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Near-infrared light increases ATP, extends lifespan and improves mobility in aged *Drosophila melanogaster*

Rana Begum,[1] Karin Calaza,[2] Jaimie Hoh Kam,[1] Thomas E. Salt,[1] Chris Hogg,[3] and Glen Jeffery[1]

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ABSTRACT

Ageing is an irreversible cellular decline partly driven by failing mitochondrial integrity. Mitochondria accumulate DNA mutations and reduce ATP production necessary for cellular metabolism. This is associated with inflammation. Near-infrared exposure increases retinal ATP in old mice via cytochrome *c* oxidase absorption and reduces inflammation. Here, we expose fruitflies daily to 670 nm radiation, revealing elevated ATP and reduced inflammation with age. Critically, there was a significant increase in average lifespan: 100–175% more flies survived into old age following 670 nm exposure and these had significantly improved mobility. This may be a simple route to extending lifespan and improving function in old age.

1. INTRODUCTION

Mitochondria provide cellular energy via adenosine triphosphate (ATP). But, their DNA (mtDNA) suffers from progressive mutations resulting in reduced ATP production, which is thought to run concomitantly with an increase in pro-inflammatory reactive oxygen species (ROS) [1,2]. Hence, hallmarks of ageing are reduced cellular energy and progressive systemic inflammation. Metabolic demand also plays a role as tissues and organisms with high metabolic rates generally suffer from rapid ageing [3,4]. The retina has the greatest metabolic demand in the body [5], but ATP decline in the central nervous system can be significantly improved by near-infrared/infrared light (NIR/IR, [6]). Specific wavelengths in this range are absorbed by cytochrome *c* oxidase in mitochondrial respiration, improving its efficiency [7–10]. These wavelengths improve mitochondrial membrane potentials, significantly reduce inflammation and reduce macrophage numbers with brief exposures of around 60–90 s repeated over approximately a week [11,12]. NIR/IR also reduces experimental pathology when insult impacts on mitochondrial function, as in experimental Parkinson's disease, where NIR significantly reduces cell death in the substantia nigra [13]. However, NIR/IR studies have largely used light for short periods and their impact on lifespan has not been assessed [7,11,12]. If NIR improves mitochondrial function we predict it may extend life. The fly has been used here because of its relatively short life [14]. Hence, we ask if long-term exposure to 670 nm in *Drosophila melanogaster* can increase lifespan and improve function in old age.