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Can physical exercise improve venous function in the context of chronic venous diseases? The impact of sport on varicose veins of the lower limbs - a review

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Abstract

Varicose veins, often linked to our upright posture, are dilated and twisted veins and are a sign of chronic venous disease (CVD). They arise from vein degeneration, leading to blood flow issues and inefficiencies in the muscle pump function. Venous diseases, including varicose veins and chronic venous insufficiency (CVI), are widespread. Prevalence varies, with significant differences based on location and study methods. The incidence of these conditions increases with age. CVI is mainly caused by venous hypertension due to blood reflux or obstruction. Risk factors include hormonal changes, genetic predispositions, lifestyle habits (e.g., prolonged sitting, smoking), and conditions like obesity and pregnancy. Regular exercise and a balanced diet help manage CVD by reducing weight and improving blood flow. Effective activities include calf muscle exercises, while high-pressure sports may worsen the condition. The 2023 guidelines stress the need for lifestyle changes, including physical exercise, to better manage CVD.

Keywords: Varicose veins; Chronic venous disease; Chronic venous insufficiency; Hormonal influence; Obesity; Physical activity.

Introduction: Varicose veins, a common form of chronic venous disease, arise from the dysfunction of veins in the lower limbs due to increased pressure and impaired blood flow. Regular physical activity and a balanced diet are crucial in managing and potentially improving symptoms of this condition.

Material and methods: We have gathered the available materials and scientific reports, analyzing and summarizing them in a single study.

Aim of study: We aimed to evaluate how physical activity and lifestyle changes impact the progression and management of varicose veins and chronic venous disease.

Conclusion: The study underscores the significant role of physical activity and lifestyle changes in managing varicose veins and chronic venous disease. By enhancing calf muscle function and improving venous blood flow, these interventions can help reduce symptoms, prevent disease progression, and potentially decrease the need for surgical treatments.

The definition.

Are varicose veins of the lower limbs a consequence of our evolution? It is somewhat believed that evolution, and thus the adoption of an upright posture by our species, is an inevitable factor causing the development of pathologies in the venous system of the lower limbs. We can speak of varicose veins when a vein is dilated, lengthened, and tortuous [8,9]. Varicose veins are one of the symptoms of chronic venous disease. As a result of degenerative changes in the venous vessels, blood flow is disrupted, leading to a reversal of flow direction in the superficial system, with blood beginning to flow downward. Consequently, the blood outflow generated by muscle contractions ("muscle pump") is less effective because, shortly afterward, the blood accumulating in the superficial system quickly refills the deep system to maximum pressure levels [4]. So, can more frequent activation of the muscle pump due to physical activity worsen or improve the condition of the venous system in the lower limbs?

Epidemiology.

Venous diseases, including varicose veins and chronic venous insufficiency (CVI), are the most frequently reported chronic conditions [3,30]. These two diseases are yet understudied conditions in the general population. Estimations of the true prevalence of varicose veins have varied widely from less than 1% to upwards of 70%, and between 1 and 40% for CVI, depending on the population surveyed and the definition of disease [1]. Determining the prevalence of chronic venous insufficiency is complicated due to the wide spectrum of clinical symptoms of the disease, which can range from purely cosmetic blemishes to serious complications such as venous stasis, ulcers, and venous embolism [2,30]. Epidemiological studies conducted in Poland in the subject of varicose veins, covering over 40,000 patients, indicate that the disease affects 61% of women and 38% of men in the adult population. Some studies suggest smaller gender differences in disease prevalence, while others report the opposite proportions. The most severe stage, active venous ulcers, affects less than 1% of the population (up to 0.5% of adults in Poland), but is found in 3% of people over the age of 65. [4]. A study conducted in the UK shows that half of the adult population has minor signs of

venous disease (50-55 percent of women; 40-50 percent of men), but fewer than half of these individuals will have visible varicose veins (20-25 percent of women; 10-15 percent of men) [5]. Thus, reviewing the current literature makes it difficult to precisely determine the age at which symptoms of lower limb venous insufficiency and varicose veins appear. However, studies conducted so far clearly show that the incidence of lower limb varicose veins increases with age, due to the weakening of calf muscles and blood vessels [6,7,11].

Pathophysiology and risk factors.

The precise process of the pathogenesis of venous diseases leading to their insufficiency has not been fully elucidated [14]. The anatomy of the venous system in the legs appears to play a significant role in this disease. The venous vessels in the lower limb can be divided into two main groups: the deep venous system and the superficial venous system. These two systems are connected by perforating veins. In simple terms, the deep system is located "within the muscles," while the superficial system is "under the skin," and it is primarily the superficial system that is affected by chronic venous insufficiency [12]. The main pathophysiological cause of clinical symptoms of chronic venous insufficiency (CVI) in the lower limbs is venous hypertension [11]. It can be caused by reflux of blood in veins with damaged valves, obstruction of venous flow, or both [10,12]. Varicose veins are therefore a symptom of venous hypertension [13]. Researchers suggest that stasis of deoxygenated venous blood leads to chronic hypoxia of the vessels and the development of an inflammatory process that can affect their walls, causing damage [15]. Structural changes in the vein wall cause weakening and dilation. Varicose veins show increased collagen type I, decreased collagen type III, and disrupted smooth muscle cells and elastin. High levels of tissue inhibitors of metalloproteinases, transforming growth factor β1, and fibroblast growth factor β contribute to these changes [16].

Risk factors for varicose veins can be classified into four categories:

- Hormonal- Female gender. Women aged 40-79 have a higher tendency to develop varicose veins compared to men in the same age range, most likely due to the adverse effects of estrogen on the venous system [16,17]. The direct effects of estrogen on the human vein wall include more methylation of the ERα gene in older people, which suggests lower activity and may contribute to aging of the blood vessels. 17β-estradiol affects how veins contract, increasing the effect of ET-1 without causing them to widen, and it also inhibits Ca2+-dependent vein constriction, indicating it might interfere with Ca2+ channels. High estrogen

levels in postmenopausal women are linked to more varicose veins and greater stretchiness of veins [18].

- Genetic- Current evidence shows a strong link between varicose veins and a positive family history [16]. Genes such as desmuslin and thrombomodulin can directly influence vein function, with mutations linked to the development and progression of varicose veins. While some genetic studies using SNP (single nucleotide polymorphism) arrays have explored the genetic role in varicose vein formation, most research has been qualitative and epidemiological, and has not pinpointed specific susceptibility genes or variants [19].
- Lifestyle- Prolonged standing or sitting is strongly correlated with the development of venous hypertension, while smoking contributes to endothelial damage in the veins, including severe form of CVD such as ulceration [16,29]. Additionally, some studies have identified diets low in fiber-rich plant foods and resulting constipation as risk factors for varicose veins [17].
- Acquired- Pregnancy significantly influences the onset and progression of varicose veins in women. The alterations in the venous system during pregnancy are linked not only to hormonal changes but also to the compression of the iliac veins by the expanding uterus. Studies revealed that the likelihood of developing varicose veins grew with each advancing week of pregnancy [20]. According to the study results, the most reported risk factor worsening venous system issues is overweight and obesity, cited by 93% of respondents [21]. The link between obesity and varicose veins can be explained by several biological mechanisms. First, abdominal obesity can increase intra-abdominal pressure, potentially hindering venous return from the lower limbs or causing venous dysfunction, which can lead to varicose veins. Second, obesity is frequently associated with dyslipidemia, which may raise blood viscosity and cause hemodynamic issues. Lastly, obesity can trigger inflammatory factors that negatively impact the vascular wall [22].

Physical activity.

Many factors can contribute to the development or worsening of chronic venous disease. Besides unsightly visible veins, the presence of varicose veins is associated with painful symptoms, aching, swelling, itching, skin changes, ulceration, thrombophlebitis, and bleeding [23,30]. The safest management, though not a cure, for varicose veins is graduated compression stockings. Wearing these stockings may reduce venous reflux while they are worn, but the reflux resumes once they are removed [24]. Surgical treatments such as high ligation and stripping are commonly used but come with drawbacks, including scarring, risk of recurrence and extended recovery periods [24,31]. Valvuloplasty targets problems with deep venous valves but has its limitations. Minimally

invasive methods, like endovenous laser therapy and sclerotherapy, provide promising alternatives, though there is still a risk of recurrence [24,25]. Can physical activity reduce the frequency of postoperative recurrences of chronic venous disease or even slow the progression of the condition before surgical treatment?

Regular physical activity combined with a balanced diet helps reduce weight, addressing the significant risk factor for CVD, which is overweight and obesity. Additionally, it improves blood flow in the lower limbs by enhancing muscle pump function and improving hemodynamics. Venous return is primarily driven by the natural muscle pumps in the lower limb: the foot, calf, and thigh pumps, while the calf muscle pump is very effective for blood flow because it can hold a lot of blood, generate high pressures, and is located in the lower part of the leg where venous pressure is highest [27]. Studies show that a short, supervised calf exercise program can greatly improve blood flow in patients with leg ulcers caused by valve issues and weak calf muscles. After 7 days of calf exercises with a 4-kg pedal machine, patients had a significant increase in calf muscle endurance and better blood ejection, with venous volume and ejection fraction rising by 67.5% and 62.5%, respectively. While venous reflux, which indicates valve problems, did not change, the exercise significantly reduced leftover blood in the veins by 25% and the proportion of residual blood by 28.6%, suggesting reduced venous hypertension [27].

As mentioned earlier, ineffective functioning of the calf muscle pump leads to incomplete emptying of the lower limb veins, causing blood stagnation and resulting in venous hypertension [26]. Beneficial effects are seen from exercises that activate the lower limb muscles, ranging from simple activities such as toe flexion and extension, rotational foot movements, and calf raises, to regular walking and sports activities like running, gymnastics, and recreational cycling. Conversely, sports that increase pressure in the veins, such as weightlifting, strength training, or even competitive cycling, seem to have a negative impact [26,27]. It is not without reason that the 2023 guidelines for managing chronic venous disease published in ‘Polish Journal of Surgery’ recommend increasing awareness and encouraging patients to adopt lifestyle changes, including regular physical exercise, as they play a crucial role in modifying the course of the disease. [28]

Conclusion.

In conclusion, varicose veins and chronic venous disease, potentially influenced by evolutionary changes in posture, present significant challenges in terms of prevalence and

management. Effective treatment strategies include both lifestyle modifications and targeted physical activities, which improve venous circulation and reduce symptoms. Regular exercise, especially calf muscle activation, along with a balanced diet, plays a critical role in mitigating disease progression and enhancing overall venous health. The integration of these strategies into patient care is essential for better management and prevention of chronic venous disease. It is important to remember that despite the seemingly minor nature of varicose veins, this condition can progress to chronic venous insufficiency, which carries significant morbidity. If left untreated, varicose veins can lead to serious complications.

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References:

1. Orhurhu, V., Chu, R., Xie, K., Kamanyi, G. N., Salisu, B., Salisu-Orhurhu, M., ... & Anahita, D. (2021). Management of lower extremity pain from chronic venous insufficiency: a comprehensive review. *Cardiology and therapy*, *10*, 111-140.
2. Eberth-Willershausen, W., & Marshall, M. (1984). Prvalenz, risikofaktoren und Komplikationen peripherer Venenerkrankungen in der Münchner Bevölkerung [Prevalence, risk factors and complications of peripheral venous diseases in the Munich population]. *Der Hautarzt; Zeitschrift fur Dermatologie, Venerologie, und verwandte Gebiete*, *35*(2), 68–77.
3. Beebe-Dimmer, J. L., Pfeifer, J. R., Engle, J. S., & Schottenfeld, D. (2005). The epidemiology of chronic venous insufficiency and varicose veins. *Annals of epidemiology*, *15*(3), 175–184.
4. Chwała, M., Szczeklik, W., Szczeklik, M., Aleksiejew-Kleszczyński, T., & Jagielska-Chwała, M. (2015). Varicose veins of lower extremities, hemodynamics and treatment methods. Advances in Clinical and Experimental Medicine, 24(1).
5. Callam, M. J. (1994). Epidemiology of varicose veins. *The British Journal of Surgery*, *81*(2), 167-173.
6. Clark, A., Harvey, I., & Fowkes, F. G. R. (2010). Epidemiology and risk factors for varicose veins among older people: cross-sectional population study in the UK. *Phlebology*, *25*(5), 236-240.
7. Kroeger, K., Ose, C., Rudofsky, G., Roesener, J., & Hirche, H. (2004). Risk factors for varicose veins. *International angiology : a journal of the International Union of Angiology*, *23*(1), 29–34.
8. Kiran Shankar, H. (2017). Clinical study of varicose veins of lower limbs. *International Surgery Journal*, *4*(2), 633.
9. Eklöf, B., Rutherford, R. B., Bergan, J. J., Carpentier, P. H., Gloviczki, P., Kistner, R. L., Meissner, M. H., Moneta, G. L., Myers, K., Padberg, F. T., Perrin, M., Ruckley, C. V., Smith, P. C., Wakefield, T. W., & American Venous Forum International Ad Hoc Committee for Revision of the CEAP Classification (2004). Revision of the CEAP classification for chronic venous disorders: consensus statement. *Journal of vascular surgery*, *40*(6), 1248–1252. https://doi.org/10.1016/j.jvs.2004.09.027
10. Joński, M., Joński, J., & Jońska, K. Doświadczenie własne w terapii owrzodzeń żylnych z punktu widzenia lekarza w poradni chorób naczyń Personal experience of venous ulcer therapy from the physician's perspective in the vascular diseases outpatient clinic.
11. Radosz, Z., & Ptaszyńska, M. (2017). Niefarmakologiczne sposoby leczenia żylaków kończyn dolnych u pacjentów niezakwalifikowanych do leczenia chirurgicznego. *Health Promotion & Physical Activity*, *2*(3), 111-120.

12. Santler, B., & Goerge, T. (2017). Chronic venous insufficiency–a review of pathophysiology, diagnosis, and treatment. *JDDG: Journal der Deutschen Dermatologischen Gesellschaft*, *15*(5), 538-556.
13. Travers, J. P., Brookes, C. E., Evans, J., Baker, D. M., Kent, C., Makin, G. S., & Mayhew, T. M. (1996). Assessment of wall structure and composition of varicose veins with reference to collagen, elastin and smooth muscle content. *European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery*, *11*(2), 230–237. https://doi.org/10.1016/s1078-5884(96)80058-x
14. Serralheiro, P., Soares, A., Costa Almeida, C. M., & Verde, I. (2017). TGF-β1 in vascular wall pathology: unraveling chronic venous insufficiency pathophysiology. *International journal of molecular sciences*, *18*(12), 2534.
15. Mutlak, O., Aslam, M., & Standfield, N. J. (2019). Chronic venous insufficiency: a new concept to understand pathophysiology at the microvascular level-a pilot study. *Perfusion*, *34*(1), 84-89.
16. Piazza, G. (2014). Varicose veins. *Circulation*, *130*(7), 582-587.
17. Ahti, T. (2010). *Risk factors of varicose veins*. Tampere University Press.
18. García-Honduvilla, N., Asúnsolo, Á., Ortega, M. A., Sainz, F., Leal, J., Lopez-Hervas, P., ... & Buján, J. (2018). Increase and redistribution of sex hormone receptors in premenopausal women are associated with varicose vein remodelling. *Oxidative Medicine and Cellular Longevity*, *2018*(1), 3974026.
19. Anwar, M. A., Georgiadis, K. A., Shalhoub, J., Lim, C. S., Gohel, M. S., & Davies, A. H. (2012). A review of familial, genetic, and congenital aspects of primary varicose vein disease. *Circulation: Cardiovascular Genetics*, *5*(4), 460-466.
20. Aksoy, S. D., Kanza Gül, D., & KIRCA, A. (2023). Varicose veins during pregnancy: risk factors and impact on quality of life. *Phlebolymphology*, (1).
21. Urbanek, T., Dorobisz, A., Gabriel, M., Hendiger, W., Jawień, A., & Kucharzewski, M. et al. (2015). Assessment of public awareness in the field of epidemiology, prevention and treatment of chronic venous diseases in Poland. Phlebological Review, 23(2), 45-53. https://doi.org/10.5114/pr.2015.54035
22. Tan, S., Peng, K., Feng, J., Li, Z., Zhao, F., Li, B., ... & Zhao, L. (2024). Causal Relationships between Overall and Abdominal Obesity and Varicose Veins: A Two-Sample Mendelian Randomization Study.
23. Ghosh, S. K., Al Mamun, A., & Majumder, A. (2023). Clinical presentation of varicose veins. *Indian Journal of Surgery*, *85*(Suppl 1), 7-14.
24. Whiteley, M. S. (2022). Current best practice in the management of varicose veins. *Clinical, Cosmetic and Investigational Dermatology*, 567-583.
25. Wąs, M., Latała, A., Zozula, N., Rykucka, A., Kiełbasa, J., Kowalczyk, A., ... & Przestrzelska, M. (2024). Treatment Methods for Varicose Veins of the Lower Limbs. *Journal of Education, Health and Sport*, *74*, 52561-52561.
26. Radosz, Z., & Ptaszyńska, M. (2017). Niefarmakologiczne sposoby leczenia żylaków kończyn dolnych u pacjentów niezakwalifikowanych do leczenia chirurgicznego. *Health Promotion & Physical Activity*, *2*(3), 111-120.
27. Kan, Y. M., & Delis, K. T. (2001). Hemodynamic effects of supervised calf muscle exercise in patients with venous leg ulceration: a prospective controlled study. *Archives of surgery (Chicago, Ill. : 1960)*, *136*(12), 1364–1369. https://doi.org/10.1001/archsurg.136.12.1364

28. Krasiński, Z., & Krasińska, B. (2023). Leczenie wczesnego stadium zaawansowania przewlekłej choroby żylnej–standardy postępowania w 2023. *Pol Przegl Chir*, *95*(1), 64-69.
29. Elamrawy, S., Darwish, I., Moustafa, S., Elshaer, N., & Ahmed, N. (2021). Epidemiological, life style, and occupational factors associated with lower limb varicose veins: a case control study. *Journal of the Egyptian Public Health Association*, *96*, 1-11.
30. Aslam, M. R., Muhammad Asif, H., Ahmad, K., Jabbar, S., Hayee, A., Sagheer, M. S., ... & Sharif, A. (2022). Global impact and contributing factors in varicose vein disease development. *SAGE Open Medicine*, *10*, 20503121221118992.
31. Bentes, L. G. D. B., Lemos, R. S., Santos, D. R. D., & Reis, J. M. C. D. (2022). Epidemiological profile of surgical treatment of varicose veins in Brazil from 2010 to 2020. *Jornal Vascular Brasileiro*, *21*, e20210202.