

Cardiovascular Disease in the Post-COVID-19 Era: A Narrative Review on the Impact of Lifestyle Behaviors

Mark A. Faghy¹, Jack Carr², David R. Broom², Rebecca Owen¹, Ruth E. Ashton²

¹School of Sport and Exercise Sciences, Biomedical and Clinical Exercise Science Research Theme, University of Derby, Derby, ²Research Centre for Physical Activity, Sport and Exercise Sciences, Coventry University, Coventry, UK

Abstract

Responsible for ~18 million global deaths annually, cardiovascular disease (CVD) is a prominent cause of morbidity and mortality that negatively affects population health and well-being. Despite increased knowledge and advancements in medicine, technology, and an array of global initiatives to slow the prevalence of CVD across the world in recent decades, future projections for prevalence and the wider societal and economic impacts are alarming. It is outlined in this review that little progress is being made against a series of landmark initiatives and that, in a postpandemic world, we might need to consider innovative approaches to tackle the unprecedented growth and projections in CVD prevalence. To address the sustained reductions in positive health behaviors which is coupled with an established rise in cardiovascular risk factors and events following infections with severe acute respiratory syndrome coronavirus 2, there is an urgent public health challenge that lies ahead. Accordingly, we must establish bespoke systems that can recognize and address the complexity and interactive and interdisciplinary nature of chronic diseases. Future approaches must heed learning from the many previous unsuccessful approaches that have not been appropriately monitored or evaluated. Establishing or aligning international and collaborative approaches that have a clear mandate to oversee the development and implementation of analysis of global surveillance and interventions is needed to address the spiraling growth in CVD prevalence, healthcare costs, morbidity, and mortality.

Keywords: Cardiovascular disease, COVID-19, lifestyle factors, policy, public health, risk factors

INTRODUCTION

Cardiovascular disease (CVD) is a prominent cause of morbidity and mortality that negatively affects population health and well-being. The World Health Organization (WHO) estimates that in 2019, there were almost 18 million global deaths due to CVD.^[1] Specifically in Europe, CVD remains the most common cause of death in the region, accounting for approximately 42.5% of all deaths annually.^[2] Furthermore, mortality from CVD in those aged <70 years is a particular concern, with an estimated 60 million potential years of life lost in Europe annually.^[2] While the mortality incidence from CVD is higher in women than men, when data are standardized to account for age, both morbidity and mortality are significantly higher in men, especially in those aged <70 years.^[3] The current state of global health in the context of CVD is poor, with projections derived from logistic regression models highlighting sustained increases in CVD prevalence between

2025 and 2060.^[4] This will undoubtedly impact population health and health services globally. Compounding this is the current and long-standing impacts of the severe acute respiratory syndrome coronavirus 2 – COVID-19 pandemic. Current data suggest that the pandemic has not impacted CVD prevalence due to suggested increases in the attention being paid to established risk factors;^[5] however, access to medical care, screening, and referrals during the pandemic was reduced as health services were widely curtailed to address the urgent care needs of the pandemic. Therefore, urgent approaches are needed to identify and treat individuals who remain undiagnosed to prevent future excess CVD events as an indirect impact of the COVID-19 pandemic.^[6]

Address for correspondence: Prof. Mark A. Faghy, Biomedical and Clinical Exercise Science Research Theme, University of Derby, Derby, UK.
E-mail: m.faghy@derby.ac.uk

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Despite increased knowledge and advancements in medicine, technology, and an array of global initiatives to slow the prevalence of CVD across the world in recent decades, future projections for prevalence and the wider societal and economic impacts are alarming. In response, there is a need to adopt proactive approaches that are underpinned with interdisciplinary thinking to influence human behavior and address the rising prevalence and associated burden to healthcare services. The prevalence of CVD is exacerbated by long-standing health inequalities in all measures of morbidity and mortality that occur irrespective of geographical location as disadvantaged groups bear the brunt of disease and suffering caused by inequalities in health.^[7] Material deprivation and poorer health outcomes are observed in surveillance reports, but a complete understanding of the nature of health inequality is needed. To be effective here, an appreciation of social gradients in different parts of the world and societal groups is required.^[8,9]

A series of global initiatives which includes the United Nations Sustainable Development Goals established a blueprint of 17 goals that were created with an aim to achieve peace and prosperity for people and the planet by 2030.^[10] These goals serve as a pledge to be relevant to all economies, promote prosperity, protect the environment, tackle climate change, and most importantly, improve equity to meet the needs of women, children, and disadvantaged populations so that “no one is left behind.” Such initiatives are commendable but remain challenged by the persistence and enormity of entrenched health inequalities globally and the incidental but important injustices they create. In a recent report, the European Parliament^[11] sets out a series of policy guidelines that need to be implemented to ensure delivery of the Sustainable Development Goals but also identifies that to achieve the intended plan, strategies, supporting policies, and governmental structures must be intensified and that some goals are likely to be achieved after 2030. The authors call for organizations such as the European Union to lead the global community in the aftermath of the COVID-19 pandemic in search of renewed momentum. Health inequalities have been aggravated by the COVID-19 pandemic, intensifying the divide between those considered “health poor” and the “health rich” which is further exacerbated by access to health services, implementation of interventional and proactive policies, and a clear disparity in data surveillance systems.^[12] When referring back to previously cited data, it is indicated that in white individuals, the prevalence of CVD is projected to decrease, compared with significant projected increases in racial and ethnic minority groups.^[4] This suggests that previous and current interventions and approaches are ineffective in addressing the continual widening of health inequalities. Increased funding, resources, and prioritization within the global health picture are urgently needed to offset continual growth and realization of current projections which would have stark impacts on population health. While the global impact of COVID-19 is unquestionable, other similar initiatives that have attempted to address health equalities have

also been unsuccessful, and much work is required to address and reduce international health equity gaps.

The American Society for Preventive Cardiology (ASPC) produces an annual summary document to highlight the most important CVD risk factors [Figure 1]. Currently, these include (1) unhealthful nutrition, (2) physical inactivity, (3) dyslipidemia, (4) hyperglycemia, (5) high blood pressure, (6) obesity, (7) considerations of select populations (older age, race/ethnicity, and sex differences), (8) thrombosis/smoking, (9) kidney dysfunction, and (10) genetics/familial hypercholesterolemia.^[13] While some of the risk factors sit outside of this article, it is important to note that the ASPC recognizes that there are other important risk factors at play relating to lifestyle behaviors that are not contained within the “Top 10” that remain pertinent to preventive cardiology. In this review, we will specifically consider the most modifiable lifestyle factors and provide an overview of global initiatives that have been implemented to reduce the prevalence and impact of CVD.

MODIFIABLE LIFESTYLE BEHAVIORS

While the cause–effect relationship between lifestyle behaviors and chronic disease is not a certainty, the role and importance of lifestyle behaviors is an important risk factor for CVD, thus emphasizing the importance of practicing positive lifestyle behaviors.^[14,15] On all fronts, prevention is considered an optimal approach to address the surge in CVD prevalence and continual decline in population health,^[16] but the potential for positive change in systemic function and the associated protective benefits occurs regardless of previous lifestyle habits.^[17]

Physical activity

Physical activity (PA) is well regarded for its positive impact on physical function and mental health.^[18,19] However, despite the well-documented benefits, the WHO highlights that 31% of individuals globally who are >15 years old are physically inactive and this prominent unhealthy lifestyle behavior can be attributed to approximately 3.2 million deaths per year.^[20] Furthermore, Ding *et al.* demonstrate that physical inactivity had an annual cost of 53.8 billion dollars to healthcare systems around the world and that attributable deaths from physical inactivity were responsible for associated with 13.7 billion dollars in productivity losses and resulted in 13.4 million disability-adjusted life years.^[21] The socio-ecological model of PA is well recognized and references a mixture of factors that influence the adequacy of PA participation.^[22] These factors include intrapersonal, interpersonal, organizational, environmental, and policy factors, and the cumulative impact upon resultant behaviors is dependent on social hierarchy.^[22] Despite leading organizations recognizing efforts to increase PA, the trend of inactivity continues to demonstrate a far from positive picture and Guthold *et al.* report that levels of physical inactivity remained consistent between 2001 and 2016. Findings from this study which completed regression

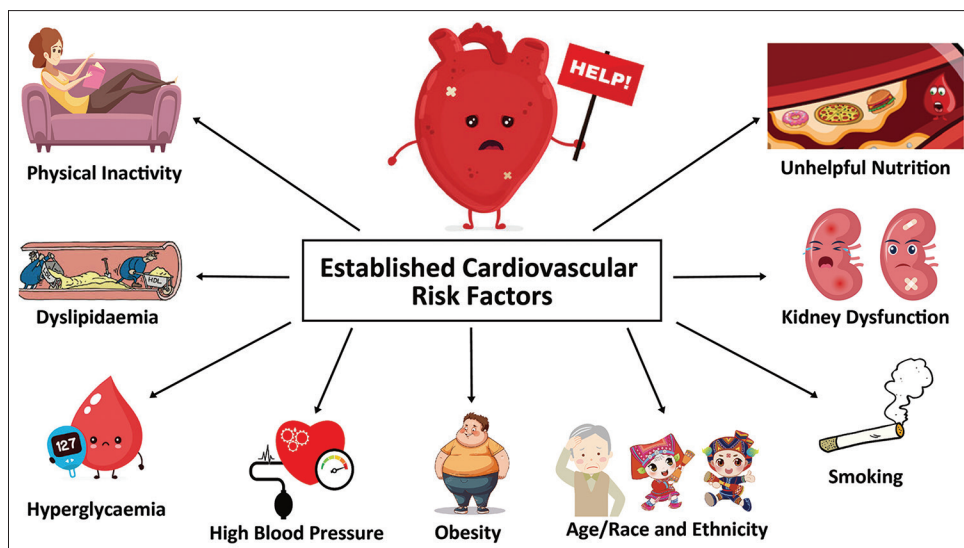


Figure 1: Most important cardiovascular disease risk factors as described by the American Society for Preventive Cardiology

models from 168 countries (~1.9 million participants) observed that the global age-standardized prevalence of insufficient PA was 27.5% (95% uncertainty interval: 25–32.2) in 2016, with a mean difference between males and females of more than 8% (males 23.4% and 31.7% in females).^[23] Importantly, this study provides clear evidence that the WHO goal of reducing global physical inactivity by 10% in 2025 will not be met.^[23] A recent study by Katzmarzyk *et al.*^[24] provides data on a similar initiative by the World Health Assembly which aimed to reduce physical inactivity by 15% in 2030. The authors highlight that this is unlikely to be achieved as the data demonstrates reported stagnation across all domains. Failure to achieve this high profile and global objective could have been impacted by the COVID-19 pandemic. During this time, an urgent shift in attention, resources, and funding toward dealing with a global health emergency was needed, however, it is plausible that the failure here stems from long-standing and deep-rooted behavioral profiles that show a global reduction in physical activities coupled with an increase in sedentary behavior. The data are also convincing to indicate that physical inactivity and the associated health and economic impacts were apparent before the pandemic and will persist long after the COVID-19 pandemic.

The concept of the COVID-19 pandemic in the context of PA and human movement more generally does create an interesting conversation about human attitudes and behaviors. The COVID-19 pandemic was a historic moment for public health that society was ill-prepared for^[25], and future pandemics pose a real threat to public health. It is well-documented that lifestyle factors such as PA, alcohol consumption, obesity, and smoking were affected by the COVID-19 pandemic, some of which were positive and others negative. Most behaviors appear to have been restored to prepandemic levels, but one factor that has seemingly remained in place is the change to employment routines, namely the increased rise in remote working, which is characterized by increased sedentary/

sitting time and poor posture.^[26,27] Despite a large shift to restore prepandemic societal and economic activities, remote working in most sectors has been retained due to evidence relating to improved work–life balance, productivity, and job satisfaction.^[28] However, remote working is a multi-faceted area of conversation due to a multitude of considerations with respect to people, productivity, and the environment,^[26] and there is evidence that physical inactivity, eating habits, and socialization are negatively impacted, which has broad implications for the global health picture.^[29] Therefore, this shift in behaviors, which was arguably unaccounted for in 2019, poses a new challenge to those seeking to increase PA profiles.

Body mass

Maintaining a healthy body mass is crucial for reducing the risk of CVD. Obesity, defined as a body mass index (BMI) of 30 kg/m² or higher, significantly increases the risk of developing CVD, including hypertension, coronary artery disease, and heart failure.^[30] Excess visceral fat also contributes to a range of metabolic dysfunctions such as insulin resistance, inflammation, dyslipidemia, and increased blood pressure, all of which are established risk factors for CVD.^[31,32] Additionally, individuals with a high BMI are at an increased risk of COVID-19 disease severity and have a moderate-to-high risk of medical complications following an initial COVID-19 infection.^[33–35] Globally, the prevalence of excessive weight gain has doubled since 1980, with one-third of the population considered to be living with overweight or obesity.^[36] The Health Survey for England^[37] reports that 25.9% of adults are classified as living with obesity, with an additional 37.9% classified as living with overweight but not obesity. The proportion of adults living with obesity has risen from 14.9% in 1993 to 28.0% in 2022.^[38]

The impact of body mass on cardiovascular health is profound. A BMI above 23 kg/m² has been demonstrated as a risk factor

for adverse outcomes, and overweight and obese individuals without prior comorbidities are also at a substantially increased risk of hospital admission and death due to COVID-19, especially for younger adults and Black people.^[34] Furthermore, there is evidence that the pandemic is responsible for increased BMI in adults^[39] and children;^[40] however, current evidence is gleaned from small-scale studies, and further population-level analysis is required to identify global trends and determine any resulting long-term health impacts from the COVID-19 pandemic. Obesity can lead to changes in the structure and function of the heart, such as left ventricular hypertrophy, which increases the risk of heart failure.^[41] Additionally, excess weight can lead to atherosclerosis which can obstruct blood flow and increase the risk of heart attacks and strokes.^[42] Research indicates that each unit increase in BMI is associated with a 4% increase in the risk of coronary heart disease.^[43] Weight management strategies are essential in mitigating these risks. Regular PA and a balanced diet are the cornerstones of effective weight management with PA contributing to increased energy expenditure, therefore improving heart health, and enhancing overall fitness.^[44] The American College of Sports Medicine recommends at least 150 min of moderate-intensity aerobic PA per week for adults to maintain a healthy weight and reduce the risk of CVD.^[45] A meta-analysis by Kyu *et al.*^[46] demonstrated that regular PA significantly reduces the risk of CVD by improving lipid profiles and reducing blood pressure.

To address the growing global prevalence of obesity and its associated cardiovascular risks, comprehensive and long-term strategies are essential. Excess weight is a modifiable risk factor and investment in the treatment of overweight and obesity alongside long-term preventive and educational strategies could help reduce the severity of both COVID-19 and CVD.^[34] Behavioral interventions have shown effectiveness in supporting weight loss and maintenance by helping individuals develop healthier eating habits, increase PA, and address emotional eating patterns.^[47] However, individual efforts must be supported by broader systemic changes. Community-based programs have been effective in promoting positive lifestyle changes. Recent examples include the “Healthy Together” program in Australia, which integrates school, community, and family-based interventions to promote healthy eating and PA among children and their families.^[48] Another notable initiative is the “Better Health, Better Families” campaign in the UK, providing practical tips and tools to help individuals incorporate PA into their daily lives.^[49] These community-based programs underscore the need for comprehensive approaches that go beyond individual behavior change. They highlight the importance of creating supportive environments and implementing policies that facilitate healthy living. By fostering collaboration among governments, healthcare providers, and communities, these initiatives aim to create sustainable changes that reduce the prevalence of obesity and its associated cardiovascular risks.

Nutrition

Appropriate nutrition is a key component in maintaining a healthy body mass and reducing the risk of CVD. Nutritional

practices that encourage the consumption of fruits, vegetables, whole grains, lean proteins, and healthy fats are associated with a lower risk of CVD.^[50] These nutrient-dense foods help regulate body mass by promoting satiety and reducing overall calorie intake. Conversely, diets high in saturated fats, sodium, and added sugars contribute to weight gain and the development of hypertension, dyslipidemia, and insulin resistance, exacerbating the risk of CVD.^[51] The Mediterranean diet in particular has been studied extensively and has been shown to significantly reduce CVD risk. The Prevención con Dieta Mediterránea (PREDIMED) trial found that consuming a Mediterranean diet was associated with a 30% lower risk of major cardiovascular events compared to those on a low-fat diet.^[52] This dietary pattern is rich in monounsaturated and polyunsaturated fats and fiber which collectively contribute to improved heart health.^[53] Additionally, it includes moderate consumption of red wine, which has been suggested to have cardiovascular benefits due to its antioxidant properties.^[52] Other diets such as the Dietary Approaches to Stop Hypertension (DASH) have also demonstrated significant cardiovascular benefits. The DASH diet, which emphasizes the consumption of fruits, vegetables, whole grains, and low-fat dairy products, has been shown to lower blood pressure and improve lipid profiles.^[54] A meta-analysis of randomized controlled trials reported that adherence to the DASH diet resulted in a substantial reduction in systolic and diastolic blood pressure, further highlighting its cardiovascular benefits.^[55]

Since the COVID-19 pandemic, there have been a plethora of reports that have demonstrated altered unhealthy eating and drinking habits across nations^[56-59] and across age groups.^[60-63] It is clear that social distancing had a negative impact on nutrition/food choices, but it remains unclear if these impacts have returned to the prepandemic baselines, a question to be answered by future research, and it is unclear what impact the choices would have had on CVD prevalence during the pandemic and in the endemic phase. To effectively combat the global rise in CVD, a more proactive and holistic approach is necessary, involving individual dietary changes and community- and policy-level interventions supporting healthy eating behaviors. Moreover, long-term strategies that focus on sustainable lifestyle changes are crucial. For example, the “Salt Reduction Initiative” by the WHO aims to reduce the global population’s salt intake by 30% by 2025.^[64] The initiative involves public health campaigns, the reformulation of processed foods, and the implementation of policies to limit salt content in foods. To achieve lasting impact, global efforts must continue to promote dietary patterns that support cardiovascular health. This includes integrating nutritional education into school curriculums, creating supportive environments for healthy eating in workplaces and communities, and ensuring access to affordable, nutritious food for all populations. By fostering environments that make healthy choices easier and more accessible, the global community can work toward reducing the prevalence of CVD and improving overall health outcomes.

Smoking

It is well established that smoking is linked to cardiovascular morbidity and mortality, with research consistently demonstrating the strong link between smoking and early-onset atherosclerosis, increased risk of acute myocardial infarction, stroke, peripheral artery disease, aortic aneurysm, and sudden death.^[65,66] Smoking is responsible for 10% of all CVDs, causing ~6 million deaths per year globally.^[67] In the context of COVID-19 outcomes, there is a 30%–50% excess risk of COVID-19 progression for current and former smokers, with a 16% higher risk of being hospitalized, a 44% higher risk of having a more severe form of the disease, and a 39% higher risk for COVID-19 mortality.^[68] Tobacco and COVID-19 impact multiple organs, significantly affecting the outcomes of various health conditions and disproportionately affecting individuals with comorbidities. The combined dangers of tobacco use, CVD, and COVID-19 present a particularly dangerous scenario.^[69]

The relationship between smoking consumption and COVID-19 is complex, and in some areas, nicotine consumption during the pandemic has been found to increase, which has been attributed to increased anxiety, stress, and isolation.^[70] However, global findings from a systematic review indicate that there was a decrease in tobacco use with most smokers reducing their consumption of both cigarettes and e-cigarettes from before the pandemic to during which may be attributed to an increased willingness to quit smoking due to concerns about the pandemic and its progression.^[70] Additionally, worldwide lockdowns and a decline in social activities likely reduced opportunities for social smoking and access to cigarettes; notably, regions with the strictest COVID-19 restrictions, such as the UK, China, Midwestern USA, Pakistan, and Spain, saw a significant decrease in smoking prevalence.^[70] While more advantaged groups quit tobacco, disadvantaged populations continued and/or increased smoking.^[69]

The pandemic has also indirectly affected tobacco use and cardiovascular health with excessive pressure on healthcare systems, social distancing, and lockdowns disrupting the management of CVD and tobacco cessation services.^[5] Access to health services during the COVID-19 pandemic has resulted in delayed diagnosis and treatment of acute and chronic noncommunicable diseases, and the return to prepandemic levels of CVD care activity has been stagnant.^[69] Moving forward, it is essential that noncommunicable disease prevention and tobacco control are central to pandemic preparedness and response strategies.

The popularity of electronic cigarette (e-cigarette) usage has grown among long-term tobacco cigarette smokers.^[71] E-cigarettes are promoted as less harmful alternatives to tobacco-containing cigarettes, due to their lower emissions and toxicants, and are encouraged as a replacement for tobacco cigarette smokers who are unable or unwilling to quit.^[71] In the absence of conclusive evidence on the long-term risks of CVD associated with e-cigarettes, there are concerns that the use and acceptance

of e-cigarettes may normalize smoking behavior, encourage continued use of e-cigarettes and traditional tobacco cigarettes, and initiate and sustain nicotine addiction.^[71] Furthermore, there has also been a substantial increase in e-cigarette usage in youth with no smoking history.^[71] Reported abnormalities in risk factors for sudden death, including heart rate variability and ventricular repolarization in e-cigarette users, are concerning, and the lack of conclusive long-term outcome studies is alarming due to unknown health risks, policy and regulation, public health messaging, youth and adolescent usage, second-hand exposure, comparative harm reduction and addiction, and dependence, particularly in the postpandemic world.

Time to think outside of the box

Even before the COVID-19 pandemic, the global health picture was bleak, but aspects have undoubtedly been exacerbated as a result of the pandemic. To address the growing and urgent challenge that lies ahead, we must broaden the knowledge base and consider the importance of whole systems thinking in the context of disease etiology and intervention mapping approaches.^[72] This includes widening the lens and considering the role and impact of physical, mental, and behavioral considerations which should be considered alongside the external political, societal, and economic environment which can augment CVD risk and more broadly population health. Accordingly, systems need to be established that are capable of recognizing and addressing the complexity of infectious and chronic diseases.^[73] Future approaches to address this global health need must heed learning from the many previous unsuccessful approaches, thus creating a need for an international body or organization to oversee the development, and implementation of analysis of global surveillance and interventions. It is imperative that these are underpinned by mutually beneficial and effective global collaborations as set out in Figure 2 which can be applied broadly to the global threat of chronic disease. This might sound like a panacea, but previous attempts have done little to curtail the continual increases in CVD prevalence and mortality. To stand any chance of making a positive impact in this area, drastic and radical changes are needed.

CONCLUSION

CVD is an urgent public health matter that results in high levels of morbidity and mortality and has a vast impact on population health and well-being. Current trends paint a bleak picture for the future of global public health and well-being, which are likely to be compounded by the COVID-19 pandemic in relation to reduced diagnosis and treatment during the pandemic and also because of widening health inequalities. Previous intervention efforts and associated targets have had very little impact and suffer from mono-disciplinary/unscalable and/or local approaches that are not able to address broader issues. Future interventions must, therefore, prioritize strategies to promote long-term approaches to adopting healthy living behaviors. These approaches must use innovative means that are

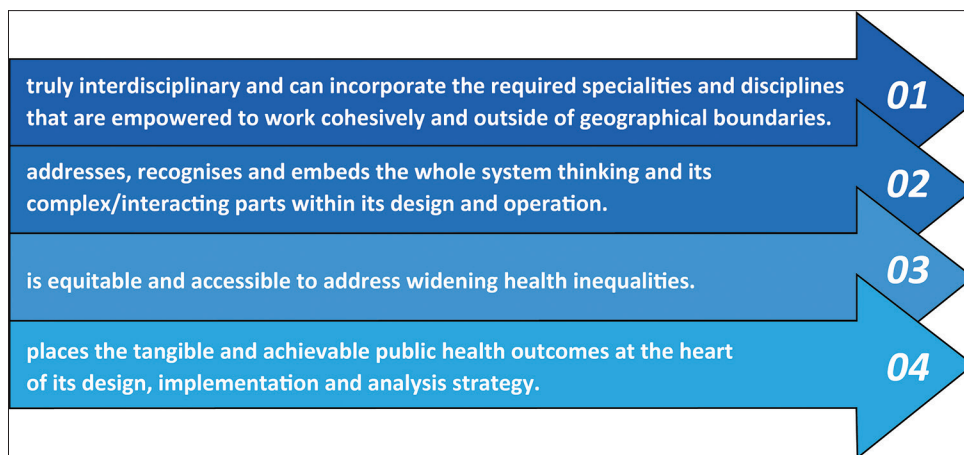


Figure 2: Recommendations for a truly collaborative approach to addressing the growing burden of cardiovascular disease

accessible and equitable and embrace the rapid development of utilization of various technologies in the design, development, and implementation of prevention and optimal management efforts to ensure broad efficacy and effectiveness that if implemented effectively can create a healthier world for all.

Author contributions

Mark A Faghy and Ruth E Ashton conceived the idea for the article and invited contributions from David R Broom, Rebecca Owen, and Jack Carr. All named authors contributed sections to the manuscript, and Mark A Faghy and Ruth E Ashton led the editing and finalizing of the manuscript. All named authors read and approved the manuscript prior to submission.

Ethical statement

An ethical statement is not applicable to this article.

Data availability statement

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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Conflicts of interest

There are no conflicts of interest.

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