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# From positive psychology to positive biology: laughter and longevity

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## Abstract

Gelotology (the study of laughter) has it seems mainly evaded the attention of longevity scientists, positive biologists, and geroscientists. However, the potential of laughter to result in immediate improved affect, increase overall well-being, reduce cortisol levels, benefit the immune system, and support cardiovascular health, to name only a few of its possible effects, renders it of high interest as an anti-aging strategy. As an intervention, laughter has, at least theoretically, the potential to slow the process of aging, and to ameliorate its lived experience. What makes laughter particularly attractive is that it is accessible to all, is very low risk, and is inherently, for most people, enjoyable. Ten years ago, lifestyle medics first proposed that laughter be prescribed in primary care. They pointed to its efficacy in general patient care, geriatrics, rheumatology, critical care, oncology, rehabilitation, psychiatry, home care, palliative care, terminal care, and hospice care. Nevertheless, laughter prescription has been slow to take off. It is therefore of interest to contemplate why, how, and to what effect, laughter can be harnessed to improve people's lives. Quality research is recommended to uncover the secrets of laughter, its dynamic effects on the body, if, and how, it may impact longevity, and how it can best be used to promote successful and active aging.

## Keywords

Longevity, laughter, laughter therapy, successful aging, centenarians, laughter prescription

## Introduction

Lifestyle and life experiences play an important role in longevity [1]. The link between subjective well-being (which covers positive affect, life satisfaction, and low negative affect) on health and all-cause mortality appears to be robust (e.g., [2–4]). As lifestyle and behaviours can be modified, a positive biology approach that investigates the phenotypes of the longevous is particularly pertinent [5]. Positive biology includes insight into how to improve well-being including by increasing opportunities for play and joy [6]. This is relevant as a meta-analysis of 150 studies [7] indicated that "the probability of living longer increases by 14% for individuals with high well-being compared to those with low well-being". A range of behaviours

are associated with well-being, happiness, and positive affect, but one that is accessible to all is laughter. Calls from the medical community highlighting the prescriptive potential of laughter [8], motivated the conception of the one-minute Laughie (Laugh Intentionally Everyday) laughter prescription [9], and PhD research on the psychology of laughter prescription [10]. The purpose of this commentary is to briefly investigate evidence from positive psychology to positive biology that may support the hypothesis that laughter can promote longevity, and reduce, prevent, or delay diseases associated with aging.

Positive psychology focuses on how to live happy and meaningful lives including by developing inherent "character strengths", one of which (of the 24 strengths identified) is humour [11]. Positive biology, on the other hand, seeks to investigate positive phenotypes associated with longevity [6]. Both positive psychology and positive biology are concerned with physiology and applied research. William Fry, the "father of gelotology", saw laughter as an especially profitable overall body exercise for the elderly to counteract aging due to its cardiovascular benefits and potential to stimulate circulation, and strengthen and relax muscles [12]. Laughter is a particularly suitable behaviour to improve well-being in seniors by inducing positive affect and mitigating negative affect as it is a low-impact exercise, is accessible to all, is low risk, and it can have an immediate effect. Moreover, it can be undertaken intentionally, and without excess: Just one minute of intentional laughter, alone, or with others, has been found to improve well-being [9, 13]. To date, few centenarian studies have directly investigated laughter. In the Longevity Genes Project of independently living Ashkenazi Jewish centenarians ($n$ = 243; age 95–107), Kato et al. [14] identified a positive attitude towards life as a centenarian personality phenotype. They also found that these centenarians tended "to consider laughter as an important part of their life".

## Evidence that may support a laughter-longevity link

Anecdotal evidence associating laughter with longevity is rich and dates back 4,000 years to Democritus, named the "laughing philosopher" for his penchant to laugh, often alone, at the absurdity of life. So concerned were his fellow Abderians, that they invited Hippocrates to provide a diagnosis [15]. Hippocrates found nothing amiss. Democritus, a "father of science", supposedly died aged 109 [16]. The oldest seemingly verified person to ever live was the super-centenarian Frenchwoman Jeanne Calment. She died in 1997 aged 122. According to her biographers [17], Calment advised "Always keep your sense of humor. That's what I attribute my long life to. I think I'll die laughing. That's part of my program."

One Korean study on successful aging [18], compared laughter frequency in centenarians ($n$ = 109), octogenarians ($n$ = 135), and sexagenarians ($n$ = 145). Centenarians scored higher in "laughing more than two times a day" than the sexagenarians and the octogenarians. In Japan, research comparing laughter frequency to health outcomes, particularly using the Japan Gerontological Evaluation Study (JAGES, adults aged 65 years and over) cohort, is well-developed. For example, Hayashi et al. [19] reported that daily laughter can support subjective health in older adults ($n$ = 26,368). Hayashi et al. [20], found daily laughter was associated with lower cardiovascular disease prevalence ($n$ = 20,934). And Tamada et al. [21], found that the risk of functional disability was 1.42 times higher in those who did not laugh most days ($n$ = 14,233). Meanwhile, Hirosaki et al. [22], found a significant association between laughter frequency and oral health ($n$ = 24,038). And Wang et al. [23], found laughing with friends, children, grandchildren, or the radio was associated with a decreased risk for dementia ($n$ = 12,165). Another Japanese prospective cohort study [24], in those aged 40 years and over [$n$ = 17,152; mean (M) = 62.8], also found low laughter frequency was independently associated with cardiovascular disease and, moreover, all-cause mortality. Research is ongoing and a recent study [25] points to a protective effect of laughter frequency on hypertension in older Japanese adults ($n$ = 22,503).

The majority of the studies mentioned so far rely on cross-sectional data interpretation. Nevertheless, the epigenetic impact of laughter and humour on phenotype has been investigated, and seemingly demonstrated. For example, Hayashi et al. [26] found that 23 out of 18,716 genes in older patients ($n$ = 12; M = 63) with type 2 diabetes had significant gene expression changes following a laughing episode. In a subsequent study [27], the authors discovered that many of those genes were implicated in improved natural killer cell activity.

A systematic review of seven laughter yoga studies [28] in older adults (65 years and over) found laughter yoga was effective in improving physical function and psychosocial outcomes. Ko and Youn [29] found a beneficial effect of laughter therapy on cognition, sleep, and depression, in a randomized control trial (RCT) in Korean community-dwelling elderly ($n$ = 109; M = 76). Recent RCTs have also highlighted benefits for older adults. Significant changes in body mass index (BMI), cognitive function, functional activity, blood pressure, and depression in the "elderly" in Egypt ($n$ = 60; M = 66) were revealed following three laughter yoga sessions [30], and significant amelioration in depression and anxiety following 16 sessions ($n$ = 62, retired women) in Iran [31].

Laughter therapy, in various forms (e.g., laughter yoga, humour therapy, clown therapy, laughter qigong, and the Laughie laughter prescription) can be beneficial for a range of conditions that impact older adults from low levels of well-being through to cancer, cardiovascular disease, and diabetes. For example, a seven-week laughter therapy RCT [32] reported significant reductions in pain in cancer patients ($n$ = 61; M = 55). Another Japanese study [33], 12-week RCT for those at risk from metabolic syndrome ($n$ = 235; M = 67), reported significant benefits to body weight, well-being, and optimism. Laughter has also been found to regulate homeostatic abnormalities associated with type 2 diabetes [34].

As shown, laughter appears to have wide-ranging positive impact on physiology and psychology. In order to research and harness these benefits daily, the Laughie laughter prescription has been proposed, including for the promotion of healthy and successful aging in the oldest-old [35]. Two recent theoretical models speculate on how habitual and intentional laughter may ameliorate psychophysiology and neuroimmunology (i.e. the "positive biology" Laugh-Health model), as well as emotion and affect (i.e. the "positive psychology" Laugh-Thrive model) [10]. The pertinence of the evidence underpinning these models to the potential physiological determinants of laughter on longevity will now be contemplated.

## What are the physiological mechanisms involved?

As a physical behaviour, laughter can provide exercise that involves abdominal muscles, facial muscles, and lungs. This may explain why many of the physiological benefits of laughter are those that can be seen in physical exercise. Fry [12] found laughter impacted most if not all physiologic systems, and stated that while we cannot laugh away our natural aging process, laughter can modify its impact. Fry [12] viewed laughter as an advantageous all-body and cardio-vascular exercise that is particularly beneficial for the elderly for whom traditional and strenuous exercise may not be feasible. Research has supported this vision of laughter as exercise. One small study even found laughter, albeit in the form of laughter yoga, to be superior to "traditional exercise" for trunk muscle function following assessment of its impact on abdominal, paraspinal, and internal oblique muscles [36]. As with any exercise, laughter also needs to be undertaken regularly to harness ongoing benefits, hence the pertinence of laughter prescription.

The potential far-reaching and dynamic impact of laughter on physiology, psychophysiology, and neuroimmunology can be linked to the release of chemicals including "feel-good" endorphins during laughter [37]. Laughter has been associated with ameliorating serotonin levels and the dopaminergic reward system. For example, in a study ($n$ = 10) undertaken by Berk et al. [38], 3,4,-dihy-drophenylacetic acid (DOPAC), a dopamine catabolite, appeared to be regulated by mirthful (i.e. humour-induced) laughter. A range of studies have found that laughter can decrease cortisol [38, 39], a primary stress hormone, as well as epinephrine/adrenalin [38]. Miller and Fry [37] hypothesized that laughter results in the release of nitric oxide (NO), potentially providing a mechanism linking positive emotions to vascular health. This could be one explanation for the benefits of laughter on endothelial function [37] implicated in arthrosclerosis, diabetes, coronary artery disease, and hypertension. Nevertheless, while aging has been associated with reduced NO bioavailability, this mechanism is not fully elucidated (e.g., [40]).

In addition to the benefits of laughter on overall and cardiovascular health (e.g., [37]), there is evidence that laughter can ameliorate a range of biomarkers associated with aging, including cytokines, blood pressure, and inflammation ("inflamm-aging" [41]). For example, mirthful laughter was found to attenuate inflammatory cytokines implicated in diabetes and benefitted metabolic function by raising "good"

high-density lipoprotein (HDL) cholesterol in a study ($n$ = 20) by Berk and Tan [42]. Both heart rate and levels of C-reactive protein (CRP), an inflammatory biomarker, were found to reduce in a study by Bains et al. [43] following laughter induced by a humorous video ($n$ = 32).

## Caveats to consider

While there is a growing body of evidence for the benefits of laughter on health, and thus by implication on longevity, larger scale studies are needed in order to investigate and clarify cause-effect pathways. More precision is also needed in measuring laughter and elucidating its benefits before we can be assured of the effects of laughter *per se* in interventions [44]. This is because laughter therapy can involve a number of confounding variables, including non-laughter driven physical exercises, humour, and social interactions. Furthermore, while many large-scale studies support the plausibility of a laughter-longevity link, most rely on one self-report laughter item only (e.g., "How often do you laugh out loud?", [24]), which is overly simplistic. Precise laughter measurements, and for prescription purposes minimum effective dose insight, are needed [10].

Laughter is also associated with pathology, and little is known about the mechanisms involved. For example, dysfunctional serotonin and glutamine neurotransmission are implicated in pseudobulbar affect [45]. While laughter is very low risk [46], death by laughter has been recorded. Most well-known cases are anecdotal and distant. For example, the Stoic Chrysippus is said to have died laughing at his own joke (he enquired of a donkey if it would also enjoy some wine, on seeing the donkey eat figs from his silver platter). Another point to consider is that some study results can be interpreted as running contrary to a potential laughter-longevity link. For example, Rotton [47] compared the biographical details of over 1,000 comedians, entertainers, and writers, and found no association between the ability to generate humour and longevity. However, Rotton [47] did not investigate laughter.

Laughter and humour are often confounded, but they are distinct [48]. Intentional laughter as an exercise, with or without humour, is not intuitive for many people, nor is laughing alone, but it can be learnt. Solirisy, a term for laughing alone, may have a place as a prescribed exercise [10]. Laughter interventions can be tailored to preferences. Gelotophobia, or the fear of laughter, is thought to affect up to 20% of the population [49]; however, laughter interventions may be used to address this issue.

## Concluding thoughts

A positive biology approach that explores the role of lifestyle, life experiences, and behavioural patterns on aging is recommended to advance insight into longevity [1, 50]. To date, a range of interventions to slow aging in humans have been proposed (e.g., [51]). However, thus far, laughter does not feature on most lists. What makes laughter particularly attractive to investigate is its accessibility, immediate impact, low risk, unique social bonding qualities rendering it ideal to be undertaken with others, and its capacity to also be enjoyed alone. Evidence for a clear laughter-longevity link is tenuous, in part perhaps because it has not been an area of interest for longevity scientists. Nevertheless, an increasing body of research is providing evidence that laughter can ameliorate a range of age-related conditions, and lending weight to recommendations that laughter be endorsed to support successful aging. Positive psychology and positive biology investigation of the psychophysiological impact of laughter on aging and longevity merit more attention.

## Abbreviations

M: mean

RCT: randomized control trial

## Declarations

### Author contributions

FGS: Conceptualization, Writing—original draft, Writing—review & editing.

### Conflicts of interest

The author declares that she has no conflicts of interest.

### Ethical approval

Not applicable.

### Consent to participate

Not applicable.

### Consent to publication

Not applicable.

### Availability of data and materials

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