous training with running line, with a value of t_{count} = 6.305 > t_{table} = 4.304. So it is concluded that continuous training with running line seems to be effective in increasing cardiovascular endurance in visually impaired athletes classified as totally blind, which is indicated by an increase in VO_{2max} value of 6.98%.

Keywords

Continuous Training, Running Line, Athletes with disabilities, Visually Impaired, VO_{2max}

Resumen

El objetivo de esta investigación fue probar la aplicación del entrenamiento continuo con línea de carrera para mejorar la resistencia cardiovascular en deportistas con discapacidad visual clasificados como totalmente ciegos. Tres atletas masculinos de velocidad de 100 m con discapacidad visual clasificados como totalmente ciegos por el Comité Paralímpico Nacional de Indonesia, con edades entre 20 y 30 años y un peso de 65.33 ± 4.93 kg. En este estudio experimental se utilizó un diseño pre-post de un grupo. Cada participante realizó 3 sesiones semanales durante 6 semanas de entrenamiento continuo con línea de carrera. Los datos recopilados fueron datos de resistencia cardiovascular mediante pruebas de caminata y carrera basadas en distancia. Los resultados mostraron un aumento en el $VO_{2máx}$ promedio en atletas con discapacidad visual después del entrenamiento continuo con línea de carrera, que inicialmente fue de 47.36 ± 2.40 ml/kg/min y luego aumentó a 50.66 ± 1.65 ml/kg/min. Existe una diferencia en el $VO_{2máx}$ de los deportistas ciegos entre antes y después del entrenamiento continuo con línea de carrera, con un valor de t_{count} = 6.305 > t_{table} = 4.304. Por lo que se concluye que el entrenamiento continuo con línea de carrera parece ser efectivo para aumentar la resistencia cardiovascular en atletas con discapacidad visual clasificados como totalmente ciegos, lo cual se indica con un aumento en el valor de VO_{2max} del 6.98%.

Palabras clave

Entrenamiento Continuo, Línea de Carrera, Deportistas con discapacidad, Discapacidad visual, VO_{2max}

Introduction

The number of people with special needs who are visually impaired (blind) in Indonesia is quite large. Based on data from the Ministry of Health, the number of people with visual impairments is ± 1.5% of the total population. The population of Indonesia in 2023 is 278.8 million, with the number of visually impaired people ± 4.2 million people. In recent decades, participation in Paralympic sports has grown exponentially with more countries and athletes participating in this event. By participating in Paralympic events, people with visual impairments have a higher quality of life and improve their social life (Papadopoulos et al., 2023). Athletes with visual impairments, in Paralympic sports, are athletes who experience impaired visual acuity or vision and field of view angles caused by damage to the structure of the eye, optic nerve or optic pathway, or the visual cortex of the brain (World Para Athletics, 2018). The Paralympics is a world-class sporting event where athletics is the most medal- winning event in the Paralympics (Kim & Hong, 2022). In Paralympic sports, athletes with visual impairments can participate in para athletics (Aleksandrović, 2018). Athletes are classified by their class number with the code "T" which means track. The para athletics sport which is referred to as the core of the Summer Paralympic Games consists of seven wheelchair racing classes and 20 running classes, in which athletes with visual impairments participate in classes T11-13 (Kim & Hong, 2022).

The physical capacity of athletes is one of the important elements of successful sports performance, and aerobic capacity has been accepted as its main component. Maximal oxygen uptake (VO_{2max}) has been considered as the best indicator of an organism's aerobic capacity, and at the same time it is also the best indicator of an athlete's physical capacity (Ranković et al., 2010). Compared with people without blindness, adolescents with visual impairments have lower levels of VO_{2max} (Żebrowska, Zwierzchowska, & Gawlik, 2007). Through exercise, individuals with visual impairments can increase aerobic capacity. T11 athletes and their guides did not show any differences in VO_{2max} (49.29 ± 9.25 ml/kg/min VO_{2max} T11 athletes and 51.30 ± 8.92 ml/kg/min VO_{2max} guide) and there was a positive and moderate relationship in T11 athletes and guides on the speed achieved at maximal oxygen consumption (vVO_{2max}) ($R^2 = 0.684$, $p < .01$) (Winckler et al., 2024). Traditionally, distance running performance is associated with three main physiological variables, one of which is maximum oxygen uptake (VO_{2max}) (Rivera-Kofler, et al., 2024). High VO_{2max} is also a prerequisite for success in running. VO_{2max} increased from 100 to 1.500 m in runners with the same performance level, indicating the increasing importance of this parameter for training and selection purposes. In distance events, varying performance is discriminated by the VO_{2max} variable, but this is not the case in a homogeneous group of elite athletes (Legaz-Arrese et al., 2007).

Given the importance of VO_{2max} in the running performance of visually impaired athletes, athletes need to be trained to improve it. Nigussie & Tegegne (2024) explained that running performance is greatly influenced by training methods, including continuous, interval, and combined training methods. In their study, Nigussie & Tegegne (2024) reported a significant difference between the continuous and interval training groups in the multiple sprint test ($p = 0.024$, mean difference = -1.75), with an effect size of 0.356. This study focused on continuous training. Continuous training is an exercise that is done repeatedly and can increase cardiovascular endurance (VO_{2max}) (Mülle & Ritzdorf, 2009). VO_{2max} increased after continuous training carried out by running (before: 47.9 ± 1.5; after: 49.7 ± 1.5 ml/kg/min, $p < 0.05$) (Litleskare et al., 2020). A review and meta-analysis showed that comparing changes from pre- and post-intervention, oxygen cost increased more in continuous training when compared to interval training interventions. The increase in oxygen cost was greater in participants with higher VO_{2max} (≥ 52.3 ml/kg/min), and in programs longer than or equal to 8 weeks. Continuous training appears, overall, to be a better strategy than interval training to reduce oxygen cost in recreational endurance runners (Gonzalez-Mohino et al., 2019). In the tandem cycling sport, after undergoing training for 7 months of cycling, running, and swimming, a statistically significant increase in VO_{2max} in visually impaired athletes was found (VO_{2max} increased 9.1%) (Malwina, Krzysztof, & Piotr, 2015).

For running athletes with visual impairment, continuous training also needs to be implemented, in this case continuous training is carried out with a running line. A previous study reported that walking with a line guide for 20 minutes increased VO_{2max} of individuals with vision loss by 12.4% from 30.6 ± 10.7 ml/kg/min in the fourth week (Sanshoj & Nakata, 1994). Line guidance is needed because running

athletes with visual impairments require individual assistance to walk and run properly. The aim is to correct body and head posture as well as arms and legs movements simultaneously, with the right stride length, pace and rhythm (Aleksandrović, 2018). Therefore, this study was conducted with the aim of determining the effect of continuous training with running line to increase cardiovascular endurance in athletes with visual impairment classified as totally blind.

Method

The research type was used pre-experimental with one group pretest-posttest design. The research subjects were sprint athletes with visual impairment classified as totally blind at the National Paralympic Committee of Indonesia, totaling 3 athletes, aged 20-30 years with a body weight of 65.33 ± 4.93 kg. The three athletes were the result of athlete selection who were entered into the National Paralympic Committee of Indonesia training center. Each participant underwent 3 weekly sessions for 6 weeks with a duration of 20 minutes. Participants trained with an intensity in the range of 65-85% HRmax (Esatbeyoğlu et al., 2022) (figure 1).

Figure 1. Continuous training with running line

The data including of cardiovascular endurance data using distance-based walk and run tests (Fukuda, 2019). The test was carried out with a 1.5 mile (2.4 km) run using a 400 m (437.5 yd) track (figure 2). Using a 400 m track, participants run 6 full laps and an additional 13.8 m (2.3 m x 6 laps). The test results are the time needed to cover the distance in seconds, which is then used to estimate maximum aerobic capacity. VO_{2max} (ml/kg/minute) is calculated using the formula 91.736 - (0.1656 x weight in kg) - (2.767 × time in minutes) (Fukuda, 2019).

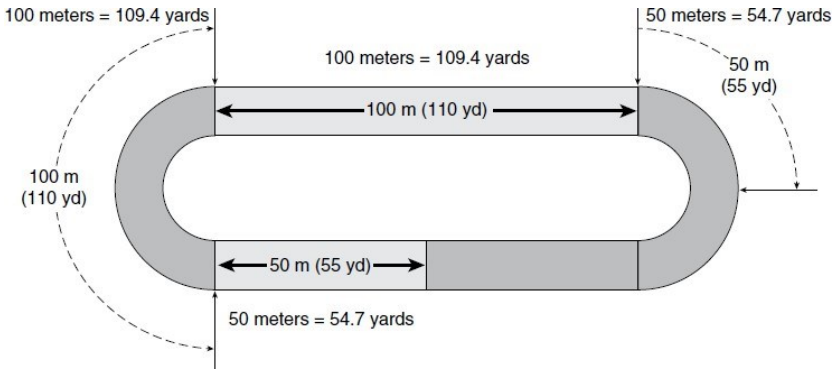

Figure 2. Track for distance-based walk and run tests (Fukuda, 2019)

All data were normally distributed so that research data analysis was conducted using paired t-test to determine the changes in VO_{2max} before and after undergoing training. The percentage increase in VO_{2max} is calculated using descriptive percentages. The data were analyzed using SPSS17.

Results

Each subject experienced an increase in VO_{2max} after 6 weeks of continuous training with a running line. An increase in VO_{2max} from 45.11 ml/kg/min to 48.88 ml/kg/min occurred in subject 1, VO_{2max} from 49.88 ml/kg/min to 52.12 ml/kg/min occurred in subject 2, and 47.08 ml/kg/min to 50.97 ml /kg/min occurred in subject 3. Figure 3 presents a graph of the increase in each subject. There was a significant difference in the pretest and posttest VO_{2max} of running athletes with visual impairment after undergoing continuous training with a running line (table 1).

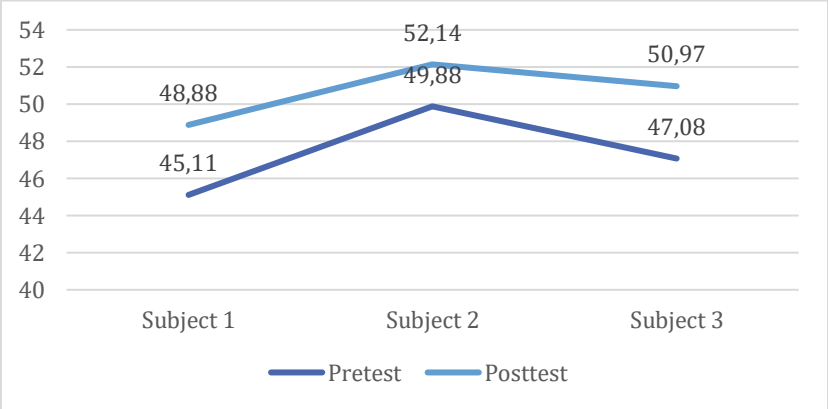

Figure 3. Graph of Increase in VO_{2max} for Each Subject

Table 1. Differences in pretest and posttest VO_{2max} in running athletes with visual impairment

Test	Mean±SD	Md	% Improvement	t_{count}	p	$t_{table\ 5\%}$
Pretest	47.36±2.40	3.307	6.98%	6.305	0.024	4.304
Posttest	50.66±1.65					

Discussion

This study aims to determine the effect of continuous training with a running line to increase cardiovascular endurance in running athletes with visual impairments classified as totally blind. This study provides evidence of an increase in VO_{2max} in running athletes with visual impairment using continuous training with a running line. VO_{2max} increased by 6.98%. Athletes in the present investigation showed higher VO_{2max} results than blind cyclists in other investigations (Malwina, Krzyszof, & Zmijewski, 2015). It was also higher than visually impaired subjects with rope-guided training (Sanshoj & Nakata, 1994). Runners need to develop general and specific endurance, both long and medium distances, according to the energy needs of their sport. This endurance comes from developing the correct energy system. There are three metabolic energy systems that operate in our body. These energy systems operate continuously and it depends on how long and how hard we perform any physical activity that determines which system makes the greatest contribution. Longer races require aerobic endurance, while shorter races require endurance of the lactic system.

Bacon et al. (2013) explained that high intensity continuous running almost certainly contributed to a large increase in VO_{2max}. This increase occurs due to an increase in peripheral oxygen extraction and cardiac output. However, the contribution of changes in stroke volume, blood volume, capillary density, muscle mitochondrial content and many other factors associated with training-induced increases in VO_{2max} may vary both individually and perhaps through interactions with specific elements of a particular training program. In this research, the continuous training program was modified using assistive equipment such as a running line. Using line assistance when running makes it easier for visually impaired athletes to know their route, overcoming the limitations of their inability to visually monitor body movements so that visually impaired athletes remain on the running route. In addition to overcoming movement limitations, this also overcomes the obstacles experienced by visually impaired runners that previous studies have presented. The obstacle was finding sighted runners to guide them. Visually impaired runners feel tired because they are constantly trying to find people to do training with

(Ball et al., 2022). Therefore, the training program uses continuous training with a running line, apart from increasing aerobic capacity, it also helps visually impaired runners overcome the difficulty of finding a sighted guide to train with. In addition, running lines help visually impaired runners know and navigate running routes in training. Previous studies have shown that visually impaired runners need time to adjust, sometimes bumping into things or falling (Powis & Macbeth, 2024). Touch is best understood as a form of knowledge that includes kinesthesia, proprioception, and the vestibular system, and practice shows that vision-impaired runners' understanding of touch must go beyond the hands. Touch allows safe navigation of terrain allowing them to have a visual memory (Powis & Macbeth, 2024).

The research study has the implication that continuous training with a running line can be used by coaches of visually impaired runners. However, this research also has certain limitations. For more relevant conclusions, the participant sample should be expanded in terms of number and presence of a control group. Small samples can be a limitation because they may not be representative of the larger population, which can cause findings to be inaccurate or incomplete. Future studies may include a larger sample size and runners without visual impairment may be included as controls for the experiment.

Conclusions

The results obtained show that continuous training with running line seems to be effective in increasing cardiovascular endurance in visually impaired athletes classified as totally blind, which is indicated by an increase in VO_{2max} value of 6.98%. This study has the implication that continuous training with a running line is useful for coaches to develop special training programs. Athletes with visual impairments classified as completely blind can also carry out independent running training using continuous training with a running line without using a sighted guide.

References

Aleksandrović, M. (2018). Characteristics of physical training of persons with visual impairment: From instruction and workout to training and competition. *Fizičko vaspitanje i sport kroz vekove*, *5*(1), 67-83. https://doi.org/10.2478/spes-2018-0006

Bacon, A. P., Carter, R. E., Ogle, E. A., & Joyner, M. J. (2013). VO2max trainability and high intensity interval training in humans: a meta-analysis. *PloS one*, *8*(9), e73182. https://doi.org/10.1371/journal.pone.0073182

Ball, L. E., Lieberman, L. J., Beach, P., Perreault, M., & Rich, J. (2022). Exploring the experiences of runners with visual impairments and sighted guides. *International Journal of Environmental Research and Public Health*, *19*(19), 12907. https://doi.org/10.3390/ijerph191912907

Esatbeyoğlu, F., Karaçoban, L., Akın, Ş., & Dönmez, G. (2022). Exercise programming for individuals with vision loss. *Spor Hekimliği Dergisi*, *57*(4), 213-219. https://doi.org/10.47447/tjsm.0690

Fukuda, D. H., (2019). *Assessments for Sport and Athletic Performance.* Human Kinetics Publisher. https://doi.org/10.5040/9781492595243

González-Mohíno, F., Santos-Concejero, J., Yustres, I., & González-Ravé, J. M. (2020). The effects of interval and continuous training on the oxygen cost of running in recreational runners: a systematic review and meta-analysis. *Sports Medicine*, *50*, 283-294. https://doi.org/10.1007/s40279-019-01201-x

Kim, M. C., & Hong, S. M. (2022). A Comparative Analysis Study on Para Athletics' Track Discipline Change and Performance Trend in the Paralympic Games (2004–2020). *Applied Sciences*, *12*(24), 12904. https://doi.org/10.3390/app122412904

Legaz-Arrese, A., Munguía-Izquierdo, D., Nuviala, A. N., Serveto-Galindo, O., Urdiales, D. M., & Masía, J. R. (2007). Average VO2max as a function of running performances on different distances. *Science & sports*, *22*(1), 43-49. https://doi.org/10.1016/j.scispo.2006.01.008

Litleskare, S., Enoksen, E., Sandvei, M., Støen, L., Stensrud, T., Johansen, E., & Jensen, J. (2020). Sprint interval running and continuous running produce training specific adaptations, despite a similar improvement of aerobic endurance capacity—a randomized trial of healthy adults. *International*

journal of environmental research and public health, *17*(11), 3865. https://doi.org/10.3390/ijerph17113865

Malwina, K. A., Krzysztof, M., & Piotr, Z. (2015). Visual impairment does not limit training effects in development of aerobic and anaerobic capacity in tandem cyclists. *Journal of human kinetics*, *48*, 87. https://doi.org/10.1515/hukin-2015-0095

Mülle, H., & Ritzdorf, W. (2009). *Run!, Jump!, Throw! : The Official IAAF Guide to Teaching Athletics*. IAAF: IAAF Coaches Education and Certification System. https://indianathletics.in/wp-content/uploads/2021/02/IAAF-Run-Jump-Throw.pdf

Nigussie, Y. T., & Tegegne, Z. M. (2024). Effects of continuous, interval, and combined training methods on middle- and long-distance runners' performance. *Retos*, *58*, 418–425. https://doi.org/10.47197/retos.v58.102976

Papadopoulos, C., Metaxas, T. I., Fotiadou, E. G., Giagazoglou, P. F., Michailidis, Y., Christoulas, K., & Tsimaras, V. (2022). Correlations between VO2max and match distance running performance of soccer players with visual impairment. *Research Square*. https://doi.org/10.21203/rs.3.rs-1453809/v1

Powis, B., & Macbeth, J. L. (2024). Running blind: the sensory practices of visually impaired runners. *Qualitative Research in Sport, Exercise and Health*, *16*(3), 244-258. https://doi.org/10.1080/2159676X.2023.2284704

Ranković, G., Mutavdžić, V., Toskić, D., Preljević, A., Kocić, M., Nedin-Ranković, G., & Damjanović, N. (2010). Aerobic capacity as an indicator in different kinds of sports. *Bosnian journal of basic medical sciences*, *10*(1), 44. https://doi.org/10.17305/bjbms.2010.2734

Rivera-Kofler, T., Soto-Lagos, R., Herrera-Amante, C., Cortés-Roco, G., Olivares-Arancibia., J., & Yáñez-Sepúlveda, R. (2024). Anthropometric Characteristics, Training Intensity Distribution, Physiological Profile and Performance of an Elite Trail Runner: A Longitudinal Case Study. *International Journal of Morphology, 42*(2), 416-423. https://doi.org/10.4067/S0717-95022024000200416

Saishoji, H., Nakata, H. (1994). Endurance Training with an Adapted Device in the Visually Impaired. In: Yabe, K., Kusano, K., Nakata, H. (eds) Adapted Physical Activity. Springer, Tokyo. https://doi.org/10.1007/978-4-431-68272-1_28

Winckler, C., Costa, S. G. D., Campos, L. F. C. C. D., & Lourenço, T. F. (2024). Differences and relationship between velocity attained at VO2max and time trial performances in Para athletes with vision impairment and their guides. *British Journal of Visual Impairment*, 02646196241252611. https://doi.org/10.1177/02646196241252611

World Para Athletics. (2018). *World Para Athletics Classification & Categories*. https://www.paralympic.org/athletics/classification

Zebrowska, A., Zwierzchowska, A., & Gawlik, K. (2007). The dynamics of maximal aerobic efficiency in children and adolescents with hearing and visual impairment. *Journal of Human Kinetics*, *17*, 53. https://www.researchgate.net/publication/297440694_The_dynamics_of_maximal_aerobic_efficiency_in_children_and_adolescents_with_hearing_and_visual_impairment

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