Journal of Optometry (2016) 9, 139–147

Journal of Optometry

www.journalofoptometry.org

REVIEW

# Intraocular pressure and glaucoma: Is physical exercise beneficial or a risk?

**Charles William McMonnies***

*School of Optometry and Vision Science, University of New South Wales, Kensington 2052, Australia*

Received 11 July 2015; accepted 7 December 2015
Available online 12 January 2016

**KEYWORDS**
Intraocular pressure;
Glaucoma;
Physical exercise;
Frailty

**Abstract** Intraocular pressure may become elevated with muscle exertion, changes in body position and increased respiratory volumes, especially when Valsalva manoeuver mechanisms are involved. All of these factors may be present during physical exercise, especially if hydration levels are increased. This review examines the evidence for intraocular pressure changes during and after physical exercise. Intraocular pressure elevation may result in a reduction in ocular perfusion pressure with the associated possibility of mechanical and/or ischaemic damage to the optic nerve head. A key consideration is the possibility that, rather than being beneficial for patients who are susceptible to glaucomatous pathology, any intraocular pressure elevation could be detrimental. Lower intraocular pressure after exercise may result from its elevation causing accelerated aqueous outflow during exercise. Also examined is the possibility that people who have lower frailty are more likely to exercise as well as less likely to have or develop glaucoma. Consequently, lower prevalence of glaucoma would be expected among people who exercise. The evidence base for this topic is deficient and would be greatly improved by the availability of tonometry assessment during dynamic exercise, more studies which control for hydration levels, and methods for assessing the potential general health benefits of exercise against any possibility of exacerbated glaucomatous pathology for individual patients who are susceptible to such changes.


**PALABRAS CLAVE**
Presión intraocular;
Glaucoma;
Ejercicio físico;
Fragilidad

**Presión intraocular y glaucoma: ¿es beneficioso el ejercicio físico, o entraña un riesgo?**

**Resumen** La presión intraocular puede elevarse con el exceso de trabajo muscular, los cambios de la posición del cuerpo y el incremento de los volúmenes respiratorios, especialmente cuando

* Correspondence to: 77 Cliff Avenue, Northbridge, Sydney, New South Wales 2063, Australia. Tel.: +61 2 9958 3046; fax: +61 2 9958 3012; mobile: +61 0409 038 799.
*E-mail address:* c.mcmonnies@unsw.edu.au

http://dx.doi.org/10.1016/j.optom.2015.12.001

los mecanismos de la maniobra de Valsalva se ven implicados. Todos estos factores pueden presentarse durante el ejercicio físico, especialmente cuando se incrementan los niveles de hidratación. Esta revisión examina la evidencia de los cambios en la presión intraocular con anterioridad y posterioridad al ejercicio físico. El incremento de la presión intraocular puede derivar en una reducción de la perfusión ocular, con la posibilidad asociada de daño mecánico y/o isquémico de la cabeza del nervio óptico. Una consideración clave es la posibilidad de que, en lugar de ser beneficioso para los pacientes susceptibles de patología glaucomatosa, cualquier incremento de la presión intraocular podría resultar perjudicial. La disminución de la presión intraocular tras el ejercicio puede ser resultado de su elevación, originando la aceleración de una descarga del acuoso durante el ejercicio. También se ha estudiado la posibilidad de que las personas con menor debilidad sean propensas a realizar ejercicio, y tengan menor probabilidad de padecer o desarrollar glaucoma. Por tanto, cabría esperar una menor prevalencia del glaucoma en aquellas personas que realizan ejercicio. La base de la evidencia para esta cuestión es deficiente, y mejoraría si se dispusiera de pruebas de tonometría realizadas durante el ejercicio dinámico, un mayor número de estudios que controlen los niveles de hidratación, y métodos de evaluación de los beneficios potenciales y generales para la salud al realizar ejercicio, en contraposición a cualquier posibilidad de empeoramiento de la patología glaucomatosa en las personas susceptibles de dichos cambios.


Elevated intraocular pressure (IOP) is a key risk factor for the development and progression of glaucoma.[1,2] A number of conditions such as congenital, angle-closure and secondary glaucoma clearly show that increased IOP is sufficient to lead to glaucomatous optic neuropathy.[3] Treatment to reduce IOP has been demonstrated to decrease glaucoma progression.[4] Fluctuation in IOP, either over the 24 h diurnal period or across visits, may also contribute to glaucomatous pathology.[5,6] There are a range of physiological IOP fluctuations as well as those due to sporadic and routine day-to-day activities which are associated with both small and large IOP elevations and fluctuations[7–10] which may also be associated with glaucoma progression.[7] Fluctuations in IOP in sitting position during office hours were concluded to not be an independent risk factor for glaucoma.[11] However, in-office sitting position measurements cannot capture the wide range of IOP fluctuation, often involving non-sitting postures, which occur during various activities performed outside an office and which are known to elevate IOP in any 24 h period. Significant IOP fluctuations were detected by assessment every 2 h for 24 h in patients with obstructive sleep apnea, especially in patients receiving continuous positive airway pressure therapy.[12] The high prevalence of glaucoma in obstructive sleep apnea patients may be explained by these fluctuations which were paralleled by a decrease in ocular perfusion pressure (OPP)[12] with the associated possibility of both mechanical and ischaemic damage to the optic nerve head (ONH).

Preventing large fluctuations in diurnal IOP may be as important as attaining target IOP in the prevention of glaucoma progression.[13] The Collaborative Initial Glaucoma Treatment Study[14] and the Advanced Glaucoma Intervention Study[15] both found that fluctuation in IOP is predictive of greater visual field loss. The goal of detecting and reducing abnormal 24-h IOP fluctuation is warranted in all newly diagnosed glaucomatous patients as well as in patients who continue to progress despite treatment which lowers pressure.[16] Avoiding or reducing exposure to elevated IOP (fluctuation episodes) may improve the prognosis for some glaucoma suspects and patients with glaucoma.[7–10] The key determinants of any pathological significance associated with IOP elevation episodes may not only be the degree of elevation, its duration and frequency as well as the time over which it occurs, but also individual susceptibility to them.[7,10] For example, the pathology associated with normal tension glaucoma (NTG) suggests that such eyes have a lower IOP threshold for neuropathic changes. Increasing glaucoma prevalence with age[17] suggests that susceptibility to IOP fluctuation and elevation episodes could increase with age.

Histories of the frequency and intensity of participation in activities which are known to elevate IOP allow an estimate of individual exposure to IOP fluctuation.[10] Most episodes of IOP elevation appear likely to remain undetected due to difficulties in monitoring IOP during many activities. Studies of IOP fluctuation with physical exercise have typically measured IOP with an insufficient sampling rate to truly measure IOP variability.[1] For example, head movement during dynamic exercise necessitates that tonometry be performed during a break in an exercise sequence or after the sequence has been completed.[18] Static isometric phases which occur during weightlifting and which enable tonometry to be performed are exceptions.[19,20] Ideally, 24 h continuous monitoring of IOP will capture a complete record of the degree, duration and frequency of episodic elevations and so the full extent of IOP fluctuation.[8,9] This review examines the mechanisms for IOP elevation and fluctuation during and subsequent to physical exercise. A key consideration is the possibility that, rather than being beneficial,[21] and that it may be reasonable to encourage dynamic exercise