Rethinking wellbeing: Toward a more ethical science of wellbeing that considers current and future generations

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The construct of wellbeing has been criticised as a neoliberal construction of western individualism that ignores wider systemic issues including increasing burden of chronic disease, widening inequality, concerns over environmental degradation and anthropogenic climate change. While these criticisms overlook recent developments, there remains a need for biopsychosocial models that extend theoretical grounding beyond individual wellbeing, incorporating overlapping contextual issues relating to community and environment. Our first GENIAL model (Kemp, Arias, & Fisher, 2017) provided a more expansive view of pathways to longevity in the context of individual health and wellbeing, emphasising bidirectional links to positive social ties and the impact of sociocultural factors. In this paper, we build on these ideas and propose GENIAL 2.0, focusing on intersecting individual-community-environmental contributions to health and wellbeing, and laying an evidence-based, theoretical framework on which future research and innovative therapeutic innovations could be based. We suggest that our transdisciplinary model of wellbeing - focusing on individual, community and environmental contributions to personal wellbeing - will help to move the research field forward. In reconceptualising wellbeing, GENIAL 2.0 bridges the gap between psychological science and population health health systems, and presents opportunities for enhancing the health and wellbeing of people living with chronic conditions. Implications for future generations including the very survival of our species are discussed.

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# Introduction and Context

*‘But no time or nation will produce genius if there is a steady decline away from the integral unity of man and the earth. The break in this unity is swiftly apparent in the lack of “wholeness” in the individual person. Divorced from his roots, man loses his psychic stability.’*

– Elyne Mitchell, Soil and Civilization (1946)

There is now considerable research interest in the topic of ‘wellbeing’ and its relationship to ‘health’, yet there has also been much debate and criticism. The Oxford English Dictionary (OED) defines ‘wellbeing’ as ‘the state of being comfortable, healthy, and happy’, suggesting that the term relates to aspects of emotions and feelings, as well as ‘health’. By contrast, the OED defines ‘health’ as ‘the state of being free from illness or injury’, a definition that does not fully capture the meaning of ‘health’ as understood by researchers in population health: ‘there is no health without mental health’ (Prince et al., 2007). We further note that absence of illness is not necessarily ‘healthy’. It is possible for instance, to be unhealthy without having illness, as one can be *on course for an illness* through having poor diet, lack of sleep, being overweight and physically inactive. Similarly, ‘not being depressed’ is not the same thing as ‘being happy’. The World Health Organisation (World Health Organisation, n.d.) defines ‘health’ as complete mental, physical and social wellbeing, thus - according to this definition - wellbeing is subsumed by an overarching concept of ‘health’, which differs from the OED definition. Although superficially appealing, the WHO definition has been criticised as being unrealistic. Petr Skrabanek, a Professor of Medicine and sceptic reportedly joked that according to this definition, health is only achievable at ‘the moment of mutual orgasm’ (Smith, 2008). A critical observer might even query whether it is possible for people living with long-term disabling conditions such as common mental disorders, diabetes, obesity and cardiovascular disease to have opportunities for experiencing wellbeing. We suggest that they do have such opportunity, and that enhancing wellbeing in such people may also improve physical health. This is an important consideration as chronic conditions and disease now outstrip the societal burden imposed by acute conditions (GBD Collaborators, 2015). In 2017, as much as 79% percent of the years lived with disability (YLDs) globally are attribtuable to chronic conditions (“GBD Compare | IHME Viz Hub”, n.d.). Prominent conditions including depression and anxiety are associated with 5.05% and 3.18% of total global YLDs in 2017, respectively (Fig ???). Critically, our work is now focused on building wellbeing in people living with chronic conditions (see section ??? for further discussion).



The global burden of disease (GBD) with respects to years lived with disability (YLDs) for all ages and both sexes in the year 2017. The entire figure represents 100% of YLDs; those conditions with increasing % annual change are highlighted in blue (non-communicable disease), red (communicable disease) and green (injuries) (“GBD Compare | IHME Viz Hub”, n.d.).

Positive psychologists have approached the construct of wellbeing from a different perspective, emphasising life satisfaction (Pavot & Diener, 2008; Diener, 1984), psychological wellbeing (Ryff & Keyes, 1995; Ryff, 2014) and flourishing (Diener et al., 2009; Seligman, 2011; Seligman, 2018). ‘Resilience’ is another associated concept  (American Psychological Association, Accessed Monday 17th June 2019), which emphasises the process of adapting well in the face of adversity or tragedy, and ‘bouncing back’ from difficult experiences. It is interesting to observe that this psychological definition conflicts with those from other disciplines (e.g. engineering), which highlight ‘stability’ and ‘efficiency’ (Quinlan, Berbés-Blázquez, Haider, & Peterson, 2015). One need only think of a ‘stable bridge’ or an ‘efficient production line’ to appreciate the distinction between psychological science and engineering here. Others have introduced the concept of ‘salutogenesis’ (Antonovsky, 1996), a word based on the Latin term ‘salus’ (health, well-being) and the Greek word ‘genesis’ meaning emergence or creation. The salutogenic concept counters the tendency of medicine to focus on ‘pathogenesis’, and emphasises a role for a ‘sense of coherence’ for managing and overcoming stress reflecting feelings of confidence that the environment is comprehensible, manageable and meaningful. However, psychological theories of wellbeing have also been criticised for ignoring wider systemic issues such as loneliness, inequality, environmental degradation and climate change (Carlisle, Henderson, & Hanlon, 2009; Ehrenreich, 2010; Frawley, 2015). These criticisms are being tackled, in part, by developments in conservation and environmental psychology, which explicitly link psychological science to some of these challenges. Developments include for instance, the positive psychology of sustainability (Corral-Verdugo & Frías-Armenta, 2015; Verdugo, 2012), sustainable happiness (O’Brien, 2010; O’Brien, 2012; O’Brien, 2016) and sustainable wellbeing (Kjell, 2011). However, others have argued that the concepts of ‘resilience’ and ‘sustainability’ have become so corrupted by neoliberalism, the fossil fuel industry and the Trump administration, that these concepts are no longer useful (Albrecht, 2019).

Here we define the word ‘wellbeing’ to refer to positive psychological experience, which can be impacted on by positive health behaviours, and is promoted through a sense of connectedness to ourselves as individuals, as well as to the communities and environment within which we live. Our GENIAL model provides and evidence-based and life-course framework for appreciating how wellbeing (or illbeing) may arise. Our paper is organised as follows: Section ??? briefly reviews our previously proposed model of wellbeing, the GENIAL model. The word GENIAL is an acronym encompassing *G*enomics, *E*nvironment, vagus *N*erve, social *I*nteraction, *A*llostatic regulation, and *L*ongevity, providing a life course framework within which to understand the pathways to health and wellbeing versus premature mortality. GENIAL provides a theoretical context with which to understand key components which determine pathways to health and wellbeing for individuals, for example, psychological experiences, health behaviours, vagal function. However, a plethora of evidence shows that health and wellbeing are influenced by individual factors but by the systems and environment that surround people. Accordingly, Section ??? expands the focus of the GENIAL model to explicitly encompass individual, community and environmental wellbeing  (see Fig ???), highlighting a key role for individual wellbeing as a foundation to build community and environmental wellbeing in line with social ecology theory, and their respective bidirectional impacts on the wellbeing of individuals. Section ??? provides a succinct summary of our updated model. Section ??? considers the implications of our updated model (GENIAL 2.0) for people living with chronic conditions, and section ??? draws some conclusions and provides some examples relating to our own work that we are doing in this regard.



Venn diagram of key wellbeing domains: the individual, community and environment. These domains are placed within the ‘symbioment’ (Albrecht, 2019) to emphasise symbiotic coexistence of all life at various scales.

# The Original GENIAL Model

Our original GENIAL model (Kemp, Arias, & Fisher, 2017) (Fig ???) emphasised the pathways to health and wellbeing versus ill-health and premature mortality, highlighting key roles for vagal function and social interaction along these pathways. The role for the vagus nerve – indexed by heart rate variability (HRV) – built on well-established theoretical models including polyvagal theory (Porges, 2011; Porges, 1995; Porges, 2001; Porges, 2003; Porges, 2007), which emphasises a role for the myelinated vagus nerve – in particular – in social engagement, and the neurovisceral integration model (Thayer & Lane, 2000; Thayer & Fischer, 2009; Thayer & Lane, 2009), which lays a neurophysiological foundation for understanding mind-brain-body linkage. The recent extension of the neurovisceral integration model named the ‘Neurovisceral Integration Across a Continuum of Time’ or ‘NIACT’ (Kemp, Koenig, & Thayer, 2017) laid a temporal framework for understanding linkage between emotion and - over time - mortality, bridging the gap between psychological science and epidemiology. This model was motivated by research (Tracey, 2002; Jarczok, Koenig, Mauss, Fischer, & Thayer, 2014; Jandackova, Britton, Malik, & Steptoe, 2016; Kemp et al., 2016) highlighting a mediating role of the vagus nerve over downstream health-relevant outcomes. NIACT provides a theoretical framework within which these disparate findings can be understood. Kevin Tracey, an American neurosurgeon identified the ‘cholinergic anti-inflammatory reflex’ (Tracey, 2002), regulated by the vagus nerve, which if impaired may contribute to a host of conditions including poor metabolic outcomes, cardiovascular disease and associated mortality (Hillebrand et al., 2013; Wulsin, Horn, Perry, Massaro, & DAgostino, 2015). The efferent vagus nerve achieves this through interaction with the peripheral $α$7 subunit-containing nicotinic acetylcholine receptors expressed on macrophages. See (Pavlov, Wang, Czura, Friedman, & Tracey, 2003) for a detailed review of the cholinergic anti-inflammatory pathway. Jarczok and colleagues (Jarczok, Koenig, Mauss, Fischer, & Thayer, 2014) demonstrated that reduced vagal function (indexed by lower heart rate variability) predicts increased levels of C-reactive protein four years later, providing *in vivo* support for this cholinergic anti-inflammatory pathway in humans. Kemp and colleagues employed modern mediation modelling on the ELSA-Brasil cohort (Kemp et al., 2016), demonstrating that vagal function lies upstream of insulin resistance and carotid-intima media thickness, an early marker of atherosclerosis, which together leads to cognitive dysfunction. Jandackova and colleagues applied cross-lagged analysis to the Whitehall Stress and Health Study cohort (Jandackova, Britton, Malik, & Steptoe, 2016) and observed that vagal function precedes development of depression over a ten-year follow-up period. These studies are part of a larger body of work summarised previously (Kemp, Arias, & Fisher, 2017; Kemp, Koenig, & Thayer, 2017; Kemp, 2018) that demonstrate how early changes in vagal functioning may contribute to downstream changes in wellbeing. The GENIAL model (Kemp, Arias, & Fisher, 2017) further developed NIACT (Kemp, Koenig, & Thayer, 2017) by highlighting the role of social relationships along the pathways to health and wellbeing, in addition to the moderating role of health behaviours (e.g. diet, physical activity, sleep, smoking and alcohol consumption) and sociostructural factors (e.g. inequality, collective efficacy). The GENIAL model draws and builds on research which highlights: 1) the role of social identity in the development of meaning and purpose in life and its impacts on health and wellbeing (Haslam, Jetten, Postmes, & Haslam, 2008); 2) that positive social ties reduce risk of early death to a degree that is equivalent to the effects of smoking cessation (Holt-Lunstad, Smith, & Layton, 2010), and 3) the impact of sociostructural factors such as inequality (Kondo et al., 2009) and collective efficacy (Bandura, 2004) on individuals’ capacity to achieve health-related goals. These ideas are further developed in the following sections.



The original GENIAL model reprinted from (Kemp, Arias, & Fisher, 2017) with kind permission from Springer Nature. (License number: 4652451214375).

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# Expanding the focus of wellbeing

In this section, we emphasise a role for individual, community and environmental contributors to personal wellbeing, their overlap and impacts. Table ??? provides a summary of major theories and models in individual, social and environmental domains, which has helped to further develop our GENIAL model, as described in section ???. These models and supporting evidence are briefly described in the following sections.

Summary of major theories and models of wellbeing

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| Domain | Theory | Description |
| Individual | Tripartite model of subjective wellbeing (Diener) | Life satisfaction, positive and negative affect. Typically characterised as tapping into hedonic wellbeing. Diener has argued that subjective wellbeing does not involve making value judgments by ‘experts’ on what a good life entails (Kesebir & Diener, 2008), such as proponents of ‘eudaimonic wellbeing’. |
|  | Six-factor model of psychological wellbeing (Ryff) | Argues that wellbeing cannot be reduced to hedonic wellbeing. Spans positive relationships with others, personal mastery, autonomy, a feeling of purpose and meaning in life, and personal growth and development. This model is characterised as tapping into ‘eudaimonic wellbeing’. |
|  | PERMA model (Seligman) | Positive emotion, engagement, social relationships, meaning and achievement all contribute to wellbeing. Spans both hedonic (affect) and eudaimonic (psychological wellbeing) aspects of wellbeing. |
|  | Salutogenesis theory (Antonovsky) | ‘Salutogenesis’ is based on the Latin term ‘salus’ (health, well-being) and the Greek word ‘genesis’ meaning emergence or creation. The salutogenic concept emphasises a role for a ‘sense of coherence’ in managing and overcoming stress. |
|  | Neurovisceral Integration Across the Continuum of Time (NIACT) model (Kemp) | A life-course theoretical framework for wellbeing, characterising pathways to ill-being versus wellbeing, highlighting a key role for the vagus nerve. NIACT is complimentary to the GENIAL model of wellbeing (see below). |
| Community | Social identity theory (Haslam) | Groups provide individuals with a sense of meaning, purpose and meaning with positive psychological consequences. This theory has led to the publication of a book titled ’The New Psychology of Health’, which emphasises the importance of positive social ties. |
|  | Conceptual models on the social determinants of health (SDOH) | Multiple models have been proposed, however a recent review by Lucyk and McLaren (2017) emphasised the role of health equity and social gradients as major concepts. |
|  | GENIAL 1.0 [genomics-environment-vagus nerve-social interaction-allostatic regulation-longevity] model (Kemp) | Builds on the NIACT model, again emphasising a role for the vagus nerve in a host of psychological and physiological processes. Novel aspects include the role of social ties and sociostructural factors. |
| Environmental | Biophilia hypothesis (Wilson) | Core assumption is that human beings have a strong, innate affiliation with the biological world. |
|  | Psycho-evolutionary theory (Ulrich) | Restorative influences of nature involve a shift toward more positive emotions, parasympathetic dominated responses (heart rate deceleration) and sustained – yet non-taxing – attention. |
|  | Topophilia hypothesis (Sampson) | A broadening of the ‘biophilia’ hypothesis to encompass non-living, physical elements, emphasising human affiliation with the local environment (‘place’) and a role for cultural experience. |
|  | Positive psychology of sustainability (Corral-Verdugo) | Sustainable behaviour is characterised as a positive behaviour aimed at protecting the socio-physical environment involving pro-ecological, altruistic, frugal and equitable behaviors, which have positive psychological consequences. |
|  | Model of sustainable happiness (O’Brien) | ‘Sustainable happiness’ is defined as individual, community, and/or global well-being that does not involved exploitation of other people, the environment, or future generations. Critically, it is distinguished from ‘sustaining happiness’ or ‘sustainable increases in happiness’. |
|  | Model of sustainable wellbeing (Kjell) | Places the construct of wellbeing within the framework of sustainability, highlighting interdependencies between the individual, others and nature. |
|  | Social-ecological theory (Cohen) | Emphasises dynamic relationships among individuals, groups and their environments. Complementary to this is Glenn Albrecht’s concept of the ’symbioment’, which has particular relevance to the present review paper given the direct link between the environment and human emotions. The symbioment refers symbiotic coexistence in which ’all life exists within living systems at various scales.’ |

**3.1: Focus on the individual**

In terms of  individual factors contributing to health and wellbeing, our original GENIAL framework highlighted the critical role of positive psychological experiences as well as positive health behaviours. We use the term ‘psychological experiences’ to refer to an individual’s interpretation of life events and the temporal narrative relating to the events over one’s life course via cognitive and emotional processes. Although there is a wealth of evidence demonstrating a reciprocal relationship between health behaviours and psychological experiences, reviews on one typically do not discuss the other. There are two potential reasons for this: 1) the distinction between mind and body remains an issue of great philosophical debate, with consequences for mental and physical health, and, 2) researchers tend to work in disciplinary silos, a phenomenon reinforced by higher education, focused research areas and targeted funding initiatives. In this section we discuss both positive psychological experiences and positive health behaviours, laying the foundation for improving individual wellbeing with an eye towards applying this information to improving wellbeing in people living with chronic conditions in future research.

### Psychological experience

Major theories relating to the wellbeing of individuals (Table ???) can be categorised according to two contrasting philosophical positions: hedonic and eudaimonic wellbeing. According to the hedonic standpoint, wellbeing is achieved by focusing on pleasurable experiences in order to enhance positive affect. A major theory is the ‘tripartite model of subjective wellbeing’, proposed by (Diener, 1984), highlighting a role for life satisfaction, decreases in negative affect and increases in positive affect. Another key model is the ‘broaden and build’ theory by Barbara Fredrickson (Fredrickson, 2001), which emphasises a role for positive emotions such as joy, interest, contentment, pride and love in broadening individual thought-action tendencies that subsequently build personal resources for individual growth, social connection and psychological resilience. Research has shown that positive emotions increase the perception of social connectedness, enhance vagal function, and facilitate the adoption of positive health behaviours, among other factors (Kok & Fredrickson, 2010; Sin, Moskowitz, & Whooley, 2015; Kok et al., 2013). Recent longitudinal research (Petrie et al., 2018) observed that participants in a low positive affect grouping have a twofold increased risk for mortality, compared to those in the more favourable grouping over a 16.5 year follow-up period. Positive affect has been shown to affect health via inflammation, such that greater trait positive affect is associated with reduced pro-inflammatory cytokines (Stellar et al., 2015). Interested readers are also referred to major reviews on this topic (Chida & Steptoe, 2008; DuBois et al., 2012; Boehm & Kubzansky, 2012). Our own work emphasises the role of vagal function over these allostatic systems (Kemp, Arias, & Fisher, 2017; Kemp, Koenig, & Thayer, 2017; Kemp, 2018; Kemp & Quintana, 2013; Kemp, 2016).

In contrast to a focus on hedonia, eudaimonic theories of wellbeing look beyond momentary happiness, focusing on purpose, meaning in life, and flourishing. According to this perspective, Carol Ryff’s Psychological Wellbeing theory (Ryff & Keyes, 1995; Ryff, 2014; Ryff, 1989) emphasises six elements that contribute to psychological wellbeing including self-acceptance, personal growth, purpose in life, positive relations with others, environmental mastery, and autonomy. As with hedonic wellbeing, psychological wellbeing has also been associated with improved health, including subjective health, chronic conditions, symptoms and functional impairment (Ryff, 2014). Purpose in life reduces risk of developing Alzheimer’s disease and mild cognitive impairment (Boyle, Buchman, Barnes, & Bennett, 2010) along with reducing risk of death (Boyle, Barnes, Buchman, & Bennett, 2009). Postmortem results have even revealed that - among those with high levels of brain pathology - those with greater purpose in life presented with better cognitive functioning whilst they were still alive, highlighting a moderating role of purpose in life on the relationship between brain-based pathology and cognitive functioning (Boyle et al., 2012). A more recent study reported that a stronger sense of purpose is associated with decreased mortality (Alimujiang et al., 2019), an effect associated with a hazard ratio of 2.43 (95% CI, 1.57-3.75) when comparing those in the lowest life purpose category with those in the highest life purpose category.

However, these theoretical models - especially those focusing on hedonia - have faced criticism. As alluded to above, the focus on ‘happiology’ has been criticised as lacking in nuance. Positive affect alone is not sufficient for improving wellbeing and over-valuing the need to be happy can actually lead one to feel less happy (Mauss, Tamir, Anderson, & Savino, 2011), and may even be associated with the symptoms and diagnosis of unipolar depression (Ford, Shallcross, Mauss, Floerke, & Gruber, 2014) and bipolar depression (Ford, Mauss, & Gruber, 2015). Other writers have criticised the individualistic focus, which ignores the impact of community and wider environmental factors (Davies, 2015; Frawley, 2015; Carlisle, Henderson, & Hanlon, 2009). Eudaimonic theories have also attracted criticism for not recognising the importance of positive emotions, leading to proposals such as Seligman’s PERMA model (Seligman, 2011; Seligman, 2018), which incorporates aspects of both hedonic and eudaimonic theory. The PERMA model argues for a five-pronged model of wellbeing including *p*ositive emotions, *e*ngagement, positive *r*elationships, *m*eaning, and *a*ccomplishment (i.e. PERMA). According to this model, all five pillars of wellbeing contribute to flourishing in life. While theories relate to concepts of hedonia and eudaimonia as well as their combination, recent research has shown a large overlap between them. For instance, research by Todd Kashdan and colleagues (Disabato, Goodman, Kashdan, Short, & Jarden, 2016) reported a high latent correlation of .96 between Diener’s subjective wellbeing model of hedonia (Diener, 1984) and Ryff’s psychological wellbeing model of eudaimonia (Ryff, 1989) indicating that the discriminant validity of these constructs is negligible. Critically, analyses across seven geographical world regions revealed similar results. The authors however, noted three exceptions to this trend, which were ‘hope’, ‘meaning orientation’ and ‘grit’, which differentially related to hedonia and eudaimonia, giving some support to the discriminant validity of the two constructs. In another study by the same authors (Goodman, Disabato, Kashdan, & Kauffman, 2017), PERMA was observed to measure the same type of wellbeing as Diener’s model of subjective wellbeing with confirmatory factor analysis yielding a latent correlation as high as .98. The authors subsequently criticised PERMA for not offering any further insights into wellbeing beyond the former theory of SWB. In response to this, Seligman has argued that PERMA is not “redundant” simply because different models correlate; instead, PERMA presents a model that constitutes the critical elements of wellbeing (Seligman, 2018) and one what that we draw and build on in our own applied research (see section ???).

Building on strong theoretical foundations and an extensive body of research, our previously published models (Kemp, Koenig, & Thayer, 2017; Kemp, Arias, & Fisher, 2017) argue that healthy vagal nerve function, underpin and are impacted on by positive psychological moments, facilitating longer-term improvements in health and wellbeing. These insights are based on a strong body of evidence. For instance, Todd Kashdan and Jonathan Rotenberg (Kashdan & Rottenberg, 2010) argued that vagal function is an index of psychological flexibility (PF) that is fundamental for psychological health. Psychological flexibility is an important component of resilience, facilitating ones capacity to assess and adapt to demands, alter mindset and behaviour when necessary, and for commitment to behaviours that are congruent with deeply held values (Kashdan & Rottenberg, 2010). Conversely, psychological inflexibility has been associated with worsened mental health and an exacerbated stress (Masuda & Tully, 2011; Kato, 2016; Chawla & Ostafin, 2007; White et al., 2013; Smeekens, Marianne, & van, 2007). An inflexible response style - characterised by withdrawal of the vagal brake - plays a key role in the development of and symptomatology of depression (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008), along with explanatory inflexibility (applying the same attribution style cross different situations) and inflexible coping behaviours (Fresco, Williams, & Nugent, 2006; Moore & Fresco, 2007). According to (Kashdan & Rottenberg, 2010), vagal function underpins the capacity for psychological flexibility. Intriguingly, Bethany Kok and Barbara Fredrickson (Kok & Fredrickson, 2010; Kok et al., 2013) demonstrated that change in vagal function - following training in loving kindness meditation - is associated with increases in positive emotions and enhanced perception of social connectedness, suggesting that positive emotions facilitate physical health via the vagus nerve. The link between individual and community is a topic that we turn to following our discussion of positive health behaviours.

### Health behaviours

Whilst health behaviours are typically thought of with respect to their impact on physical health, there is now compelling evidence that health behaviours impact on both physical and mental health. Accordingly, and in contrast to many other models of wellbeing (Ryff, 1989; Diener, 1984; Seligman, 2011), we have proposed a key role for health behaviours in facilitating individual pathways to health, wellbeing and longevity (Kemp, Arias, & Fisher, 2017). Moreover, we propose the vagal nerve acts as the structural link between physical and mental health and plays a critical role in reciprocal relationship between positive health behaviours, and physical and mental health. In this section, we present some key studies highlighting the importance of health behaviours in physical and mental health outcomes. An exhaustive review is beyond the scope of this paper however, and interested readers are referred to (Kemp, Arias, & Fisher, 2017). Given the number of health behaviours, for brevity, we focus specifically on physical activity, diet and sleep.

*Impact of health behaviours on physical health:*

A summary of public health guidelines and associated evidence-base relating to physical activity, diet and sleep is provided in Table 2.

Summary of public health guidelines and associated evidence-base relating to physical activity, diet and sleep. Key references include (Kromhout, and C J K Spaaij, de Goede, & Weggemans, 2016; Aune et al., 2017; Mujcic & J.Oswald, 2016; Firth et al., 2019; O’Keefe, Bhatti, Bajwa, DiNicolantonio, & Lavie, 2014; Plunk, Syed-Mohammed, Cavazos-Rehg, Bierut, & Grucza, 2013; Cao, Willett, Rimm, Stampfer, & Giovannucci, 2015; Wen et al., 2011; Chekroud et al., 2018; Watson et al., 2015; MILNER & COTE, 2009; Duggan, McDevitt, Whitehurst, & Mednick, 2016)

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| Health Behaviours | UK Government Guidelines (Adults 18+) | Peer-reviewed literature | Comparison: Guidelines vs Research |
| Diet: Fruit and Vegetable Intake | Consume at least five portions a day (or 400g) (Public Health England, 2016) | Dutch guidelines based on 29 systematic reviews of meta-analyses comprising RCTs and the risk of chronic disease based on diet choices - 200g of fruit and 200g of vegetables daily (Kromhout et al., 2016). Although research highlights benefits in increasing fruit and vegetable intake up to 800g per day in regards to reducing risk for heart disease, cardiovascular disease and all-cause mortality (Aune et al., 2017). In addition to these physical health benefits, increasing fruit and vegetable portions has been shown to be beneficial in improving wellbeing (Mujcic & Oswald, 2016): 8 portions a day increases life satisfaction by 0.24 points, equivalent to the psychological gain of moving from unemployed to employed. | UK guidelines may be an underestimate of the ideal amount of fruit and vegetable consumption given the health benefits of eating more than 5 a day for both physical and mental health. |
| Diet: Other food items | Consume at least two portions of fish (2x 140g) weekly (one of which is oily fish), consume some beans, pulses, eggs, meat and other proteins, and limit unsaturated oils and spreads (Public Health England, 2016) | Dutch guidelines - Limit consumption of red meat, a few dairy portions daily, eat legumes weekly, consume at least 15g of unsalted nuts daily, consume oily fish weekly, zero alcohol (or less than one glass daily), less than 6g salt daily (Kromhout et al., 2016). Dietary interventions have also been shown to improve mental health (symptoms of depression and anxiety) (Firth et al., 2019) - examples include adherence to a Mediterranean diet, coaching in healthy eating, and calorie-restricted diets. | Guidelines do not specify recommended amounts of more general food items, such as legumes and red meat. It would be beneficial to provide evidence-based recommendations on these foods. |
| Diet: Alcohol Consumption | Less than 14 units per week (Public Health England, 2016) | There is a J-shaped curve with alcohol consumption and cardiovascular health (O’Keefe et al., 2014), the benefits of drinking peaks around 2 nonheavy occasions per week (Plunk et al., 2014), with mortality risk increasing thereon after. Drinking more than 60g on one occasion increases risk of CHD (Kromhout et al., 2016). The J-shaped curve between alcohol and health is not present for risk of cancer; even light drinkers display increased risk compared to non-drinkers (Cao et al., 2015). | Limiting alcohol consumption to less tan 14 units per week is reasonable given the evidence; given that research highlights a J-shaped curve for alcohol consumption and many health outcomes it would unreasonable to recommend a zero-alcohol diet. However, a recommended restriction is beneficial given the severe health outcomes of drinking heavily. |
| Physical Activity | At least 150 minutes of moderate aerobic exercise a week, in addition to a minimum of two strength exercise sessions weekly (Public Health England, 2019) | 15 minutes of exercise a day reduces all-cause mortality risk by 14% (Wen et al., 2011); exercise also improves mental health, with specific exercises (such as team sports and cycling) being more effective (Chekroud et al., 2018) | Guidelines could be more focused in the types of exercise that is recommended, given that the evidence base highlights certain sports to be more efficacious in health outcomes. |
| Sleep | Between 6-9 hours each night (NHS, 2019) | No less than 7 hours per night to promote optimal health, with less than 7 hours per night on a regular basis being associated with adverse health outcomes, including obesity, diabetes, heart disease, stroke and depression (Watson et al., 2015). Daytime napping shown to be beneficial for healthy adult populations - improving cognition and wellbeing (Milner & Cote, 2009). However, emotional reasons for napping are associated with reduced wellbeing, while restorative reasons for napping improves the health outcomes (Duggan et al., 2018). | A discrepancy arises among sleep guidelines, with the UK recommending between 6-9 hours a night, despite the evidence base recommending no less than 7 hours to avoid adverse health outcomes. |

Research on over 20,000 participants analysed the impact of key positive health behaviours on mortality risk - non-smoking, physical activity, consumption of less than 14 units of alcohol per week and a diet rich in fruit and vegetables. Participants who adopted all four health behaviours at baseline had a mortality risk that was equivalent to being 14-years younger at follow-up (average of 11-years later), compared to those who adopted none of the positive health behaviours . A more recent study focused on six health behaviours: non-smoking, physical activity, healthy diet, sleeping seven to eight hours a night, inactivity less than eight hours a day, and daily social contact . Results again highlighted a mortality risk that was equivalent to being 14-years younger for those who adopted these behaviours relative to those who adopted none of them.  conducted a prospective cohort study with over 400,000 individuals between 1996-2008. Surprisingly, even those individuals in a low physical activity group (average of 15 mins a day or 92 mins per week) had a 14% reduced risk of all-cause mortality. Moreover, every additional 15 minutes of daily exercise beyond this minimum amount, reduced all-cause mortality by further 4%. The authors argued that less exercise is easier to achieve for those who do not engage in any physical activity at all, and yet it may still be sufficient to achieve health benefits. Moreover,  concluded that running 5-10 minutes a day at slow speeds (less than 6mph) is even associated with reduced all-cause risk of mortality, providing further evidence that exercising below current minimum guidelines is sufficient for mortality benefit. Once a routine is established individuals may then be able to be motivated to exercise at higher levels.

The relationship between diet and physical health has been widely reported in the literature. For example, the vegetarian diet has been associated with a reduced risk for disease development, including coronary heart disease and type 2 diabetes, compared with a diet containing red and processed meat . Insufficient fibre has been associated with colon cancer, high blood cholesterol, diabetes, coronary heart disease and obesity . Diet is also associated with all-cause mortality, with one study reporting findings based on a sample of 2000 individuals, finding that those adhering to a Mediterranean diet had an all-cause mortality risk that was 34% lower than those who did not adhere to the diet .  (Watson et al., 2015) concluded that 7 hours or more sleep per night produces optimal health in adults. Sleeping less than 7 hours a night is associated with obesity diabetes, hypertension, heart disease, stroke, depression and increased mortality. Moreover, a recent prospective twin study  found that both short (defined as <6.5 hours) and long (defined as ≥9.5 hours) sleep were linked to increased mortality. However, it is important to note that these statistics are generalisations and that other research has shown that  small groups of people are able to function healthily on shorter periods of sleep  .

*Impact of health behaviours on physical and mental health:* Focusing on health behaviours - including exercise, diet and sleep - typically involves consideration of one’s physical health, however there is now convincing evidence that demonstrates the impact of positive health behaviours on mental wellbeing, supporting declarations that there is ‘no health without mental health’ (Prince et al., 2007). In a study which included over 4,500 adolescents, health behaviours were measured across several domains; diet, specifically consumption of carbonated soft drinks and fast food, tobacco use and physical activity. Participants were then allocated a number ranging from zero to “four or more” depending on the number of unhealthy behaviours they engaged in . Results highlighted that participants with a score of four or more were significantly more likely to be anxious, experience suicidal ideation and have been involved in a physical fight, compared to those who scored zero. Analysis of over 2,400 Chinese college students found those who frequently consumed alcohol, had disturbed sleep, poor dietary behaviour and internet addiction disorder. This was associated with significant increased risk of depression and anxiety .

With respects to physical activity and mental health, research on a sample of 49 unique prospective studies (N=266,939), showed that physical activity protected against depression, irrespective of age and geographic region (Schuch et al., 2018). In a cross-sectional study of more than 1 million individuals in the U.S. (Chekroud et al., 2018), exercisers displayed 43% fewer days of poor mental health than non-exercisers. The authors further reported that all exercise types were associated with a lower mental health burden (from 11.8% to 22.3% reduction), and the activities identified with the largest associations included popular team sports (22.3% lower), cycling (21.6%  lower), and aerobic and gym activities (20.1% lower). Exercise duration of 45 minutes and frequencies of  three to five times per week were associated with the lowest mental health burden.

With respects to diet and mental health, combined data from four longitudinal studies found a risk estimate of highest vs. lowest adherence to the Mediterranean diet of 0.67 (95% CI 0.55-.82) for incident depression (Lassale et al., 2018). The Mediterranean diet has also been implicated in slowing age-related deterioration, including improvements in cognitive function and reducing risk of cognitive impairment and dementia  , with B-vitamins and antioxidants playing a key role  . Several randomised controlled studies, showed that a modified version of the Mediterranean diet reduced depression symptomology (Parletta et al., 2017) and (Opie, ONeil, Jacka, Pizzinga, & Itsiopoulos, 2017). Based on the evidence, dietary recommendations for the prevention of depression have been proposed; adopting “traditional” diets, such as the Mediterranean diet, increasing consumption of fruits, vegetables, legumes, wholegrain cereals, nuts, seeds, foods rich in omega-3 polyunsaturated fatty acids and limit consumption of processed foods . We note here that socio-structural factors (e.g. inequality and poverty) will impact on individuals capacity to follow such advice (Darnton-Hill, Nishida, & James, 2004).

With regards to sleep, a systematic review and meta-analysis of 14 studies found sleep disturbances significantly predicted the risk of suicidal ideation; an effect not moderated by depression (Liu et al., 2019). Poor sleep is also associated with common mental disorders, while improving sleep in these patients can lead to mental health improvements . Analyses on nearly 100,000 adolescents in Japan found a U-shaped association between mental health status and sleep duration . The authors also reported a positive correlation between mental health status and subjective sleep assessment. Similarly, among an elderly population, sleep problems were associated with worsened mental and physical health-related quality of life .

Critically, each of these health behaviours - physical activity, diet and sleep - have a powerful impact on vagal function (Kemp, Koenig, & Thayer, 2017). Thus, improving positive health behaviours is a powerful means to promote health and wellbeing. As with physical activity (Sandercock, Bromley, & Brodie, 2005; Raffin et al., 2019) and diet (Young & Benton, 2018), changes in sleep are associated with changes in vagal function, such that reduced vagal function (combined baseline and reactivity measures) is associated with sleep disruption . Intriguingly, increases in resting state vagal function have been shown to predict better subjective and objective sleep quality  . By contrast, reduced heart rate variability (HRV) - an index of vagal functioning - has also been detected during early stages of sleep-related breathing disorders .

In summary, we highlight a role for positive psychological experience and positive health behaviours in facilitating individual pathways to health and wellbeing. We argue that this effect is moderated by vagal function which triggers a cascade of downstream physiological processes (Kemp et al, 2017). Accordingly, in order to facilitate pathways to health and wellbeing, interventions should be considered that both enhance psychological experiences and positive health behaviours. Nonetheless, individual factors are not the only determinants of health and wellbeing and so in the next section we explore community or societal determinants. Before doing so however, it is instructive to point out the importance of building individual wellbeing in order to achieve community and environmental wellbeing. For instance, it has been argued that community resilience is underpinned by the individuals within it. This work highlighted the role of a positive outlook and individual strengths, which underpin a community’s capacity for resilience and agency (Berkes & Ross, 2013). A greater appreciation of the interconnectedness between individuals, and the communities and environment in which they reside is important for considerations relating to how we might improve the wellbeing of current and future generations.

## Focus on Community

In this section we focus on the relevance of community to individual wellbeing, a major focus of our original GENIAL model (Kemp, Arias, & Fisher, 2017). Unfortunately, there is much evidence to suggest that community is deteriorating (Kushlev, Proulx, & Dunn, 2017; Twenge, 2013; Twenge, 2014; Putnam, 2001). The reasons for this are complicated, but may involve a host of interconnected societal issues including generational shifts in narcissism (Twenge, 2013; Twenge, 2014), declines in perspective taking and empathic concern (Konrath, OBrien, & Hsing, 2010), increasing individualism (versus collectivism) in western society (Heu, van Zomeren, & Hansen, 2018; Brewer & Chen, 2007), and inequalities (Scheffer, van Bavel, van de Leemput, & van Nes, 2017; Scheidel, 2017; *The Spirit Level: Why Equality is Better for Everyone*, 2010; Nolan & Valenzuela, 2019). It is is worth noting here that others (Beery, Jönsson, & Elmberg, 2015; Nurse, Basher, Bone, & Bird, 2010) have argued that the boundaries of ‘community’ should be extended to the environment (section ???) including soil, water, plants and animals (to facilitate love and respect, and a commitment to environmental sustainability). Considering the climate crisis as issue we turn to in section ???, it is apparent that ‘community’ in its broadest sense is under threat.

Although we would not describe ourselves as luddites, it is worth noting that despite technological advancements and online connectedness, the use and engagement of social media - including Facebook, Twitter and WhatsApp - is negatively associated with eudaimonic wellbeing (as defined by the extent to which respondents felt their life to be worthwhile) (“Subjective Well-being and Social Media Use in Emerging Adulthood: Findings from two UK University Millennial Cohorts.”, 2019). Interestingly, decreases in sleep quality and self-esteem were also observed (“Subjective Well-being and Social Media Use in Emerging Adulthood: Findings from two UK University Millennial Cohorts.”, 2019). Young adults are increasingly connected, however their online activities are adversely affecting their wellbeing: these findings were associated with a medium effect size (observed correlations for two cohorts, r=-.32 and r=-.29). In fact, research has demonstrated that use of Facebook is associated with ill-being such that “links clicked” or “status updates” are associated with a decrease of 5% to 8% of a standard deviation in self-reported mental health (Shakya & Christakis, 2017). Importantly, this longitudinal research demonstrated that while those with compromised wellbeing may be more likely to use Facebook, use of the Facebook platform is associated with reduced *future wellbeing*, even when controlling for initial wellbeing. Research by the same authors has also shown that loneliness occurs in clusters, extends up to three degrees of separation and may spread through a contagious process (Cacioppo, Fowler, & Christakis, 2008), a finding leading to social contagion theory (Christakis & Fowler, 2012). On this background and in light of the ’[The Great Hack](https://www.netflix.com/gb/title/80117542)’ it is clear that social media companies have much to learn about promoting wellbeing and social cohesion as well as the ethical management of their platforms.

Critically, loneliness has important impacts on health and wellbeing. A meta-analysis of studies on more than 300,000 participants reported that a lack of social ties are associated with a 50% increased risk of premature mortality over a 7.5 year follow-up period, an effect that was stronger than physical activity, smoking (15 cigarettes daily) and body mass index (Holt-Lunstad, Smith, & Layton, 2010). In a more recent study on 48,673 participants, the same researchers (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015) observed that social isolation (29%), loneliness (26%), and living alone (32%) increase risk for premature mortality, reporting no differences for objective and subjective measures. Furthermore, greater impacts on mortality were observed among those under the age of 65 years. The Japanese even have a word to describe “lonely death”: ‘kodokushi’, a phenomenon that refers to people dying without friends or family. Sometimes these individuals are not found for many weeks… or months. (“Dead people don’t pay their bills”). Tragically, these experiences characterise the modern world, and especially individualistic cultures.

Social isolation and loneliness impact on a host of behavioural, psychological and physiological factors. Behavioural factors include physical inactivity and smoking (Shankar, McMunn, Banks, & Steptoe, 2011), substance use and hazardous drinking (Stickley, Koyanagi, Koposov, Schwab-Stone, & Ruchkin, 2014), while psychological factors include decreases in self-esteem, increased risk of depression, and feelings of hopelessness (Steptoe, Owen, Kunz-Ebrecht, & Brydon, 2004), both of which subsequently contribute to dysregulation of cardiovascular, metabolic, and neuroendocrine processes (Grant, Hamer, & Steptoe, 2009), higher systolic blood pressure, independent of several factors such as age, gender, cardiovascular risk factors, medications, social support and perceived stress (Hawkley, Thisted, Masi, & Cacioppo, 2010). The NIACT (Kemp, Koenig, & Thayer, 2017) and GENIAL (Kemp, Arias, & Fisher, 2017) models integrate these behavioural, psychological and physiological factors into innovative frameworks within which pathways to health and ill-health may be understood, bridging the gap between psychological moments and mortality.

Further to our original GENIAL model (Kemp, Arias, & Fisher, 2017), the relationship between social ties and health was recently comprehensively reviewed in a book titled ‘The New Psychology of Health: Unlocking the Social Cure’ (Haslam, 2018). Social identity theory helped to contextualise this research which refers to people conforming to the norms of the group to which they identify. Actions and thoughts of the group become the reference point for the individual, thus, if an individual’s perception of others in a representative group is positive, individuals of that group will think and behave similarly. Peer modelling has proven to be an effective intervention to increase fruit and vegetable intake (Horne et al., 2008), although only when modelled by someone that shares the same group identity (Cruwys et al., 2012). By contrast, if an individual was to identify with a group whose health behaviours are risky, they are more likely to participate in negative health behaviours. Research has shown there is a relationship between strength of group identification and smoking status when smoking is a normal group behaviour (Schofffild, Pattison, Hill, & Borland, 2001). Intriguingly, the more group identities an individual has, the less likely they are to engage in negative health behaviours, such as cigarette smoking, alcohol consumption, and use of illicit drugs (Miller, Wakefield, & Sani, 2016).

Social identity theory provides a useful context within which to understand the influence of community on the health and wellbeing of the individual. For example, social identity provides meaning, purpose and worth to an individuals life (de Vroome & Hooghe, 2013; Nakamura, 2013; Peterson, Park, & Seligman, 2005), the importance of which was highlighted above in our discussion of positive psychological experiences. Social identities also facilitate the extent to which others are likely to provide social support (Cohen, 2004; Levine, Cassidy, Brazier, & Reicher, 2002; Levine, Prosser, Evans, & Reicher, 2005; Platow et al., 2006), and provide a sense of efficacy, agency and power to an individual, contributing to the sense that ‘the whole is greater than the sum of its parts’ (Haslam, Jetten, Cruwys, Dingle, & Haslam, 2018). Strikingly, research has demonstrated that cardiac and respiratory patterns synchronise when members of a choir sing in unison, compared to when singing independently (Timmons, Margolin, & Saxbe, 2015). This phenomenon of ‘physiological linkage’ may help to explain relationship connectedness (Timmons, Margolin, & Saxbe, 2015) and the vagus nerve underpins ones capacity for connecting with others, regulating downstream allostatic systems that are also involved (e.g. the hypothalamic-pituitary-adrenal axis) (Porges, 2011; Kemp, Arias, & Fisher, 2017; Kemp, Koenig, & Thayer, 2017).

To conclude, community is important for individual health and wellbeing as it provides the environment in which individual health and wellbeing may be achieved. A supportive community will therefore contribute to the health and wellbeing of individuals within that community, and this relationship will be a bidirectional one such that improved health and wellbeing of the individual will help to foster community wellbeing. It is helpful to consider the inter-connectedness of individual, community and environmental wellbeing, consistent with social ecological theory. In this regard, research not only highlights the importance of eating less meat for individual health and wellbeing (Pan et al., 2011), (Micha, Wallace, & Mozaffarian, 2010), (Demeyer, Mertens, De, & Ulens, 2016), it also highlights the impacts of eating less meat to reduce adverse impacts on the environment (Poore & Nemecek, 2018), reinforcing this concept of the ‘symbioment’ (Fig ???) which emphasises symbiotic coexistence of all life at various scales. It is perhaps prudent to note however, that although these findings (Poore & Nemecek, 2018) led to much fanfare in the media on the need to ‘go vegan’ (“Avoiding meat and dairy is ‘single biggest way’ to reduce your impact on Earth”, n.d.), other research (Peters et al., 2016) reports on findings from modelling that shows that the diets with low to modest amounts of meat (the ‘omnivore diet’) actually outperform a vegan diet in regards to the “carrying capacity” of an agricultural land base. The authors noted that the carrying capacity of the vegan diet fell between the 60% and 40% omnivore diet options, which reflect the percentage of vegetarian food consumed. These findings highlight - as always - that one should always be mindful of evidence-based nuance. Finally, and in closing this section, we would like to highlight the relationship between individuals and community. For instance, among Western cultures, positive feelings are associated with individual success, high self-esteem, and good health (Heine, Lehman, Markus, & Kitayama, 1999; Kitayama, Markus, & Kurokawa, 2000; Taylor & Brown, 1988). In Japan however, individuals are more likely to associate happiness with negative social consequences, such as jealousy and disharmony among relationships (Uchida, Norasakkunkit, & Kitayama, 2004). We now turn our attention to the wider environment in which individuals live and work, focusing on a major societal challenge to human health and wellbeing: the climate crisis.

## Focus on the Environment

Psychological science has been criticised for a blinkered focus on the individual while ignoring wider, systemic issues issues (Carlisle, Henderson, & Hanlon, 2009; Frawley, 2015). Critics have argued that the construct of wellbeing is a socio-cultural construction of western individualism that places importance on wealth, fame and materialistic pursuits, while neglecting neglecting our shared environment (Carlisle, Henderson, & Hanlon, 2009). These criticisms in combination with an ever-increasing body of peer-reviewed literature on ‘happiness’ and ‘wellbeing’ were, in part, reason for proposing our original GENIAL framework (Kemp, Arias, & Fisher, 2017), which extended theoretical frameworks of individual wellbeing to community wellbeing. Here we focus on the contributions from the wider environment to individual wellbeing, and on the implications for tackling the greatest societal challenge facing mankind: the climate. We use the term ‘environment’ in a very general sense in this paper, encompassing natural as well as human-built environments, although we place emphasis on the relationship between individual wellbeing and the natural environment given the sheer scale of the challenge associated with the climate crisis.

It is now accepted in scientific circles (Intergovernmental Panel on Climate Change, 2007; Intergovernmental Panel on Climate Change, 2014) that humanity will face catastrophic climate change should we fail to commit to climate action. An increase in the frequency, duration and intensity of extreme weather events increases risk of population distress and psychiatric disorders through disruption to food supply and damage to community wellbeing (Berry, Bowen, & Kjellstrom, 2009; Hayes, Blashki, Wiseman, Burke, & Reifels, 2018). Extreme weather events have even been shown to influence the future health and wellbeing of an unborn child with implications for brain development and metabolic outcomes (Dancause et al., 2015; Dufoix et al., 2015). Other research has also shown that climate change has increased global economic inequality by ~25% over the last 50 years, with wealthy countries benefiting disproportionally (Diffenbaugh & Burke, 2019). Rising inequality has been linked to the middle-class squeeze, intergenerational immobility, erosion of trust, more divided societies, rising populism, poverty, crime, ill-health and ill-being. Interested readers are referred to the excellent recent review by Brian Nolan and Luis Alenzuela in this regard (Nolan & Valenzuela, 2019). Critically, ratings of peer-reviewed climate-science and self-ratings by climate change scientists themselves has indicated that there is 97% endorsement that humans are contributing to the warming climate (i.e. anthropogenic climate change) (Cook et al., 2013; Cook et al., 2016). Unfortunately, this finding remains under appreciated in a brave new world of alternative facts and disinformation (Lewandowsky, Oberauer, & Gignac, 2013; Lewandowsky, Ecker, & Cook, 2017).

Human beings have a strong, innate affiliation with the biological world, a phenomenon captured by the ‘biophilia hypothesis’. Recent research indicates that people who spend at least two hours a week in nature are more likely to report good health and high levels of wellbeing than those who spend no time in nature (White et al., 2019). Furthermore, these findings were consistent across a variety of demographic variables including sex, age-group, occupational social grade, presence of chronic illness and whether or not individuals met physical activity guidelines. Prior research had indicated that spending time in nature over a two-week period boosts hedonic as well as eudaimonic wellbeing (Howell, 2014), and that effect sizes are larger (*d*s from .37 to .63) than those reported for other positive psychology interventions (*d*s from .20 to .34) (Bolier et al., 2013). Exposure to nature can lead to transcendent emotions (Bethelmy & Corraliza, 2019), peak experience (Maslow, 1964) and psychological flow (Csikszentmihalyi, 2014). Interestingly, transcendent emotions - including compassion, gratitude and awe - foster healthy social relationships (Stellar et al., 2017) and such relationships are facilitated by spending time in nature (Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2008; Richardson, Cormack, McRobert, & Underhill, 2016), further highlighting the inter-connectedness between individual, community and environmental domains. Research also reports that exposure to nature is associated with stress reduction (Hansmann, Hug, & Seeland, 2007; Ulrich et al., 1991), feelings of restoration (White, Pahl, Ashbullby, Herbert, & Depledge, 2013; Wyles et al., 2017), subjective wellbeing (Johansson, Hartig, & Staats, 2011; LUCK, DAVIDSON, BOXALL, & SMALLBONE, 2011; White, Pahl, Wheeler, Depledge, & Fleming, 2017), and improved cognitive functioning (Berman, Jonides, & Kaplan, 2008; Berto, 2005). Human beings also have a strong affiliation with the local environment (‘place’), driven by cultural experience (Beery, Jönsson, & Elmberg, 2015; Sampson, 2012). This is known as the ‘topophilia hypothesis’; the word topophilia combines *topos*(place) with *philia*(love). These biophilia and topophilia hypotheses provide a foundation on which to understand the distress, pain or sickness associated with environmental degradation of home or territory. Glenn (Albrecht, 2019), an Australian environmental philosopher coined the term ‘solastalgia’ after reflecting on the environmental impacts of open cut coal mining and pollution of local power stations on the residents of the Upper Hunter Region of NSW in Australia. He wrote that ‘solastalgia’ reflects a:

“specific form of melancholia connected to a lack of solace and intense desolation” associated with place-based distress (Albrecht, 2005).

Feelings of guilt, shame, fear, emotional discomfort and solastalgia have been associated with motivation to engage in environmental sustainability behaviours (Albrecht et al., 2007; Dickerson, Thibodeau, Aronson, & Miller, 1992; Kaiser, Schultz, Berenguer, Corral-Verdugo, & Tankha, 2008; Malott, 2010). In order to encourage such behaviours, scholars have proposed an ‘aesthetics of elsewhere’, which involves encouraging a double aesthetic judgment of ‘here’ and ‘elsewhere’ to induce an aesthetic melancholia to influence consumption decisions (Maskit, 2011). However, researchers have also begun to investigate the value of positive psychology in encouraging pro-environmental behaviours. Positive psychology refers to the scientific study of human flourishing and an applied approach to enabling individuals, communities and organisations to thrive  (Gable & Haidt, 2005), (Sheldon & King, 2001).  The positive psychology of sustainability (Corral-Verdugo, Tapia-Fonllem, & Ortiz-Valdez, 2014; Verdugo, 2012; O’Brien, 2016) is a strategy that may help to foster what has been described as sustainable wellbeing (Kjell, 2011). In a study on 606 undergraduate students in Mexico (“Happiness as Correlate of Sustainable Behavior”, 2011), researchers reported that pro-ecological, altruistic, frugal and equitable behaviours reflect the sustainably-oriented person, and that these behaviours have positive psychological consequences (i.e. greater happiness). A major goal of positive psychology should now be focused on developing interventions that promote pro-environmental behaviours, an effort that would have substantial benefits for the wellbeing of current and future of generations as well as the environment. In this regard, prior research has shown that individuals engaging in pro-ecological behaviours – such as resource conservation – report greater happiness (Brown & Kasser, 2005), that altruism leads to greater long-term happiness (*The psychology of helping and altruism: Problems and puzzles*, 1995), and that frugality predicts greater psychological wellbeing, satisfaction and motivation (Brown & Kasser, 2005). Notably however, equitable individuals have been reported to be less happy due to the ‘negative hedonic impact of inequality in society’ as climate change exacerbates existing inequities (Hayes, Blashki, Wiseman, Burke, & Reifels, 2018), highlighting a need for sociostructural reforms that combat various types of inequality. Importantly, (Nolan & Valenzuela, 2019) concluded that we now have a window of opportunity for designing and implementing sociostructural changes through strategies and policies to halt and reverse rising income and wealth inequality.

The grave threat of anthropogenic climate change - referring to the production of greenhouse gases emitted by human activity - may help to inspire a variety of positive feelings such as altruism, compassion, optimism as well as a sense of purpose “as people band together to salvage, rebuild, and console amongst the chaos and loss of a changing climate” (Hayes, Blashki, Wiseman, Burke, & Reifels, 2018), feelings that reflect ‘active hope’ (Macy J, 2012). The concept of ‘sustainable happiness’ (O’Brien, 2016) has been defined as “happiness that contributes to individual, community, and/or global well-being without exploiting other people, the environment, or future generations”(O’Brien, 2010).

A central concept within the field of Positive Psychology is that of ‘character strengths’. In their book ‘Character strengths and virtues: A handbook and classification’, (*Character strengths and virtues: A hand-book and classification*, 2004) describes a framework for the identification of individual cognitive,  emotional, social and community strengths, protective strengths, and spiritual strengths. In total (*Character strengths and virtues: A hand-book and classification*, 2004) describe 24 character strengths which individuals possess to more or less of a degree. A structural model of the relationships between character strengths, virtues and sustainable behaviours (i.e. altruistic, frugal, equitable and pro-ecological behaviours) has been presented such that all 24 character strengths are associated with all four sustainable behaviours (Corral-Verdugo & Frías-Armenta, 2015). The knowledge that pro-environmental behaviours provide opportunities to promote happiness and build resources for resilience, in addition to much-needed environmental benefits provides a useful foundation on which psychological scientists could address environmental challenges through targeted interventions focusing on the individual (Clayton et al., 2016; “Happiness as Correlate of Sustainable Behavior”, 2011; Verdugo, 2012). Recommendations included the need for psychological scientists to incorporate a contextualised or ‘place-based’ approach - including aspects of the built environment and different cultures - into initiatives designed to facilitate pro-environmental behaviours and to engage in more interdisciplinary research.

Unfortunately, the vast majority of people do not engage in pro-environmental behaviours, a result of helplessness and low self-efficacy (Salomon, Preston, & Tannenbaum, 2017). The difficulty in comprehending problems associated with climate change, and the intangibility and invisibility of such change may lead individuals to ‘sit on their hands and do nothing’, a phenomenon known as ‘Giddens Paradox’ (Giddens, 2009). Recent qualitative research (“Learning from Co-Founders of Grassroots Initiatives: Personal Resilience, Transition, and Behavioral Change – a Salutogenic Approach”, 2017) has investigated the psychological processes that foster pro-environmental behaviours. Findings were interpreted in the context of ‘salutogenesis’ (Antonovsky, 1996), which emphasises a role for a ‘sense of coherence’ for managing and overcoming stress. This ‘sense of coherence’ reflect feelings of confidence that stimuli in the (internal and external) environment are comprehensible, manageable and meaningful. The researchers reported that grassroots activists relied on values and attitudes, emphasising that the problems are so vast that limits are imposed on knowledge (i.e. comprehensibility), arguing that emotions are a key mediator between the appraisal of a situation and motivation to take action. A sense of personal responsibility for change was associated with an improved perceived quality of life, attributable to empowerment and social cohesion, which provides a sense of meaning and purpose in life. Concrete and collective action was also observed to enhance positive emotions and mastery experiences subsequently enhancing beliefs about self-efficacy (i.e. manageability) (“Learning from Co-Founders of Grassroots Initiatives: Personal Resilience, Transition, and Behavioral Change – a Salutogenic Approach”, 2017).

In summary, we have observed emerging research interest in the concepts of sustainable happiness and wellbeing, directly linking positive psychology to concepts relating to sustainability and pro-environmental behaviours. Although much work remains to be done, these efforts serve to combat criticisms of psychological science relating to a blinkered focus on personal happiness that ignores important societal challenges. Spending time in and caring for for the natural environment may also provide an under-appreciated means to promote  wellbeing that is over and above the beneficial impacts of outdoor physical activity (Franco, Shanahan, & Fuller, 2017; Capaldi, Passmore, Nisbet, Zelenski, & Dopko, 2015; Bowler, Buyung-Ali, Knight, & Pullin, 2010) and may even promote commitment to pro-environmental behaviours, supporting efforts to combat the climate crisis.

# The Updated GENIAL model: GENIAL 2.0

”Models, of course, are never true, but fortunately it is only necessary that they be useful”.

– George Box, 1979, Journal of the American Statistical Association, 74:365, 1-4

The GENIAL framework illustrates common pathways to ill-health and ill-being versus health and wellbeing. The evidence-base for these pathways - including a key regulatory role for vagal function - have been described previously (Kemp, Arias, & Fisher, 2017; Kemp, Koenig, & Thayer, 2017; Kemp, 2018). While our original GENIAL model highlighted the importance of positive social ties for individual health and wellbeing (Kemp, Arias, & Fisher, 2017), our updated model (see Fig ???)  provides an important update to our original GENIAL model, emphasising individual, community and environmental contributors to personal wellbeing. In doing so, our model characterises the relationships between individuals, communities and their environments, as well as the impacts of sociostructural factors (e.g. inequality) and their impact on the health and wellbeing of the individual. Key features of the individual, community and environmental domains are now briefly described with a particular focus on vagal function.

Our original GENIAL and NIACT models suggest that enhancing positive psychological experiences and positive health behaviours can facilitate individual pathways to health and wellbeing (Kemp, Arias, & Fisher, 2017; Kemp, Koenig, & Thayer, 2017). In terms of enhancing psychological experiences, broadly speaking, there have been two approaches; the reduction of impairment or the promotion of wellbeing. Historically psychological interventions have typically been weighted towards interventions that seek to reduce impairment (Ryff & Singer, 1996). This approach assumes that health and wellbeing are synonymous with the absence of illness, as opposed to the presence of wellness. However, (Ryff & Singer, 1996) suggest that the ‘absence of wellbeing’ facilitates pathways to ill-health and ill-being, and they argue that the route to recovery will not come from only attempting to ameliorate negative symptoms associated with ill-health. We also advocate interventions that create a platform for the experience of ‘positive psychological experiences’ because environments that promote positive emotions may help people learn to better short circuit downward spirals to illness. In this regard, interventions from the feld of Positive Psychology have much to offer. Meta-analyses have demonstrated that positive psychological interventions (PPIs) are effective for people with or without diagnosed disorders (Bolier et al., 2013; Hendriks, Schotanus-Dijkstra, Hassankhan, de Jong, & Bohlmeijer, 2019; Chakhssi, Kraiss, Sommers-Spijkerman, & Bohlmeijer, 2018; Sin & Lyubomirsky, 2009; White, Uttl, & Holder, 2019), with effect sizes ranging from small to large. Meta-analyses have further demonstrated the effectiveness of specific positive psychological interventions (PPIs) on increasing SWB, PWB, optimism, positive affect and life satisfaction, including the practicing of gratitude (Davis et al., 2016), the ‘best possible self’ intervention (Malouff & Schutte, 2016), savouring positive emotions (Smith, Harrison, Kurtz, & Bryant, 2014), mindfulness-based interventions (Simpson et al., 2019), and performing acts of kindness (Curry et al., 2018). The three main models of wellbeing (Seligman, 2018; Diener, 1984; Ryff & Keyes, 1995) provide a theoretical foundation for developing new and novel interventions for enhancing positive psychological experience. Importantly, research demonstrates that despite the different theories that have been proposed for wellbeing, each of these contributes to the same higher order construct of wellbeing (Goodman, Disabato, Kashdan, & Kauffman, 2017; Disabato, Goodman, Kashdan, Short, & Jarden, 2016). In other words, there are many strategies through which positive psychological experience may be enhanced.

Other meta-analyses on health behaviours have emphasised the role of physical activity (Chekroud et al., 2018), diet (Firth et al., 2019) and sleep (Baglioni et al., 2016) on our mental lives. Our recent review on vagal function (Kemp, Koenig, & Thayer, 2017) concluded that higher resting state vagal function is associated with positive mood states, highlighting the utility of PPIs for enhancing a critical regulator of health and wellbeing. Our work further emphasises the structural link between the vagus nerve, and physical and mental health (Kemp, Arias, & Fisher, 2017; Kemp, Koenig, & Thayer, 2017; Kemp, 2018; Kemp & Quintana, 2013; Kemp, 2016). It is interesting to note here that purpose in life has been shown to predict allostatic load ten years later (Zilioli, Slatcher, Ong, & Gruenewald, 2015) as measured by the sum of seven scores across multiple physiological systems including cardiovascular, lipid, glucose metabolism, inflammation, autonomic function, and hypothalmic-pituitary-adrenal risk scores. Unfortunately however, this study did not distinguish between upstream and downstream systems driving increases in metabolic risk as we do here. Critically, vagal function plays a known regulatory role over inflammatory processes, as demonstrated previously: (Tracey, 2002).

In addition to focusing on positive psychological experience and health behaviours, recent developments in psychological science have highlighted a key role for social relationships for the health and wellbeing of the individual. Therefore, individual wellbeing may also be promoted by focusing on community, the focus of our original GENIAL model (Kemp, Arias, & Fisher, 2017). The implications of social relationships for the health and wellbeing of the individual were recently summarised by (Haslam, 2018). (Haslam, Cruwys, Haslam, Dingle, & Chang, 2016) evaluated a new intervention that targets social isolation and disconnection, “Groups 4 Health” (G4H). Results highlighted the intervention to improve mental health, wellbeing, and social connectedness up to 6-months post intervention. In addition to this, improvements in depression, anxiety, stress, loneliness, and life satisfaction correlated with heightened identification with the G4H group and with multiple groups. The work by Barbara Fredrickson and colleagues is especially relevant here, emphasising the upward spiral of positive emotions, social connectedness and vagal function (Kok & Fredrickson, 2010; Kok et al., 2013). Other well established theories of vagal function, such as the polyvagal theory (Porges, 2011; Porges, 1995; Porges, 2001; Porges, 2003; Porges, 2007) highlight a role for the vagus in promoting capacity to engage with others and regulating our emotions during such encounters.

Finally, our updated model emphasises the environmental context within which individual health and wellbeing is promoted and communities reside. Glenn (Albrecht, 2019) provides a solid foundation for understanding the link between human emotion and the environment, coining numerous words to emphasise the negative and positive ‘psychoterratic’ states that have important implications for the health and wellbeing of individuals, communities and nations now and into the future. Environmental contributors include negative and positive psychoterratic states such as solastalgia (chronic place-based distress) and soliphila (a neutral political term for combatting solastalgia) (Albrecht, 2019). A review of the literature on potential mechanisms linking nature to health identified 21 potential pathways empirically linked to nature (Kuo, 2015). These pathways included environmental factors including phytoncides - antimicrobial volatile organic compounds with physiological effects - and vegetation filtering of pollutants, physiological factors such as elevation of vagal function and immune function, psychological factors involving positive emotions and attention restoration, and behavioural factors including positive health behaviours such as the promotion of physical activity and social ties. Interestingly, this paper suggested that enhanced immune functioning might reflect a central pathway for mediating the beneficial effects of nature on health. It is apparent however, that vagal function plays a regulatory role over immune function via the cholinergic anti-inflammatory response (Pavlov, Wang, Czura, Friedman, & Tracey, 2003).  Other research has shown that vagal function may be facilitated by spending time in nature. For instance, a recent review of the literature (Kondo, Jacoby, & South, 2018) on the impacts of spending time outdoors on stress reported that of 17 studies reporting on measures of HRV, 14 reported significant findings. Measures of the high frequency (HF) component - a commonly reported measure of vagal function - increased for participants spending time outdoors. It is relevant to note here that measures of HF HRV are generally negatively correlated with meaures of heart rate. That is, high levels of vagal function - as is typically indexed by high HF HRV - are associated with a low heart rate. Interested readers are referred to recently published reference values for short-term resting-state HRV (Dantas et al., 2018). Thus, it is against this background of findings that we suggest that vagal function both affects and are affected by the effects of psychological experience, health behaviours, social ties, as well as the environment.

In conclusion, our updated GENIAL model (fig ???) summarises individual, community and environmental contributors to human health and wellbeing. Our model also characterises the major targets for potentially improving wellbeing in the community including, potentially, those people living with chronic conditions and disorders. Clinical targets include psychological experience, health behaviour, social connections and outdoor nature-based activities to which the tools from positive psychology and behaviour change may be applied.



GENIAL 2.0: Illustrates pathways to premature mortality versus longevity within the context of community and environmental contributors to health and wellbeing. Our original paper (Kemp, Arias, & Fisher, 2017) provides a detailed review on which our life-course model was based.

# Implications for Chronic Conditions and Non-Communicable Disease

Chronic conditions include diabetes, obesity, cardiovascular disease, cancer, chronic respiratory diseases, some neurological conditions and mental health conditions. Chronic conditions are also referred to as non-communicable disease (NCDs) . The global burden of disease attributable to NCDs has now outstripped the burden of communicable conditions (Fig ), a phenomenon known as the ‘epidemiological transition’. The worldwide increasing burden of chronic conditions (Fig 1), treatment gaps and treatment lag (Wang, Berglund, Olfson, & Kessler, 2004; PATEL et al., 2010) are major obstacles to be overcome. The treatment gap refers to the numbers of people who need treatment that are not receiving it. As an example, the treatment gap for mental health disorders has been estimated to exceed 50% in all countries of the world, and to reach 90% in those with less resources (PATEL et al., 2010). The amount of time taken to receive mental health treatment when it does exist—treatment lag— has been estimated to be longer than a decade (Wang, Berglund, Olfson, & Kessler, 2004).

As a function of this epidemiological transition, healthcare systems are struggling to meet increasing demand . In the United Kingdom (UK), it is estimated that approximately 30% of the UK population have one or more chronic conditions and that this 30% accounts for 70% of the spend (Department of Health, 2012). People living with chronic conditions are the biggest users of the National Health Service (NHS). They are more likely to see their general practitioner (accounting for approximately 50% of consultations), to be admitted as inpatients and to use more inpatient days than those without such conditions (70% of all inpatient bed days), and account for 64% more outpatient appointments (Department of Health, 2012).  Our theoretical models of health and wellbeing allow several inferences to be drawn regarding health care for people with chronic conditions.

*Models of health care:* Despite the epidemiological transition, healthcare models have not adapted to the changed landscape. The dominant model of health care, ‘the acute medical model’ was designed to treat acute conditions. Inherent in the medical model are several assumptions that are ‘not a good fit’ when applied to people with chronic conditions. For example, the acute model is underpinned by the assumption that a person’s ‘acute problem’ can be fixed and that they can be returned to a ‘pre-injury state’. However, chronic conditions cannot be fixed and whereas impairment may be reduced to some extent, a healthcare approach that attempts only to reduce symptoms misses opportunities to promote wellbeing. The absence of illness or impairment does not equate to wellbeing, and interventions which focus only on reducing impairment are insufficient to tackle the challenge of chronic conditions. With reference to our framework we argue that by building positive psychological experiences (e.g. individual strengths, optimism and resilience) within a supportive social network and environment, pathways to self-sustaining cycles of positive health and wellbeing may be triggered and maintained, supporting and facilitating wellbeing despite the limitations imposed by the condition. Accordingly, the management of people with chronic conditions requires a holistic approach both within the health service and beyond – an approach that extends beyond a) medicine which by definition is the science and practice of establishing diagnosis, treatment and prevention of disease; and b) the health service given major determinants of health are influenced by the communities and the environment we live in. Another assumption of the medical model is that patients are ‘passive recipient of care’. However, treatment outcomes for people with chronic conditions are contingent on active collaboration between clinician and patient. For example, adherence to treatment regimens, and adoption of recommended lifestyle changes etc. With respect to interventions to promote psychological experiences, interventions cannot be ‘done to the patient’ and successful outcomes depend on an active and collaborative approach.

*Organisational and institutional barriers within health services and beyond:* Epidemiological studies have shown that common mental health disorders and physical diseases are strongly inter-connected, highly co-morbid and share critical pathways to ill health and disease (Druss, Walker, 2011 ), . This evidence has been captured by the tagline: ‘there is no health without mental health’ . As an example, the senior author on the current review (AHK) investigated the relationship between the mood and anxiety disorders and coronary heart disease (CHD) in Brazil , observing that these common mental disorders are associated with a threefold increase in CHD, after full adjustment for potentially confounding factors. Common mood disorders share an underlying diathesis whereby mechanisms that predispose individuals to depression and anxiety for example, contribute to the development of a range of chronic physical health conditions across the life span, and vice versa. While the mechanisms for such a relationship are complex, our work on this topic      - including our GENIAL model  - have emphasised a role for vagal function as a mediating link between mental and physical health     . A greater appreciation - and understanding - of the relationships between mental and physical illnesses and their underlying mechanisms are needed so that improved interventions and treatments may be developed which bridge the gap between physical and mental health services. Accordingly, this tight interconnection between physical  and mental health needs to be reflected in the models, infrastructure and commissioning of health services that support people with chronic conditions.  For example, relative to physical health conditions, mental disorders are much less likely to receive treatment and this holds true across the world (Book Authors, 2009). However, if one considers the global burden of chronic conditions in terms of disability rather than mortality, major depression is the second leading cause of disability (O’Neil et al., 2015) preceded only by cardiovascular disease. Moreover, there is a high degree of co-morbidity with mental and physical health conditions and we know that mental ill health affects adherence to treatments and prognosis (DiMatteo, Giordani, Lepper, & Croghan, 2002). Accordingly, the commissioning bias in favour of physical health services actually disadvantages the majority of people with chronic conditions given the tight linkage between physical and mental health and serves to exacerbate the challenges for the prevention and amelioration of chronic conditions.

There are also biases in the types of interventions offered by mental and physical health services (with the exception of pharmacological treatment). People with physical health difficulties are typically prescribed physical health treatments. For example, people with cardiovascular disease (CVD) are typically advised to partake in healthier diets and physical activity. However, we know that there is a strong reciprocal relationship between CVD and depression (Gasse, Laursen, & Baune, 2012; Kemp et al., 2015). This bias misses several opportunities to enhance health and wellbeing for people with CVD. For example, positive psychological experiences have been associated with decreased risk of secondary cardiovascular events and mortality (Boehm & Kubzansky, 2012); (DuBois et al., 2015). It has been argued that psychological wellbeing is a modifiable protective factor that could decrease the impact of CVD through its potential influences on health behaviours and CVD-related biomarkers (DuBois et al., 2012); (Sin, Moskowitz, & Whooley, 2015). Conversely, mental health services typically focus on offering psychological therapies in addition to medication whereas much research has shown that people with mental health conditions have poor diets (Storlien et al., 1996), disturbed sleep [(Lee 2012,](https://www.authorea.com/users/9886/articles/378536-rethinking-wellbeing-an-examination-of-individual-community-and-environmental-contributions-to-personal-wellbeing-with-application-to-chronic-conditions#Lee2012) [Ancoli-Israel 2006)](https://www.authorea.com/users/9886/articles/378536-rethinking-wellbeing-an-examination-of-individual-community-and-environmental-contributions-to-personal-wellbeing-with-application-to-chronic-conditions#Ancoli__minus__Israel2006), lower levels of physical activity (Goodwin, 2003) and social isolation (Domènech-Abella, Mundó, Haro, & Rubio-Valera, 2019). Moreover, interventions that target these health behaviours significantly ameliorate symptoms ,  (Stathopoulou, Powers, Berry, Smits, & Otto, 2006), [(Opie et al., 2015;](https://www.authorea.com/users/9886/articles/378536-rethinking-wellbeing-an-examination-of-individual-community-and-environmental-contributions-to-personal-wellbeing-with-application-to-chronic-conditions#Opie2015) [Parletta et al., 2019)](https://www.authorea.com/users/9886/articles/378536-rethinking-wellbeing-an-examination-of-individual-community-and-environmental-contributions-to-personal-wellbeing-with-application-to-chronic-conditions#Parletta2019).  Given that undesirable health behaviours contribute to the aetiology and amelioration of chronic conditions; a plethora of guidelines and recommendations regarding optimal diet, physical activity etc. have been developed (for a summary, see Table 2). Often treatment approaches for people with chronic conditions includes educating them about healthier life choices. Despite such education, the majority of individuals fall short of pursuing a healthier lifestyle (Newsom et al., 2011).

Evidence shows that such strategies have minimal impact upon inducing sustained change, especially in individuals of a lower socio-economic status (Angermayr, Melchart, & Linde, 2010).  That is, ‘common knowledge is not common action’. There is an inherent disconnect between what people know and what they do - often referred to as the intention-behaviour gap ([Sheeran, 2002](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5682236/#R84)). It is this intention-behaviour gap that creates a barrier to the uptake of evidence surrounding well-being activities into healthcare practice (Francis, O’Connor, & Curran, 2012). This is because successful change requires more than education or communication of personalised risk information (French, Cameron, Benton, Deaton, & Harvie, 2017). Accordingly, in order to better understand how to effectively target health behaviours we must move beyond giving information and attempt to better understand how to facilitate behavioural change. Moreover, our GENIAL framework demonstrates that social relationships offer a target for intervention that is typically not exploited by the health service despite research showing that a) people with chronic conditions are often socially isolated and, b) a lack of social ties predicts premature mortality to a greater degree than physical activity, smoking (15 cigarettes daily) and body mass index (Holt-Lunstad, Smith, & Layton, 2010).  Accordingly, interventions which seek to foster positive social ties may have much to contribute to tackling the challenge of chronic conditions. This may be achieved by creating networks based on collaborations between the health service and community organisations, with both parties having a theoretical and applied understanding of how to create environments that promote social connectivity and wellbeing - we describe an example of this from our own clinical practice below.

The original GENIAL framework highlights individual pathways to illness and premature death and health, wellbeing and longevity. When negative, health behaviours, psychological experiences and social ties (social relationships, integration and cohesion) contribute to the aetiology of chronic conditions and exacerbate the condition when present. Accordingly, we have argued that they should be targeted in the prevention and amelioration of chronic conditions. Given that the health service is typically organised by ‘disease specific’ services as discussed above, and given that health behaviours, psychological experiences and social ties offer a common target for intervention across a range of diseases, we advocate for a transdiagnostic approach to management. That is, creating a balance between the need for disease specific ‘specialisms’, but also for transdiagnostic approaches that treat some of the common diathesis that many people with chronic conditions share (undesirable health behaviours, negative psychological experiences, social isolation and exclusion). This approach would mean that people with chronic conditions would be able to access interventions based on need and efficacy not diagnosis. Transdiagnostic services would hold expertise in; a) interventions for optimal sleep, nutrition and  adapted physical activity interventions couple with an understanding of promoting behavioural change; b) links with the community to facilitate community integration and positive relationships with others; c) psychological interventions to both reduce impairment, but also to improve wellbeing; d) links with academic institutions to promote urgently needed cross disciplinary research into effective management strategies. With a mind to the financial difficulties facing the health service, the addition of transdiagnostic services would negate the need to resource and skill-up all diagnostic specific services to deliver interventions targeting heath behaviours, psychological experiences and social connectivity. Moreover, in relation to bridging the gap between the health service and the community, this would be difficult for diagnostic services to do in reality.

Finally, our extended GENIAL 2.0 framework makes it clear that in order to promote the health and wellbeing of entire populations, the healthcare cannot and should not shoulder the burden alone. We present a range of compelling evidence that the health and wellbeing of individuals are not just determined by individual factors alone, and that community and environmental determinants of health must also be targeted to reduce the burden imposed by chronic conditions. This requires a shared understanding of the problems and solutions and joined up working between the healthcare services, community organisations and academia. Our own work in the National Health Service has focused on re-developing our services for people living with acquired brain injury.  In addition to traditional impairment focused services, we are developing interventions to improve wellbeing, social relationships, community integration and social identity in addition to some interventions that involve environmental sustainability. We are doing so in collaboration with academic institutions as well as community, third sector and industry organisations. This service development, based on our GENIAL framework, has application across chronic conditions. We discuss our work further in the following section and draw some conclusions.

# Discussion

Here we have presented a modern understanding of wellbeing; one that involves ‘connection’… connection to ourselves, to others and to the environment. We suggest that vagal function provides an important mediator of wellbeing that affects and is affected by activities to promote wellbeing across these multiple domains. The vagus nerve connects us to ourselves (i.e. 80% of vagal nerve fibres are afferent nerves (Agostoni, Chinnock, Daly, & Murray, 1957) providing a structural link between mental and physical health), to others (increases in vagal function facilitate a ‘calm and connect’ response promoting social connectedness, (Porges, 2011; Kemp, Arias, & Fisher, 2017; Kok et al., 2013)), and to nature (vagal function is impacted on by a host of environmental factors, as discussed in section ???, that will subsequently promote individual health and wellbeing). Vagal function may be considered as an index of resilience, underpinned by psychological flexibility (Kashdan & Rottenberg, 2010) that can be enhanced through a variety of interventions within individual, community and environmental domains, providing a target for focused interventions. We suggest that benefits to vagal function could be maximised by drawing upon multiple interventions that span these multiple domains of wellbeing. While we have been greatly influenced by the maturing discipline of positive psychology, we argue that the field has been limited by a restricted focus on strategies that promote positive psychological moments and experience. As recent research has argued that the impacts of positive psychological interventions are smaller in size than previously reported (White, Uttl, & Holder, 2019), we argue that their impact could be improved by integrating interventions that also focus on physical health, which we now know to have important impacts on mental - in addition to physical - health (Chekroud et al., 2018). Integrating interventions within community and environmental domains will likely improve the impact of interventions further. It is also important to note that wellbeing can be influenced through sociostructural factors such as governmental policy, a consideration highlighted in our original GENIAL model (Kemp, Arias, & Fisher, 2017) (see section ???). Our updated GENIAL model (section ???) further extends beyond the individual and community, to incorporate the broader impacts of the environment. Mindful of previously proposed social ecological theories such as Glenn Albrecht’s work on ‘Earth Emotions’ (Albrecht, 2019), which emphasise the connectedness between human emotions and the state of our natural environment, we emphasise that the individual is intimately connected to the community and environment within which they live, in a ‘symbioment’. In this regard it is interesting to observe calls (Bratman et al., 2019) for the modification of the natural environment in ways that will promote the mental health of communities, with research even demonstrating relationships between urban tree density and numbers of antidepressant medications prescribed (Taylor, Wheeler, White, Economou, & Osborne, 2015). Researchers have also argued that sociostructural changes aimed at improving the natural environment will further contribute to improvements in wellbeing through the reduction of inequalities (Bratman et al., 2019). As noted earlier, income and welath inequalities have substantial impacts on societal wellbeing, and this topic is now the subject of major international and interdisciplinary reviews on the subject (e.g. the 5-year Deaton Review: [https://www.ifs.org.uk](https://www.ifs.org.uk/) funded by the Nuffield Foundation).

Over the last few years, we have developed a novel 8-week positive psychotherapy intervention (see table ??? for a summary of individual components) built on our innovative GENIAL framework, incorporating interventions that focus on the individual, community and environmental domains. Presently, we are working with university undergraduate students and people living with acquired brain injury, although we are seeking to broaden our focus to patients with a variety of chronic conditions including for example, diabetes, obesity, cardiovascular disease, common mental disorders and their comorbidity. Interventions focusing on the individual include activities from positive psychology (section ???) as well as education relating to positive health behaviours (section ???). Interventions involving the community domain focus on building positive relationships with others in line with social identity theory (Haslam, 2018), supported by partnership working with community organisations, such as “Surfability” (<https://surfabilityukcic.org/>) and “Bikeability” (<https://bikeability.org.uk/>), which serve to encourage community integration (section ???). Finally, interventions focusing on the environment include activities such as mindful photography, as well as partnership working with the community organisation, ‘Down to Earth’ (<https://www.downtoearthproject.org.uk/>). This organisation promotes wellbeing in disadvantaged populations through engagement with the environment, especially in regards to environmental sustainability and social ecology. For instance, our patients with acquired brain injury were recently involved in the construction of a ‘community building’ using sustainable and locally sourced raw materials on the Gower Peninsula, the first place in Britain to be named an Area of Outstanding Natural Beauty. These are just some selected examples to illustrate the potential to promote wellbeing in each of the domains, and we are always seeking to engage with other academic groups, health boards and community organisations to improve health and wellbeing in the community, based on strong theoretical foundations.

Overview of our 8-week positive psychotherapy intervention. Astute readers will note that our intervention has been built around Martin Seligman’s PERMA model (Seligman, 2011; Seligman, 2018) and positive psychotherapy (Rashid & Seligman, 2018), which combines models of ‘hedonic’ and ‘eudaimonic’ wellbeing, supplemented by a focus on positive health behaviours, behavior change and connections to the natural environment.

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| --- | --- | --- |
| Week | Focus | Comment |
| 1 | Character strengths | Identifying one’s character strengths is the foundation to ’building on what is strong, rather than fixing what is wrong’. Ryan Niemiec’s work in this regard provides a solid foundation in this regard. |
| 2 | Emotions | Positive emotions are fundamental to theories of hedonic wellbeing. While Barbara Fredrickson’s ’Broaden and Build Model’ is the major focus of this section - as is Martin Seligman’s ’learned optimism’ and Ed Diener’s tripartite model - we also emphasise the utility negative emotions, as described by Todd Kashdan & Robert Biswas-Diener in their ’Upside of Your Darkside’. |
| 3 | Engagement and ’Flow’ | A core feature of positive psychology is to promote task engagement by facilitating ’psychological flow’ as coined by Mihály Csíkszentmihályi. Flow is facilitated through activities that involve both a high level of skill and challenge. |
| 4 | Positive health behaviours | Recent research highlights that positive psychological interventions may be associated with smaller effect sizes than prior studies suggested. We emphasise here the importance of building positive health behaviours to facilitate vagal function that will have positive impacts on psychological experience. We further draw upon behaviour change theory to reinforce sustain positive change. |
| 5 | Positive social relationships | Our original GENIAL model emphasised the need to move beyond a focus on the individual given recent findings highlighting the impacts of social ties on health and wellbeing. We emphasise here the need to focus on positive social relationships to facilitate individual wellbeing in line with Alex Haslam’s ’social identity theory’. |
| 6 | Reconnecting with nature | A more moral and ethical science of wellbeing is needed that tackles criticisms of positive psychology relating to western neoliberalism and rampant individualism. We emphasise a need for reconnecting with nature and in doing so, suggest that a modern science of wellbeing could be applied to tackle major societal challenges including the climate crisis. |
| 7 | Meaning and purpose | Meaning and purpose in life are major component to eudaimonic wellbeing. The work by Viktor Frankl and Paul Wong are particularly influential in this regard. We argue that meaning and purpose in life might be enhanced and facilitated through a combination of interventions that focus on the individual, community and environment. |
| 8 | Achievement | Achievement orientation is also considered to be a fundamental component to the promotion of wellbeing. Influencers include Angela Duckworth and Carol Dweck. |

In conclusion, we have presented a novel approach to understanding and improving wellbeing, connecting psychological science with a social ecological approach that considers the individual in the context of community and the wider environment (Fig ???). Our GENIAL framework bridges the gap between psychological science and [population health health systems](https://www.kingsfund.org.uk/sites/default/files/field/field_publication_file/population-health-systems-kingsfund-feb15.pdf), and provides a solid foundation for future research on the wellbeing of the individual as well as the communities and environments within which individuals live. In doing so, we hope that this framework and updated theoretical review helps to move the science of wellbeing forward to a more ethical and moral science that considers the wellbeing of current as well as future generations, providing an evidence base for groundbreaking national polices such as the [‘Well-being of Future Generations (Wales) Act’ (2015)](https://futuregenerations.wales/about-us/future-generations-act/), and alerting researchers to consider the implications and context of human wellbeing in relation to major societal challenges such as the climate crisis. Wellbeing researchers ignore this context at their peril, and it is time that funding bodies take a more supportive stance of the transdisciplinary science that is urgently needed to achieve this goal, let alone, better understand relationships and inter-dependencies between individual, community and environmental wellbeing. We look forward to a future - well-funded - scientific effort that embraces the science of behavioural change to improve the wellbeing of not just the individual, but also of communities,and the wider environment, bearing in mind the potential positive impacts that improved community and environmental wellbeing will also have at the individual level.

# Acknowledgements

We would like to acknowledge the support of Swansea University and the National Health Service in recognising and promoting our work through various awards including the University Research and Innovation Award for Outstanding Impact on Health and wellbeing (2018) and the Swansea Bay University Health Board Chairman’s VIP Award for Commitment to Research and Learning (2018). We also acknowledge the partial funding that we have received from our partner, Fieldbay, which has been used to co-fund a PhD studentship that was awarded to the first author of this manuscript (JM). Finally, we would like to express our heartfelt thanks for the support of our service users, with whom we have built and implemented our novel and innovative positive psychotherapy intervention that is based on the GENIAL theoretical framework. This intervention is now being supported by grant funding from Health and Care Research Wales through the Research for Public Patient Benefit Scheme.

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